

## CHAPTER 17

### HANDLING, CONTROLLABILITY AND PERFORMANCE

#### 17.1 General

The operational safety of the craft in normal service conditions and in equipment failure situations of a craft to which this Code applies shall be documented and verified by full-scale tests, supplemented by model tests where appropriate, of the prototype craft. The objective of tests is to determine information to be included in the craft operating manual in relation to:

- .1 operating limitations\*;
- .2 procedures for operation of the craft within the limitations;
- .3 actions to be taken in the event of prescribed failure; and
- .4 limitations to be observed for safe operation subsequent to prescribed failures.

Operational information shall be available on board for guidance, or the craft shall have an instrument system for on-line check of operational performance which shall be approved by the Administration taking into account the standards for the processing and presentation of measurements developed by the Organization. As a minimum, the system shall measure accelerations in three axes close to the craft longitudinal centre of gravity.

\* Refer to *MSC.1/Circ.1329 Guidelines for uniform operating limitations of high-speed craft*, developed by the Organization and caveat noted in Annex 2.

*Heavy weather sea trials (see Annex 9) should be used to establish the limit of the safe operational envelope of the craft in normal service conditions and in equipment failure situations.*

*The heavy weather sea trials are operational and involve more than just heavy weather.*

#### 17.2 Proof of compliance

17.2.1 The information on controllability and manoeuvrability which shall be contained in the craft operating manual\* shall include the characteristics under 17.5 as applicable, the list of parameters of the worst intended conditions affecting the controllability and manoeuvrability according to 17.6, information on safe maximum speeds as described in 17.9 and the performance data verified in accordance with annex 9.

\* *The contents of the craft operating manual is described in 18.2.1.*

17.2.2 The information on operating limitations which shall be contained in the route operational manual<sup>†</sup> shall include the characteristics under 17.2.1, 17.5.4.1 and 17.5.4.2.

<sup>†</sup> *The contents of the route operational manual is described in 18.2.2.*

### 17.3 Weight and centre of gravity

Compliance with each of the handling, controllability and performance requirements shall be established for all combinations of weight and centre of gravity position significant for the operational safety in the range of weights up to the maximum permissible weight.

*It should be noted that the handling, controllability and performance of high-speed craft are significantly affected by changes in longitudinal centre-of-gravity (LCG), so that it is important that such variations be considered in determining the safe operational envelope of the craft.*

*If craft behaviour dictates that limitations must be placed on the permissible LCG position, such limitations and instructions on how control may be exercised should be included in the craft operating manual.*

### 17.4 Effect of failures

The effect of any likely failure in handling and control devices, services or components (e.g. power operation, power assistance, trimming and stability augmentation) shall be assessed in order that a safe level of craft operation can be maintained. Effects of failure identified as being critical according to annex 4 shall be verified in accordance with annex 9.

### 17.5 Controllability and manoeuvrability

17.5.1 Instructions to crew members shall be provided in the craft operating manual regarding required actions and craft limitations subsequent to prescribed failures.

17.5.2 It is necessary to ensure that the effort required to operate the controls in the worst intended conditions is not such that the person at the control will be unduly fatigued or distracted by the effort necessary to maintain the safe operation of the craft.

*Manually operated controls should be demonstrated to show that this requirement can be met. To be considered adequate the manual force to be applied should not generally exceed 100 N. (ref: guidance on 5.2.3)*

17.5.3 The craft shall be controllable and be capable of performing those manoeuvres essential to its safe operation up to the critical design conditions.

17.5.4.1 When determining the operating limitations of a craft, particular attention shall be paid to the following aspects during normal operation and during failures and subsequent to failures:

- .1 yawing;
- .2 turning;
- .3 automatic pilot and steering performance;
- .4 stopping in normal and emergency conditions;
- .5 stability in the non-displacement mode about three axes and in heave;
- .6 trim;

- .7 roll;
- .8 plough in;
- .9 lift power limitations;

*Refer to “Stability and Control of Hovercraft – Notes for Commanders” published by the Department of Industry, 1980.*

- .10 broaching;
- .11 slamming; and
- .12 bow diving.

*Refer to note below in 17.5.4.2.4 on broaching / slamming and bow diving aspects.*

17.5.4.2 The terms in 17.5.4.1.2, .6, .7 and .11 are defined as follows:

- .1 "Turning" is the rate of change of direction of a craft at its normal maximum operating speed in specified wind and sea conditions.
- .2 "Plough in" is an involuntary motion involving sustained increase in drag of an air-cushion vehicle at speed, usually associated with partial collapse of the cushion system.
- .3 "Lift power limitations" are those limitations imposed upon the machinery and components which provide the lift.
- .4 "Slamming" is the water impact on the underside of the hull in the bow area of the craft.

*“Broaching” is a severe, and often uncontrollable, yawing movement in following seas which turns the vessel beam on to the waves. (MGN 328)*

*“Bow diving” occurs when a high-speed craft buries its bow into a wave in following or stern quartering seas. (MGN 328)*

*For more details of these phenomenon see MGN 327 on design guidance and MCA Research Project 502 “High Speed Craft Dynamic Stability in Following and Quartering Seas“ which is supplemented by an instructional video intended to advise operators and masters.*

## **17.6 Change of operating surface and mode**

There shall be no unsafe change in the stability, controllability or attitude of the craft during transition from one type of operating surface or mode to another. Information on change in the behaviour characteristics of the craft during transition shall be available to the master.

*Behaviour during transition from displacement to semi-displacement mode and vice versa should be investigated. For amphibious craft, transition from land to sea (and ice if appropriate) and vice versa should be investigated. Any warnings or guidance derived from such trials should be incorporated into the craft operating manual.*

## **17.7 Surface irregularities**

Factors which limit the ability of the craft to operate over sloping ground and steps or discontinuities shall be determined, as applicable, and made available to the master.

*This paragraph specifically relates to amphibious ACVs, which normally have limitations on gradient-climbing ability and obstacle clearance. Obstacles may either be ridges or troughs. Such limitations should be documented in the craft operating manual.*

## **17.8 Acceleration and deceleration**

The Administration shall be satisfied that the worst likely acceleration or deceleration of the craft, due to any likely failure, emergency stopping procedures or other likely causes, would not hazard the persons on the craft.

*Refer to annex 3, table 1 and chapter 4, para 4.3.1.*

## **17.9 Speeds**

Safe maximum speeds shall be determined, taking account of the limitations from 4.3.1, modes of operation, wind force and direction and the effects of possible failures of any one lift or propulsion system over calm water, rough water and over other surfaces, as appropriate to the craft.

## **17.10 Minimum depth of water**

The minimum depth of water and other appropriate information required for operations in all modes shall be determined.

*For many types of high-speed craft, due to a combination of sinkage and trim, the depth required is at a maximum when accelerating through the resistance hump Froude Numbers in the range 0.4 to 0.6, ie: at speeds (in knots) of approximately 2.5 to 3.5 times the square root of the waterline length (in metres).*

*The effect of depth of water on the generation of wash waves hazardous to small craft or persons on the shoreline should be considered – see guidance to 18.1.3.1 and in the introduction to annex 2, and appendix D.*

## **17.11 Hard structure clearance**

For amphibious craft, when cushion-borne, clearance of the lowest point of the hard structure above a hard flat surface shall be determined.

## **17.12 Night operation**

The schedule of tests shall include sufficient operation to evaluate the adequacy of internal and external lighting and visibility under conditions of normal and emergency electrical power supply during service, cruising and docking manoeuvres.