CHAPTER 3

STRUCTURES

3.1 General

This chapter covers those elements of hull and superstructure which provide longitudinal and other primary and local strength of the craft as a whole and also other important components such as foils and skirts which are directly associated with the hull and superstructure.

To determine whether the proposals relating to the construction of the ship comply with the requirements of the regulations the surveyor should obtain from the shipbuilder, owner, or his consultant, all plans and particulars necessary for the consideration of the craft. See also Survey and Certification Instructions.

All plans, particulars and calculations should be in the English language, or should include an adequate English translation. Measurements should be in metric (SI) units.

The plans and particulars to be submitted should include the procedures and calculation methods used to justify the arrangements, materials, constructional methods, scantling and closures proposed.

Reference should be made to the requirements for surveys (1.5), maintenance of conditions after survey (1.7) and provision of information on structural failures (1.14.2).

3.2 Materials

Materials used for the hull and superstructure and the other features referred to in 3.1 shall be adequate for the intended use of the craft.

The quality, strength and testing of materials and constructional methods proposed for the hull, bulkheads, decks, superstructures and deckhouses; and any attachments thereto, are to be in accordance with recognised standards such as the requirements of a recognised Classification Society or BS or ISO standard. Otherwise particulars are to be provided for consideration, as noted under 3.1.

In assessing “adequacy for intended use” reference should be made to the provisions of chapter 7, in particular:

-7.4.1.3 requiring that the hull, superstructure, structural bulkheads, decks, deckhouses and pillars generally be constructed of approved non-combustible materials (defined in 7.2.3), but see note below;

-7.4.2.3 requiring certain main load-carrying structures to be designed not to collapse when exposed to fire;

-7.4.2.4 and 7.4.2.5 requiring measures to limit the temperature rise of aluminium alloys and combustible materials;

-7.4.3.7 requiring the use of materials not capable of producing excessive quantities of

smoke or toxic products as determined using the FTP Code;

-7.2.1 describing the requirements for fire resisting divisions;

-7.2.5 giving the meaning of the expression “steel or other equivalent material”.

Aluminium alloys are acceptable, provided 7.2.5 and 7.4.2.4 are satisfied.

Notwithstanding the first sentence of 7.4.1.3 and paragraph 7.4.3.7, fibre reinforced composites may also be acceptable, provided they are suitably insulated as provided for by 7.4.2.5 and the second sentence of 7.4.1.3.

3.3 Structural strength

The structure shall be capable of withstanding the static and dynamic loads which can act on the craft under all operating conditions in which the craft is permitted to operate, without such loading resulting in inadmissible deformation and loss of watertightness or interfering with the safe operation of the craft.

Structural plans

All structural plans should identify the nature and physical properties of the materials being used and their means of connection.

Where the craft is classed with one of the UK's recognised organisations[†], (see Appendix B and MSN 1672(M+F) including amendments, SI 1996 No.2908 The Merchant Shipping (Ship Inspection and Survey Organisations) Regulations 1996, and MGN 322 (M+F), Ship Survey Standards, for details) it will be sufficient for the surveyor to obtain from the shipbuilder or consultant stamped approved copies of the drawings submitted to the recognised organisation (Classification Society) together with that Society's approval. The surveyor should ensure that the scantlings are approved for the proposed maximum operational weight (as defined in paragraph 1.4.37 of the Code) and that the strength is sufficient for the intended service.

[†] note that Class NK is not authorized to undertake work for passenger vessels.

The adequacy of the structural strength should be determined in relation to the critical design conditions (defined in 1.4.19) in order to provide for a margin over the worst intended conditions (defined in 1.4.61).

Arrangements and scantlings should be suitable to maintain watertight and weathertight integrity as required by paragraph 2.2.

In particular, watertight bulkheads are to be of sufficient strength and construction to withstand, with an adequate margin of resistance, the pressure due to the maximum head of water which may be sustained following damage to the ship, see chapter 2, or the pressure due to a head of water up to the margin line or top of the air/overflow pipe, whichever is greater. Such maximum head shall include any additional head that may result from flooding or heeling.

Where a ship is not classed with one of the recognized organisations, the guidance laid down in MGN 322(M+F) on Ship Survey Standards should be followed and the owner’s proposed structural arrangements attachments and means of closure should be examined locally and forwarded to MCA headquarters with comments for approval. If the vessel is unclassed and under 24 m in length refer to MGN 322(M+F) and to MCA Headquarters for

guidance.

Requirements for side scuttles and windows - general

The requirements for external windows fitted to spaces included in the stability calculations are described in detail in the paragraphs below, as are those for the internal windows. External windows fitted to spaces excluded from the stability calculations and above the weathertight spaces should be of toughened glass panes to an appropriate standard (for the type/size/restrictions of the vessel and positioning/size of the glass on the vessel), see also 4.1.4.

In considering the design and strength of side scuttles and windows, reference should be made to the requirements of paragraphs 2.2.7 (windows in weathertight boundaries) and 4.1.4 (escapes) and Chapter 7 (fire safety) of the Code.

The approach to be taken when considering the acceptance of windows or side scuttles shall depend upon the basis upon which these items have been constructed.

They may be of a type which has previously been “type approved” by a recognised organisation, they may be constructed to the rules of a recognised organisation or they may have been designed and constructed on a “one-off” basis, in which case approval shall be by testing to the appropriate standard.

In general, where it is proposed to use materials other than toughened safety glass panes, their use should be in accordance with the requirements of an acceptable standard appropriate to the proposed Class and service of the vessel. Otherwise full details of the proposed materials and their use should be submitted to MCA Headquarters for consideration of acceptance as an ‘equivalent’ to the requirements of a relevant standard.

Note that MGN 322 (M+F) requires vessels to be classed, and one of the items covered under Class is side scuttles and windows. Therefore the type approval process will be followed by the recognised organisation.

ISO 5779 (Ordinary Rectangular Windows – Positioning) specifies the allowable positioning of windows approved to ISO 3903 (Ships Ordinary Rectangular Windows), ISO 5780 (Shipbuilding — Side scuttles — Positioning) specifies the allowable positioning of windows approved to ISO 1751 (Ships’ Side Scuttles). ISO 3902 (Gaskets for rectangular windows and side scuttles) provides further detail to these standards.

Side scuttles and windows in conventional ships are addressed through the Loadline Convention, however in the case of high speed craft this is dealt with within the HSC Code itself, see Chapters 1 and 2 for details: paragraph 2.2 for loadline issues, 2.9.2 for marking of the design waterline, and 4.11 for protection of the crew.

Type approved side scuttles and windows

Where side scuttles and windows are constructed in accordance with a type approved design, then their frames should be marked in accordance with the applicable standard under which such type approval was given. Recognised standards are ISO 21005 (Thermally toughened safety glass panes for windows and side scuttles), ISO 1751 (Ships' side scuttles) and ISO 3903 (Ships' ordinary rectangular windows).

In addition, glasses used in the construction of side scuttles and windows should also comply with the relevant requirements of ISO 21005 or ISO 614 (Toughened safety glass panes for rectangular windows and side scuttles — Punch method of non-destructive strength testing)

Additional checks should be undertaken during plan and as fitted approval, and comparison of the frames and fitting with the requirements of the applicable standard. Where there is any doubt, further comparison would need to be made with the approved drawings cited in the type approval certificate (or attached schedules) before any referral was made to

headquarters for advice regarding non-compliance of the frame with the approved design or of the approved design in relation to the applicable standard.

Class approved side scuttles and windows

Where side scuttles and windows are constructed in accordance with the requirements of a UK recognised organisation, then the surveyor should approach the builders to provide supporting documentation in the form of copies of the approved construction drawings stamped and endorsed by the class society.

It is of particular importance in such cases that the surveyor should satisfy himself that approval of both the frame and the glasses is given with respect to construction rules which are fully appropriate for the design, the proposed protection and the service of the vessel.

Side scuttles and windows of non-approved type

Where side scuttles and windows presented for survey are not of a type previously approved in accordance with the requirements of a recognised standard, then the surveyor should either ask that the approval is undertaken by a recognised organisation or evaluate such items on an individual basis for the vessel concerned (see Para. 3.1 guidance on the plans detail to be required).

In cases where non-approved frames presented for survey do not conform to any recognised standard, or are not in full accordance with the provisions of the applicable standard, full details including supporting documentation regarding the chemical composition and mechanical strength of the materials used should be referred to MCA Headquarters for consideration of acceptance as an “equivalent” to the requirements of a relevant standard.

The surveyor should assess the materials and construction against a recognised standard appropriate to the proposed application noting that strength tests may be required on sample panes on frame materials to confirm compliance where documentary evidence is not available, and that glass thicknesses are appropriate to the position and size of the each side scuttle or window under consideration, (see under type approval, Para. above).

Where the design of proposed frames and glasses is shown to comply with the requirements of an appropriate standard the frames should be marked during manufacturing in accordance with the provisions of the standard, where such markings are specified, and formal notification of the approval should be given to the builders.

Side scuttles and windows - glazing materials other than glass

The material used for side scuttles, windows and for enclosing promenades and deck spaces should normally be heat treated toughened safety glass. However, the use of other materials may be considered provided that these fulfil relevant provisions for strength, stiffness, structural fire protection, visibility and location and suitability for use as means of escape.

In general, where it is proposed to use materials other than toughened safety glass panes, their use should be in accordance with the requirements of an acceptable standard appropriate to the proposed seagoing service / category of water and service of the vessel. Otherwise, full details of the proposed materials and their use should be submitted to MCA Headquarters for consideration of acceptance as an ‘equivalent’ to the requirements of a relevant standard.

Internal glazing of windows and other translucent divisions

Where it is proposed to fit internal glazed divisions in a vessel then application of ISO 21005 (Thermally toughened safety glass panes for windows and side scuttles), or ISO 3903

(Ships' ordinary rectangular windows), may not be appropriate.

Whilst such internal divisions should be glazed using heat treated toughened safety glass, the use of other materials will be accepted provided that these comply with the requirements of an acceptable standard. Such standards may be those of a recognised classification society, appropriate for the Class and service of the vessel, or other national or international standards applicable to such divisions, provided that they are appropriate to the application under consideration.

In such cases the surveyor should satisfy himself that any such division is constructed in a manner which shall afford passengers and crew the maximum protection in the event of breakage.

An appropriate standard for such consideration would be BS 6206 (Specification for impact performance requirements for flat safety glass and safety plastics for use in buildings) which relates to the “impact” testing of glazed constructions used in land based applications. This standard grades glazing arrangements in three strength bands A to C, where A affords the highest impact resistance. Glazing arrangements (such as a door or window unit) shall pass the test if the pane “breaks safely” or does not break during the test.

It is recommended that only units which meet Class A, and are marked as such, are accepted for marine use, noting that in the case of plastics and laminated glasses, preference should be given to constructions which did not break during impact testing. Copies of test certificates specifying the test result should be available from the manufacturers on request.

Alternatively, appropriately marked toughened glass panes, strength tested in accordance with ISO 21005 or ISO 614 (Toughened safety glass panes for rectangular windows and side scuttles — Punch method of non-destructive strength testing), or another applicable standard, may be accepted for use in internal screens/divisions with the recommendation that panes which exceed 0.75 sq.m in area have a minimum thickness of 10 mm and those smaller than 0.75 sq.m have a minimum thickness of 6 mm.

In cases where the surveyor is unsure as to the acceptability of proposed internal glazing arrangements, they should refer the case to MCA Headquarters for consideration giving comments and as much detail as possible with respect to the position, construction and glazing of each item, along with details of any markings or certification supplied by the manufacturer/shipbuilder in support of the proposed construction.

3.4 Cyclic loads

Cyclic loads, including those from vibrations which can occur on the craft, shall not:

.1 impair the integrity of structure during the anticipated service life of the craft or the service life agreed with the Administration;

.2 hinder normal functioning of machinery and equipment; and

.3 impair the ability of the crew to carry out its duties.

In considering cyclic loads, due account should be taken of the fatigue properties of the materials being employed in determining safe working stresses.
For typical catamaran designs where L<50m (and L/D ratio to be less than 12) a global analysis is not required. For vessels with these proportions then the local strength requirements "drive" the plate thickness/section modulus such that global analysis is in most cases unnecessary.

The above should not be taken to mean that plate/stiffener/girder are only looked at from a local perspective. For a vessel of the size indicated then it would be prudent to undertake analysis of several frames, generally through beam element modelling and it is this analysis where loading such as racking is assessed. In addition the transverse tunnel structure should be modelled, this is more of a global model in the sense that all the cross structure will be modelled and analysis is undertaken for transverse bending and pitch (torsional) loading.

Fatigue for L<50m, L/D <12 is addressed by the allowables for local strength but this is with the caveat that standard details are applied and Class alignment tolerances are followed. If new connection details are applied then analysis will be necessary.

3.5 Design criteria

The Administration shall be satisfied that the choice of design conditions, design loads and accepted safety factors corresponds to the intended operating conditions for which certification is sought.

The scantlings should be determined with respect to the proposed maximum operational weight (defined in 1.4.37) and that the strength is sufficient for the critical design conditions (defined in 1.4.19) in order to provide for a margin over the worst intended conditions (defined in 1.4.61).

These parameters should encompass those envisaged for the Permit to Operate. The design conditions and loads should include:

-longitudinal and transverse hull bending and torsion in a seaway, in both displacement and non-displacement modes;

-localised loads eg: due to hydrostatic pressure, slamming on hull bottom (and wet-deck if appropriate), vehicle wheels, point loads, etc.;

-high speed manoeuvres, including loads on appendages;

-emergency conditions such as anchoring, towing, collision deceleration, plough-in, flooding; and

-drydocking, (or being lifted, if appropriate).

Reference should specifically be made to the requirements in respect of:

-design accelerations (see paragraph 4.3);

-accommodation design (see paragraph 4.4); and

-attachment of passenger seating (see paragraph 4.5).

3.6 Trials

If the Administration consider it necessary, it shall require full-scale trials to be undertaken in which loadings are determined. Cognisance shall be taken of the results where these indicate that loading assumptions of structural calculations have been inadequate.