

ANNEX 9

DEFINITIONS, REQUIREMENTS AND COMPLIANCE CRITERIA RELATED TO OPERATIONAL AND SAFETY PERFORMANCE

This annex applies to all types of craft. Tests to evaluate operational safety shall be conducted on the **first** craft of a new design or of a design incorporating new features which may modify the results of a previous testing. The tests shall be carried out to a schedule agreed between the Administration and the manufacturer. Where conditions of service warrant additional testing (e.g., low temperature), the Administration or base port State authorities, as appropriate, may require further demonstrations. Functional descriptions, technical and system specifications relevant to the understanding and evaluation of craft performance shall be available.

The objective of these tests is to provide essential information and guidance to enable the craft to be operated safely under normal and emergency conditions within the design speed and environmental envelope.

The following procedures are outlined as requirements in dealing with verification of craft performance.

Attention is drawn to the various stability phenomena to which certain types of high-speed craft may be susceptible, as listed in 2.1.5 of the Code. Operational and safety trials should be used to verify that such behaviour is either not present, or if present is not hazardous to the craft or occupants.

These safety trials are sometimes termed the "heavy weather sea trials".

Refer to guidelines on Annex 12 – "Guidelines for uniform operating limitations of high-speed craft", MSC.1/Circ.1329 and Annex 2.

1 Performance

1.1 General

1.1.1 The craft shall meet the applicable operational requirements in chapter 17 of this Code and this annex for all extremes of passenger and load configurations for which certification is required. The limiting sea state related to the different modes of operation shall be verified by tests and analyses of a craft of the type for which certification is requested.

The extremes of passenger and load configurations considered should include variations in mass, and vertical and longitudinal centre-of-gravity position.

1.1.2 Operational control of the craft shall be in accordance with procedures established by the applicant for operation in service. Procedures to be established shall be start procedure, cruise procedures, normal and emergency stop and manoeuvre procedures.

1.1.3 The procedures established under 1.1.2 shall:

- .1 demonstrate that normal manoeuvres and craft responses to failures are consistent in performance;

- .2 use methods or devices that are safe and reliable; and
- .3 include allowance for any time lag in the execution of procedures that may reasonably be expected in service.

1.1.4 Procedures required by this annex shall be conducted over water of sufficient depth such that craft performance will not be affected.

1.1.5 Tests shall be conducted at minimum practicable weight and additional testing shall be conducted at maximum weight sufficient to establish the need for additional restrictions and for testing to examine the effect of weight.

2 Stopping

2.1 This test is to establish the acceleration experienced when stopping the craft in calm water with no passenger load or cargo load during the following conditions:

- .1 normal stop for 90% of maximum speed;
- .2 emergency stop for 90% of maximum speed; and
- .3 crash stop from 90% of maximum speed and from any transitional mode speed.

2.2 The tests referred to in 2.1.1 and 2.1.2 shall document that the accelerations do not exceed safety level 1 in annex 3 when control levers are used in accordance to written procedures as given in the craft operating manual or in an automatic mode. Should safety level 1 be exceeded during normal stop, control systems shall be modified in order to avoid exceedance or passengers shall be required to be seated during normal stop. Should safety level 1 be exceeded during emergency stop, then written procedures in the craft operating manual shall include detailed information of how to avoid exceedance or the control system shall be modified to avoid exceedance.

2.3 The test referred to in 2.1.3 shall document that the accelerations do not exceed safety level 2 in annex 3 when control levers of automatic modes are used in a manner which will give the highest accelerations. If safety level 2 is exceeded then the craft operating manual shall include a warning that it is a risk to passengers being injured, if a crash stop is performed.

2.4 Other tests shall be repeated during craft turning to establish the need or otherwise to impose any speed-related restrictions during manoeuvres.

Stopping during full-helm turns at high-speed may result in high horizontal accelerations. If necessary, the maximum permissible helm angle during stopping manoeuvres that is necessary to avoid exceeding safety level 1 in table 1 of annex 3 should be determined, and this information provided at the operating station, as well as in the craft operating manual.

3 Cruise performance

3.1 This test is to establish the craft performance and accelerations experienced during cruise modes with no passenger load or cargo load during the following conditions:

- .1 normal operation conditions are those in which the craft will safely cruise at any heading while manually operated, auto-pilot assisted operated or operated with any automatic control system in normal mode; and
- .2 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. For type of craft having a higher performance standard in non-displacement mode, the performance and accelerations shall also be established at displacement mode during operation in the worst intended condition.

3.2 Operation levels, as defined in 3.1, shall be established and documented by full-scale tests in at least two relevant sea conditions and in head, beam and following seas. It shall be shown that the period of every test (run) and the number of series are sufficient for achieving reliable measurements. In every sea state tested, the aggregate time in each direction shall not be less than 15 min. Model tests and mathematical simulations could be used to verify the performance in the worst intended conditions.

Limits for normal operation condition shall be documented by measurements of craft speed, heading to the wave and interpolation of measurements of maximum horizontal accelerations in accordance with 2.4 of annex 3. Measurement of wave height and period shall be made to the maximum extent practicable.

Limits for worst intended condition shall be documented by measurements of craft speed, wave height and period, heading to the wave and by root mean square (RMS) values of horizontal accelerations in accordance with 2.4 of annex 3 and of vertical accelerations close to the craft longitudinal centre of gravity. RMS values could be used for extrapolation of peak values. To obtain the expected peak values related to structural design load and safety levels (one per 5-min exceedance), multiply the RMS values by 3.0 or

$$C = \sqrt{2 \ln N}$$

where:

N is the number of successive amplitudes within the relevant period.

If not otherwise verified by model tests or by mathematical calculations, it might be assumed a linear relation between wave height and accelerations based on measurements in the two sea conditions. **The worst intended conditions shall not exceed 150% of the more severe of the two measured sea conditions.** Limits for worst intended condition shall be documented both related to passenger safety in accordance with 2.4 of annex 3 and related to the actual structural design load of the craft.

The wave height limitations imposed on the operation of high-speed craft are initially based on the critical design condition of the craft at 90% of maximum speed.

Tests in this section should be carried out to demonstrate the operational and safety performance of the craft during its normal and emergency condition. A craft should only operate within an envelope that delivers a suitable safety margin at all times.

The Shipping Safety Branch should be consulted for the initial limitation for a prototype craft of a new design or of a design incorporating new features.

An operator may wish to increase the limitation because they believe that their craft is capable of operating safely in high seas. While this may be possible in principle, supporting theoretical and practical evidence is required. Theoretical evidence can take the form of a statement from a Classification Society, certifying that the craft has been designed and built to operate safely at 90% of maximum speed in a particular weather window. The practical evidence will take the form of a series of tests (Heavy Weather Sea Trials), witnessed by an MCA surveyor – refer to the guidance at the end of this annex.

In assessing increased sea state limitations, for craft on which liferafts are to be boarded directly consideration should also be given to the practicality and safety of evacuation into survival craft in those conditions, as required by 8.7.4. Craft fitted with Marine Escape Systems are not required to be limited by these evacuation considerations.

3.3 The tests and verification process shall document the limiting seas for safe operation of the craft:

- .1 in normal operation at 90% of maximum speed the accelerations shall not exceed safety level 1 in annex 3 with an average of one per 5-min period. The craft operating manual shall include detailed description of the effects of speed reduction or change of heading to the waves in order to prevent exceedance;
- .2 in the worst intended conditions, with reduced speed as necessary, the accelerations shall not exceed safety level 2 in annex 3 with an average of one per 5-min period, nor shall any other craft characteristic motion as pitch, roll and yaw exceed levels that could impede the safety of passengers. In worst intended conditions, with reduced speed as necessary, craft shall be safely manoeuvrable and provide adequate stability in order that the craft can continue safe operation to the nearest place of refuge, provided caution is exercised in handling. Passengers shall be required to be seated when safety level 1 in annex 3 is exceeded; and
- .3 within the actual structural design load for the craft, with reduced speed and change of heading, as necessary.

3.4 Turning and manoeuvrability

The craft shall be safely controllable and manoeuvrable during:

- .1 hull-borne operation;
- .2 operation in non-displacement mode;
- .3 take-off, landing;
- .4 any intermediate or transition modes, as applicable; and
- .5 berthing operations, as applicable.

Full-helm turns at high-speed may result in high horizontal (lateral) accelerations. If necessary the maximum permissible helm angle at each speed that is necessary to avoid exceeding safety level 1 in table 1 of annex 3 should be determined, and this information provided in the operating station, as well as in the craft operating manual.

4 Effects of failures or malfunction

4.1 General

The limits of safe operation, special handling procedures and any operational restrictions shall be examined and developed as a result of full-scale trials conducted by simulating possible equipment failures.

The failures to be examined shall be those leading to major or more severe effects as determined from evaluation of FMEA or similar analysis.

Failures to be examined shall be agreed between the craft manufacturer and the Administration and each single failure shall be examined in a progressive manner.

4.2 Objects of tests

Examination of each failure shall result in:

- .1 determining safe limits of craft operation at the time of failure, beyond which the failure will result in degradation beyond safety level 2;
- .2 determining crew member's actions, if any, to minimize or counter the effect of the failure; and
- .3 determining craft or machinery restrictions to be observed to enable the craft to proceed to a place of refuge with the failure present.

4.3 Failures to be examined

Equipment failures shall include, but not be limited to, the following:

- .1 total loss of propulsion power;
- .2 total loss of lift power (for ACV and SES);
- .3 total failure of control of one propulsion system;
- .4 involuntary application of full propulsion thrust (positive or negative) on one system;
- .5 failure of control of one directional control system;
- .6 involuntary full deflection of one directional control system;
- .7 failure of control of trim control system;
- .8 involuntary full deflection of one trim control system element; and
- .9 total loss of electrical power.

Failures shall be fully representative of service conditions and shall be simulated as accurately as possible in the most critical craft manoeuvre where the failure will have maximum impact.

4.4 "Dead ship" test

In order to establish craft motions and direction of laying to wind and waves, for the purposes of determining the conditions of a craft evacuation, the craft shall be stopped and all main machinery shut down for sufficient time that the craft's heading relative to wind and waves has stabilized. This test shall be carried out on an opportunity basis to establish patterns of the design's "dead ship" behaviour under a variety of wind and sea states.

Dead ship - this is the worst scenario, but the point is not whether it is likely or unlikely to occur. This test is to establish craft motion to determine the condition of the craft during an evacuation scenario and, in case of a black-out, the safety of crew and passengers.

Heavy weather sea trials:

This program is to establish the craft performance and accelerations experienced during normal operation at the maximum permitted weather condition.

Each test run should have a duration of at least 20 minutes.

Tests may be conducted in any order as required.

The tests should be planned according to the weather forecast, supported by readings from a wave measurement buoy.

All tests should be carried out at/around the significant wave height to be entered in the Permit to Operate.

No passengers or cargo should be carried during these tests.

The following should be monitored and used to evaluate (assess) the tests:
pitch and roll, heave and yaw

the vertical and horizontal (longitudinal and transverse) accelerations at:

- the after end of the after passenger space,
- the forward end of the forward passenger space, and
- at the LCG of the craft
- if the craft is intended to carry them, the lashing forces on HGVs and cars (one at each end of the vehicle deck)

The following programme of eight tests is recommended:

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|----|-------------------------------|---------------------------|
| 1. | Dead ship | |
| 2. | Following sea | (at 50% of maximum speed) |
| 3. | Following sea | (at 90% of maximum speed) |
| 4. | Head to sea | (at 90% of maximum speed) |
| 5. | 4 points starboard bow | (at 90% of maximum speed) |
| 6. | 4 points port bow | (at 90% of maximum speed) |
| 7. | 4 points on starboard quarter | (at 90% of maximum speed) |
| 8. | 4 points on port quarter | (at 90% of maximum speed) |

During the tests, following standards should be maintained:

- people on board should not be thrown about, meaning that an average person will be able to keep their balance when holding;
- people should not fall out of their seats when not wearing seat belts;
- vertical accelerations of 1g or more should not be experienced;
- maximum horizontal (longitudinal or transverse) acceleration should not exceed 0.20g;

- *no object should be thrown about;*
- *no movement of unlashd cars at each end (stowed as normal for a typical voyage);*
- *there should be no failure of any machinery or structures; and*
- *the craft must maintain a safe cruise without requiring exceptional piloting skill.*

In general - There should be no risk of injury to people on board during normal and emergency conditions and they should be protected from unfavourable environmental conditions.