PART 4

STEEL CONSTRUCTION

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Section 4.1 – Materials

4.1.1 Steel is to be manufactured by an approved process in accordance with Lloyd's requirement for shipbuilding quality mild steel, BS EN10.025(1) [S235 JR] DIN/EN 10025, or equivalent DIN or similar Standards.

4.1.2 Scantlings are based on mild steel with the following properties:-

Yield strength (min)	235 N/mm^2
Tensile strength	340/470N/mm^2
Modulus of elasticity	200 x 10^3 N/mm.

4.1.3 Documentation in the form of mill test certificates for hull plating and main structural members should be available for inspection and identification by the Surveyor.

4.1.4 Where the use of special steels is proposed, details of material specifications are to be submitted for approval prior to commencement of construction.

4.1.5 Steel plate and sections should be stored so that distortion does not occur, and immersion in water is avoided.

Aluminium alloy plates and sections

4.1.6 Aluminium alloy plates and sheets for uses with these Standards are to be marine grade to the requirements of BS 5083/DIN 1725 (or equivalent) with consumables to BS 5356 or equivalent.

4.1.7 Aluminium alloy sections, where not available to the standard in Paragraph 4.1.6, may be to BS 6082 (or equivalent), with consumables to BS4043 (or equivalent).

4.1.8 Scantlings are based on marine grade aluminium alloy with the following properties:-

0.2% proof stress (min)	170 N/mm^2
Tensile strength (min)	260 N/mm^2
Modulus of elasticity	69 x 10^3 N/mm^2.

4.1.9 Plate materials should be suitable for the structural purpose intended.

4.1.10 Documentation in the form of mill test certificates to be provided for all aluminium materials.

4.1.11 Aluminium materials are to be stored under cover in clean, dry conditions and in such a manner that distortion is prevented. To avoid contamination, the storage area is to be separate from storage of other metals.

Steel construction

4.1.12 Construction should be carried out in a designated area and, where practicable, protected from adverse wind and weather conditions.

4.1.13 Steel plate and section may be cut by profile burning, mechanical saw, mechanical shears/guillotine, or other approved processes. Cut edges are to be straight and free from scoring, swarf, and burrs. Plate edge preparation is to be carried out prior to erection where possible.

4.1.14 Plate edges are to be carefully aligned to avoid distortion on welding.

4.1.15 Scantlings are to be obtained from the associated Tables shown in Part 6 of these Standards.

Aluminium alloy construction

4.1.16 Fabrication and erection of aluminium structures is to be carried out under cover, screened from wind and weather, and is to be kept separate from steel fabricating areas.

4.1.17 Where temperatures below 0°C can occur, the fabrication and construction area is to be heated. Welding of aluminium alloy is not to be carried out in temperatures of less than 5°C.

4.1.18 Plate, sheet, and sections may be cut by plasma process, mechanical saw or mechanical shear/guillotine. Such tools are to be free from contamination by other materials. Where plate is to be flanged for pre-forming structural sections, the inside radius is to be a minimum of 1.5 times plate thickness, and plate/sheet is to be of flanging quality.

4.1.19 All plate edges, and areas to be connected by welding, are to be de-greased with a de-greasing agent and scratch brushed to remove oxides.

4.1.20 Scantlings are to be obtained from the associated Tables for steel construction shown in Part 6 of these Standards.

4.1.21 Care is to be taken when connecting together steel and aluminium alloy structures or components. Welded connections may be by bi-metallic bar ('Kelocouple' or equivalent) or by bolting. Bolted joints are to be insulated between the metals. Bolts are to be stainless steel, or plated and insulated from bi-metallic contact, with ferrules and washers of inert materials.

4.1.22 Where construction of aluminium alloy superstructures are proposed, details of scantlings and construction methods are to be submitted for approval prior to commencing construction.

Section 4.2 – Steel hull construction

4.2.1 Minor details of construction based on existing designs, shipyard standards, and normal practices proposed as an alternative to the following standards, will be considered upon submission of details for consideration.

4.2.2 Scantlings are to be in accordance with the appropriate section or Table reference.

4.2.3 Where the hull construction is from a standard kit form, details of the kit, together with scantlings and assembly details, are to be provided prior to construction commencing.

4.2.4 Care is to be taken to avoid abrupt changes in the structure of the vessel (e.g. alignment of engine girders to side girders, tank sides, etc.), but where such changes are unavoidable, adequate compensation is to be incorporated to the approval of the Surveyor.

4.2.5 All vessels are to have frames and/or stiffening members, which may be either transverse or longitudinally arranged or be a combination of both. Such vessels having only longitudinal stiffening are to have adequate stringers on each side between the keel and the deck, and must have transverse stiffening incorporated as required by Paragraph 4.2.7 and 4.4.2.

4.2.6 Generally frames, beams, and other stiffeners are to be of flat bar, bulb, or angle section and toe welded. Details of alternative sections to those specified in Part 6 of these Standards are to be submitted for approval.

4.2.7 Longitudinal stiffeners may include stringers, engine seatings and chines, subject to approval.

4.2.8 Particular attention is to be given to the stiffening at the ends of the vessel and especially in way of areas which may be subjected to slamming.

4.2.9 Adequate access is to be arranged to double bottom tank areas and in way of boundaries to facilitate inspection and testing.

Section 4.3 – Keel, centre and side girders

4.3.1 Keel may be of bar, plate, box type, or of fabricated sections (see Figure 7.7).

4.3.2 The dimensions of bar and plate type keels are to be in accordance with Table 6.2, and should be fitted in association with a centre girder conforming to Table 6.6.

4.3.3 The centre girder in vessels with a plate keel is to extend over the whole length of the keel, except in the way of the main engine. The side girders forming the engine seating may be accepted in lieu of the centre girder, subject to the approval of the Surveyor, and provided continuity of strength

is maintained. The thickness of vertical plate girders forming engine seats shall be at least that required for the centre girders.

4.3.4 The centre girder and the engine seatings are to overlap a minimum of one frame space, and are then to be tapered to avoid abrupt changes in structure.

4.3.5 Where it is proposed to fit side girders in lieu for a centre girder, (e.g. in order to form a duct for the propeller shaft in vessels with a forward engine room), the strength of the side girders is to be at least equivalent to the substituted centre girder.

4.3.6 Where it is proposed that a box keel be fitted, details are to be submitted for consideration and approval.

4.3.7 Fabricated ballast keels constructed with heavy bars will be specially considered after submission of section and welding details prior to construction. Where practicable, the side plates of such keels should be incorporated into the bottom structure.

Section 4.4 – Bottom construction floors and longitudinals

4.4.1 In transversely framed vessels, plate floors in accordance with Table 6.5 and Figure 7.4 are to be fitted at every transverse frame, and weld connected to the side frames and shell. Where there is a considerable rise of floor, and at the fore and aft ends, the depth of the floor may require to be increased to efficiently connect to the side frames.

4.4.2 In longitudinally framed vessels, plate floors are to be fitted at every third frame or at a spacing not exceeding 1.5m whichever is the lesser, and of the height shown in Table 6.5.

4.4.3 The top edges of all floors are to be flanged or fitted with a face bar. Face bars on engine room floors and inside water tanks are to be continuously welded.

4.4.4 The depth of floors at the centreline is to be not less than that specified in Table 6.5. Where there is a rise of floor, the depth of floors is to be increased in order that the depth at 25% of the distance between the centreline and the outboard extremity of the floor is not less than 75% of the required depth of floor at the centreline.

4.4.5 An additional longitudinal girder is to be fitted each side, midway between the centre girder and the outboard end of the floor. The height of this side girder is to be the height of the floor at that point, with thickness and face flat as per Table 6.6. Where the span of the floor from centreline to outboard end is less than B/4, the side girder may be omitted.

4.4.6 Engine seats are to comprise of substantial side plate girders. Girders are to be fully welded to the plate floors, bottom plating and bulkheads were

applicable. A heavy flat bar top plate for engine mounting is to be fully welded to the top of the girder, and arranged with tripping brackets to each plate floor position.

4.4.7 Girders and top plates may be cranked to suit the engine installation, but abrupt changes in direction are to be avoided. Ends of the engine girders are to be bracketed over a minimum of two frame spaces, with top plates tapered to suit.

4.4.8 Engine seating arrangements are to meet with the requirements of the engine Manufacturer.

Section 4.5 – Integral tanks

4.5.1 The minimum depth and thickness of the centre girder is to be at least equal to that of the adjacent floor.

4.5.2 Plate floors are to be fitted at every frame in integral tanks (see Figure 7.4).

4.5.3 Generally the thickness of integral tank plate floors is to be not less than 80% of the thickness of the centre girder. The thickness of plate floors in the engine space and at the boundaries of double bottom tanks is to be at least 1mm thicker than plate floors elsewhere.

4.5.4 Where the depth of the floor exceeds 1m, vertical stiffeners are to be fitted to plate floors at a spacing not exceeding 1m.

4.5.5 Manholes are to be cut in non-watertight plate floors as necessary to provide adequate access to the double bottom structure. The edges of the manholes are fitted with face flat bars in all cases where the lower edge of the cut manhole is less than 150mm from the connecting shell plating.

4.5.6 Non-watertight plate floors are to be fitted with drainage and ventilation holes sited as low and as high as practicable. The cross-sectional area of ventilation holes in plate floors within tank spaces is not to be less than 25% greater than that of the tank filling pipe.

4.5.7 The thickness of plating forming the boundaries of such tanks is not to be less than that required for the surrounding structure.

4.5.8 The thickness of the tank tops and associated margin plating is to be 80% of the adjacent floor thickness or 6mm whichever is the greater.

4.5.9 If mechanical grabs are to be used to discharge catch, then the thickness of plating is to be increased by 1mm in way of the loading/unloading hatch. This requirement may be waived where the fish room floor is sheathed with timber or other approved material.

4.5.10 Baffle plates are to be fitted in integral tanks to minimise free surface effects.

4.5.11 Fuel/oil tanks with a capacity of 200 litres and above are to have a manhole of sufficient dimension to permit cleaning of the tank. Where the manhole is not sited at the top of the tank, a save-all is to be fitted below the manhole.

4.5.12 Side frames are to be connected to the tank tops by brackets in accordance with Figure 7.3, or to the satisfaction of the Surveyor.

4.5.13 All tanks to be pressure tested to conform fully to section 1.4.4. If it is not witnessed by a surveyor, a certificate confirming compliance is to be provided for each tank.

Section 4.6 – Stem

4.6.1 The stem may be either of the bar or plate type, or a combination of both.

4.6.2 Bar stems are to be in accordance with the scantlings given in Table 6.2, with horizontal web plates connecting the stem bar and ends of longitudinals, stringers, and bulwark rails.

4.6.3 Plate stems are to be in accordance with the scantlings given in Table 6.2, and stiffened with horizontal web plates of a thickness not less than that of the adjacent stem plate, fitted between decks and below the lowest deck, spaced such that the unsupported length of the stem plate does not exceed 1.25m. Whenever possible, the web plates are to be positioned at the ends of longitudinals and stringers. Where the radius of curvature of the plate stem is large, a centreline vertical web may be required to the approval of the Surveyor.

Section 4.7 – Bulbous bows and nozzles

4.7.1 Where bulbous bows are to be fitted, adequate provisions are to be made to ensure access for welding/moulding procedures.

4.7.2 Where bulbous bows are to be utilised as ballast or fresh water tanks, they are to meet the criteria of Sections 11.1.8 and 11.11 respectively of these Standards.

4.7.3 Where a nozzle is to be fitted, details of the hull connection and internal stiffening are to be submitted for approval (see Section 9.4).

Section 4.8 – Stern frames

4.8.1 Stern frames are to be fabricated from heavy plate and bar, stiffened with transverse web frames/floors, and forming an integral part of the hull structure.

4.8.2 Sole pieces with unsupported span of over 1m are to have a heavy centreline web fitted on the top side, suitably integrated with the radius section where the sole piece meets the stern post.

4.8.3 The sole piece is to be extended forward of the stern post by a minimum of two frame spaces, tapered off where required to form the joint to the keel bar.

Section 4.9 – Side framing

4.9.1 The scantlings of transverse main frames are to be in accordance with Table 6.7.

4.9.2 Deep web frames and deep beams fitted in way of heavy deck loads, are to have a depth of at least twice that required for ordinary frames.

4.9.3 Where deep web frames are to be fabricated from plate, face bars are to be fitted and fully welded.

4.9.4 The section modulus is to be at least four times that required for ordinary frames. In vessels of 20m 'L' and over, web frames are to be fitted at every fifth frame in the engine room.

4.9.5 Deep web frames may also be required in way of other highly stressed areas to the approval of the Surveyor.

4.9.6 Side frames are to be bracketed to deck beams, floor plates, inner bottoms and tank tops in accordance with Figure 7.3.

4.9.7 Web frames are to be either connected to deep deck beams by flanged brackets, or fabricated as a ring frame continuous across the deck, in which case the corner is to be radiused to form a ring.

4.9.8 Framing at areas of local stress, in way of gallows, gantries and winches, is to be strengthened to the approval of the Surveyor.

4.9.9 Where the Depth 'h' (Figure 7.6) in relation to side frames is greater than 2.5m, a longitudinal stringer of equal dimension to that required for side frames is to be fitted midway between the deck and floor/tank top connection.

4.9.10 When the construction of the vessel is by use of a pre-cut kit assembly, the frames should be of the web frame/ring type throughout, with 'T' or corner welded face bar.

4.10.11 When it may be decided that face bars not be fitted, the thickness of the plate frame is to be increased to enable an equivalent panel strength to that indicated at Table 6.7.

Section 4.10 – Shell plating

4.10.1 The thickness of shell plating is to be in accordance with Table 6.4.

4.10.2 The thickness of the sheerstrake plating is to be increased in accordance with the Tables in way of areas where excessive wear may occur due to fishing operations. Alternative proposals to this requirement may be submitted for consideration prior to construction commencing.

4.10.3 Chine bars, where fitted, are to be solid round and of diameter as shown in Table 6.12.

4.10.4 Increased thickness shell insert plates, where over 3mm thicker than the connecting shell, are to be tapered at the edge over a slope of 1 in 3, to the thickness of the thinner plate. Insert plate corners are to have a minimum radius of five times the plate thickness.

4.10.5 Rubbing bars, where fitted, are to be of solid section and are to be continuously welded to the shell plating.

4.10.6 In vessels with a stern ramp or chute, the thickness of plating used in that area is to be increased in thickness by 30% greater than required by the Tables for side plating. Wear plates are to be fitted where accelerated abrasion is likely to occur. Alternative proposals to use abrasion-resistant steel may be considered.

4.10.7 Butts and seams in shell plating are to be so arranged as to provide a distance of 100mm from vertical and horizontal framing and structural connections, and in no instance is to exceed 150mm.

4.10.8 All shell plating butts and seams are to run clear of internal structural members. Consideration is to be given in the design of kit vessels to ensure all buts and seams are capable of being effectively welded.

Section 4.11 – Deck beams

4.11.1 Deck beams are to be in accordance with Table 6.8, fitted and bracketed to each transverse frame. Brackets and beam knees are to be in accordance with Figure 7.1 or equivalent. Established shipyard practices for brackets and knees may be accepted at the discretion of the Surveyor, provided equivalent strength is provided.

4.11.2 Beams in way of large deck openings (i.e. greater than 0.2B) and heavy deck equipment, are to be increased in depth by not less than twice the depth of the ordinary beams, as for web frames. All beams and girders in these areas are to be fully welded.

4.11.3 End brackets of deep web beams, where connected to longitudinal bulkheads or coamings, are to be as those required for deck girders.

4.11.4 Where the construction of the vessel is by use of a pre-cut kit assembly, the deck beams are to be of the ring frame type as described at Paragraph 4.9.7.

Section 4.12 – Deck girders

4.12.1 Girders are to be in accordance with Table 6.9 and end brackets in accordance with Figure 7.2.

4.12.2 Girders are to extend over the full length of the deck, excepting where a longitudinal bulkhead is fitted at a similar position.

4.12.3 In vessels where construction is of the longitudinally framed system, consideration may be given for the use of longitudinal deck stiffening in conjunction with web frames/beams, subject to the prior submission and approval of details. Such web frames/beams are to be fitted at plate floor positions as detailed in Paragraph 4.4.2.

4.12.4 Where deck girders are scalloped for the passage of continuous deck beams, the depth of the girder is to be twice that of the beam, except where welded collars are fitted over beam/girder penetrations (see Figure 7.8).

4.12.5 Tripping brackets from beam to girder are to be fitted in way of pillars, and at every third frame space clear of pillars (see Figure 7.8).

4.12.6 Where a connection between girders of dissimilar metals is made, an insulating material is to be fitted between the girders and connected with bolts of compatible material or fitted with insulating ferrules/washers. Alternatively the joint may be transitioned using a bi-metallic welding strip connection.

Section 4.13 – Deck plating

4.13.1 The freeboard deck is to be of watertight construction and extend from stem to stern with positive freeboard throughout in any condition of loading of the vessel. The freeboard deck may be stepped, recessed or raised provided the stepped recessed or raised portion is of watertight construction.

4.13.2 The thickness of deck plating is to be not less than 6.5mm for steel and 8mm for aluminium alloy. Where frame spacing exceeds 500mm, the thickness of the deck plating is to be increased by 0.5mm per 100mm increase in spacing for steel, and 1mm per 100mm increase in spacing for aluminium alloy.

4.13.3 All openings in deck plating are to be adequately framed and with corners radiused to a minimum of 25mm.

4.13.4 Deck plating in way of masts, winches, machinery, gantries, etc., and all areas subjected to increased loads or stress, is to be increased in thickness and strengthened.

Section 4.14 – Deck sheathing

4.14.1 Wood sheathing, where fitted to a steel deck, is to be of an approved timber and fitted up to flat bar margins in way of all deck fittings and waterways. Margin bars of a thickness 15% greater than the deck plating are to be welded with a continuous sealing run to one side to prevent water ingress under the sheathing. The fastening of the deck sheathing is not to affect the integrity or strength of the deck plating.

4.14.2 The finished thickness of the wooden sheathing is to be 60mm in soft wood and 55mm in hardwood.

4.14.3 Wood sheathing is to be laid in an approved bedding compound and secured by steel studs to the deck plating, spaced not more than the width of the beam spacing.

4.14.4 The securing nuts are to be recessed below the surface of the wood. Recesses for securing nuts are to be filled with edge grained dowels or suitable filling compound flush to the surface of the deck.

4.14.5 The sheathing is to be arranged with an acceptable shift of butts, caulked or otherwise sealed to prevent the ingress of water.

Section 4.15 – Pillars

4.15.1 Where the unsupported span of deck girders exceeds 3m, pillars, in accordance with Table 6.19, are to be fitted.

4.15.2 In way of the fish hold, the hold pound stanchions may be accepted as meeting the requirements of pillars, subject to these being of equivalent section modulus and inertia, and that they are permanently attached to the hull and deck structures.

4.15.3 Details of pillars fitted in way of areas of local stress and heavy deck equipment are to be submitted for consideration.

4.15.4 Pillars may be of solid round, tubular or hollow square section, and are to be connected with brackets at the head and heel connections.

4.15.5 Pillars are to be positioned, whenever practicable, at the intersection of floors and longitudinal structural members at the bottom, and at the intersection of longitudinal deck girders and beams at the top. Where this is not practicable, or where positioned over floor or girder manholes, additional local stiffening is to be fitted to the approval of the Surveyor.

Section 4.16 – Bulkheads

4.16.1 Watertight bulkheads are to be fitted in all vessels as required by Part 3, Section 3.9.

4.16.2 The thickness of plating, stiffener spacing, and section modulus of stiffeners for watertight bulkheads are shown in Table 6.10.

Section 4.17 – Bulwarks and hand rails

4.17.1 The perimeter of any exposed deck and the top of any deckhouse is to be provided with a combination of bulwarks, guardrails or taut wires of sufficient strength and at a height of at least 1m. Bulwarks, rails or wires must be supported efficiently by stays or stanchions. The openings between the courses of any rail or wires should not exceed 230mm for the lowest course and 380mm for any other course. When application of such measures would impede the proper working of the vessel, equivalent safety measures may be considered.

4.17.2 Where there is a risk of any member of the crew falling through an opening in the deck, or from one deck to another, then so far as is reasonably practical protection, as in Paragraph 4.17.1, is to be provided.

4.17.3 Access to installations above the deck for operations or maintenance purposes is to be provided with guardrails or similar protection to prevent falls and to ensure the crew's safety. Where guardrails provide such protection, they are to be of appropriate height.

4.17.4 Where required for fishing operations, the height of the fixed bulwarks may be reduced providing portable rail arrangements are installed when not fishing to the regulatory height.

4.17.5 Plate bulwarks are to be fitted with a substantial top rail section fully welded thereto.

4.17.6 Bulwark stays of flat bar or flanged plate are to be fitted at alternate frames. Thickness of the stays is to be not less than the bulwark plating. Stays should be continuously welded to prevent corrosion, and where not landing above the deck beam, landed onto a substantial plate pad fully welded to the deck plating.

4.17.7 Additional bulwark stays are to be fitted in way of gantries or gallows.

4.17.8 Plate thickness of fixed bulwarks is to be determined from Table 6.11.

4.17.9 On stern trawlers with ramps, the upper part of the ramp, is to be fitted with a gate or similar protective guard of the same height as the bulwarks or adjacent structure. Details of other openings in plate bulwarks are to be submitted for consideration.

Section 4.18 – Bilge keels

4.18.1 Bilge keels, where fitted, are to be of plate, flat bar, or bulb flat, suitably stiffened, radiused or tapered at ends, and arranged to terminate over an internal frame or stiffener. Bilge keels should not extend beyond the projected vertical line of the side plating at waterline level.

4.18.2 The hull plating is to be reinforced in way of the bilge keel by a welded flat bar with a thickness of not less than the adjoining shell plate and with a minimum width of 12 times thickness. The flat bar is to be secured to the hull with full continuous fillet weld. Welding of the bilge keel to the flat bar is to be by light continuous fillet (see Figure 7.5).

4.18.3 Bilge keels of an unusual design will be specially considered for approval prior to fitting.

Section 4.19 - Superstructures and deckhouses

4.19.1 On vessels fitted with steel or aluminium shelter decks above the main or freeboard deck, the plating sides and associated stiffeners are to be determined from Tables 6.13 through to 6.18.

4.19.2 The shelter height is to be sufficient so as to provide adequate headroom, but should not obscure all round vision from the steering/navigation position, and are to comply fully with current statutory requirements for visibility ahead.

4.19.3 Full shelters are defined as those structures whose length extends from the stem to the stern, and whose width extends across the breadth of the vessel rail to rail.

4.19.4 Partial shelters are defined as enclosing a part of the deck forward, aft, or in the mid body, and which may extend the full breadth of the vessel.

4.19.5 Where the shelter volume is to be included in the vessel's stability criteria for the purpose of additional intact buoyancy, it is to be constructed weathertight (WT) as an enclosed superstructure, fitted with approved weathertight doors, hatches, and a means of draining the enclosed deck space.

4.19.6 Non-weathertight (NWT) shelters (which may extend full breadth over part or the whole of a vessel's length) should be fitted with freeing ports in accordance with current statutory requirements.

4.19.7 Where the shelter is to be left open at the end, consideration should be given to the installation of a full or partial bulkhead to prevent the passage of water to other parts of the deck and to minimise free surface effect.

4.19.8 Where shelters are left open at the end, consideration is to be given to the size and location of freeing ports to ensure the effects of free surface are minimised.

4.19.9 Decks and shelter tops in way of masts, derricks, machinery and other areas of additional deck loading, are to be strengthened with web frames or deep beams and pillars.

4.19.10 Where deck thicknesses are to be increased, deck inserts are to be used and are to have radius corners with a minimum radius of 10 times plate thickness. **Doublers are not to be used!**

4.19.11 Pillars are to be fitted such that the unsupported span of the deck girder does not exceed 3m. Pillars are also to be fitted in way of other areas subjected to additional loading.

4.19.12 Rails and stanchions are to be fitted to the tops of shelters and in way of all loading hatches (see Section 4.18 and 7.15).

4.19.13 Gutting hatches or ports and offal chutes fitted in weathertight shelter sides, are to be fitted with a means of closing weathertight as described in Section 3.8.

4.19.14 The shelter top should have a non-slip surface.

4.19.15 In the case of vessels fitted with an enclosed shelter, an additional access from within to the shelter top is to be fitted to facilitate escape in an emergency. The position of the escape is to be agreed with the Surveyor and dimensions are to be not less than 600mm x 600mm.

4.19.16 Full length shelters should include the provision of a recessed ladderway in the construction at each side of the shelter. Recesses should have a minimum width of 500mm and continue from the shelter top position to the freeboard deck level (see Section 7.16).

