

Liberty replacement

Design background to the Doxford & Sunderland Shipbuilding Group's standard cargo vessel

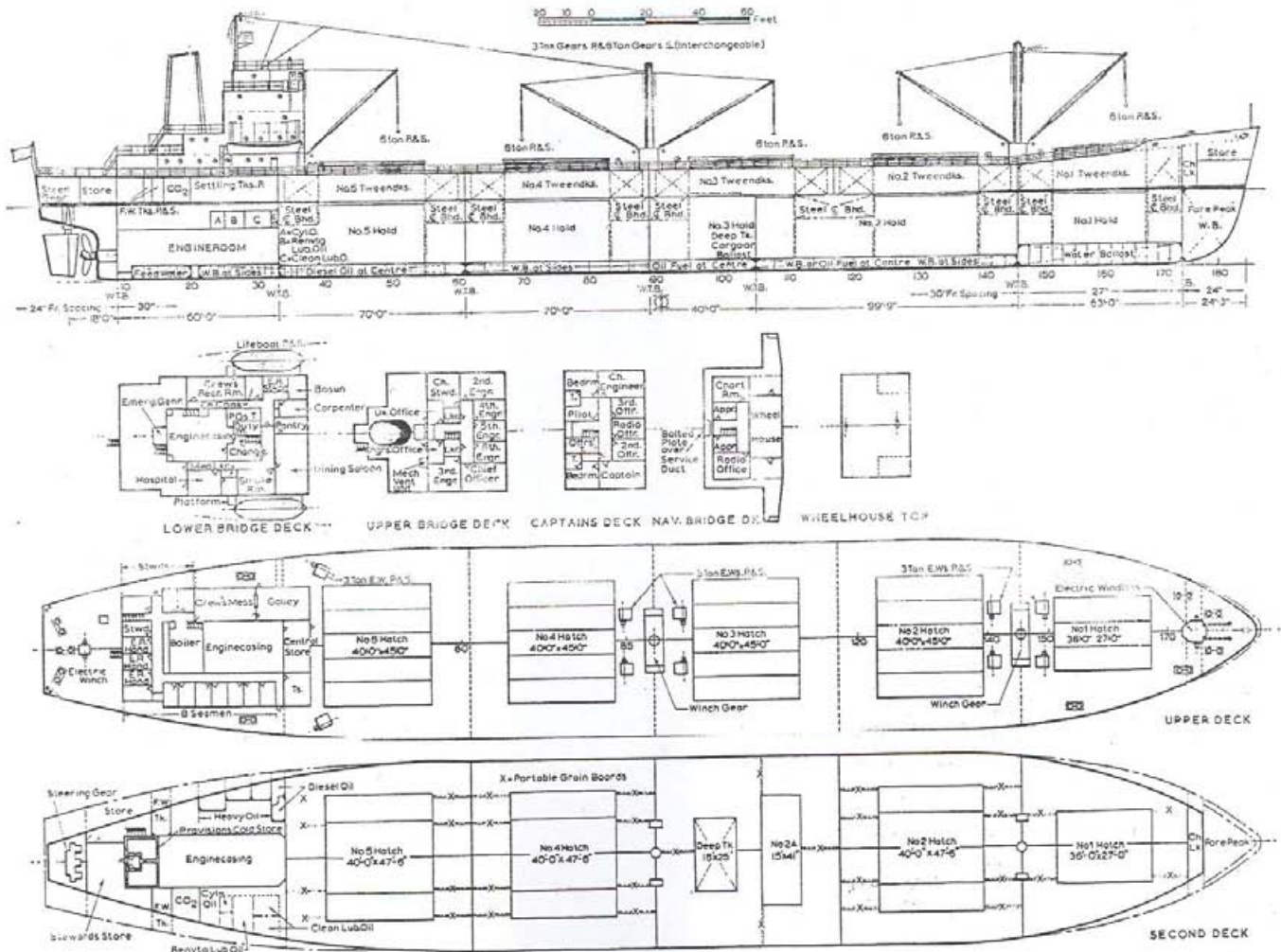
THE DEVELOPMENT of the design of this vessel has been proceeding recently in order that the Doxford & Sunderland Shipbuilding Group could offer, to interested owners, a simple type of general cargo vessel of the class which has come to be known as a Liberty replacement. The initial parameters fixed at the commencement of the design study were 14,000 tons deadweight on a draught of 28ft 0in (8.54m) and a service speed of 14 knots when powered by the new Doxford 58J4 oil engine.

In order to be able to offer the vessel at an attractive price it was essential for the basic design of the vessel to be kept as simple and straightforward as possible and indeed this has been the keynote of the development of this project. With this object in mind it was considered essential for the machinery and accommodation to be situated right

aft so as to provide clear cargo and deck spaces and eliminate the shaft tunnel. The 58J4 engine is particularly suited to this due to its compact size and freedom from objectionable forces and couples, which are prone to the production of hull vibration with aft engine installations. This led naturally to dividing the cargo spaces into five holds, one of which had to be suitable for use as a deep tank for water ballast to produce a satisfactory trim in the ballasted condition. As the length of this hold was less than the average hold length, the opportunity was taken to provide also one long hold for the carriage of long items of cargo. Also, to make the ship as versatile a cargo carrier as possible, the 'tween deck height has been arranged to provide a clear headroom of 9ft 0in (2.74m) for container stowage or the carriage of lorries, and

for the heavier types of bulk cargo scantlings have been incorporated so that these may be loaded with the deep tank empty.

At this stage of the development preliminary discussions with shipowners established that there was a definite interest in wide hatchways, and investigations into this requirement revealed that by using suitably dimensioned longitudinally disposed pontoon hatches, on both the upper and second decks, an extremely flexible layout could be produced which gives a high degree of versatility for carrying general, specified, and bulk cargoes. The major portion of the sub-division required by the Grain Regulations is provided by hinging the second deck hatch covers into a vertical position, and the sizes and positions of the hatches have been arranged so that the only other work



necessary to load grain is the fitting of standard lengths of wood planks to complete the division; no portable steelwork is required. Alternative positions of the divisions are provided to allow for cargoes of differing density and cubic. Cargo may also be carried on deck within the requirements of the classification rules.

The cargo gear has been arranged to provide a pair of derricks at each hatch with either 3 or 6 ton lifts, the latter being sufficient to lift the upper deck, pontoon sections and to open the second deck hinged sections.

A hull form with ample beam has been developed to fulfil the design parameters within a reasonable overall length, and this has also assisted in enabling the centre of buoyancy to be suitably positioned to suit the trimming of a vessel with machinery aft. A model of the form has been tested at the

P.L. establishment at Teddington with most satisfactory results. It may be worth recording that the lines of the new vessel were produced in the same department as that which was responsible for the lines of the original Liberty vessels, which were based on the "North Sands" type war built standard ship. An open water stern with spade rudder is incorporated in the design in which the whole after end structure is designed as a single fabricated unit without a separate stern frame. With this arrangement it is possible to unship the rudder without docking the vessel should the need arise.

The hull structure is, of course, completely welded and arranged to suit the facilities at any of the Group's yards. If desired, higher tensile steel may be incorporated with consequent increase in deadweight. The superstructure has been designed for simple production, and the internal arrangement in the accommodation has been laid out so that the principal services—such as piping and wiring—can be led through a service duct to all decks. Plastic faced bulkheads and linings are used throughout the accommodation to reduce the need for maintenance.

From the commencement of the project advantage has been taken of all the latest amendments of tonnage, load-line and classification rules so that the vessel is offered as completely up to date in all respects. In addition, provision has been made for the incorporation of additional features which individual owners might require above the items covered in the standard specification. The machinery specification has been developed with a view to providing a simple basic arrangement, to which a number of optional extras can be added with the minimum rearrangement of the engine room.

Details of arrangement and equipment

PRINCIPAL PARTICULARS

Length overall	462ft 6in (140.97m)	Deadweight (scantling) ..	14,650 tons
Length b.p.	445ft 0in (135.64m)	(tonnage)	12,550 tons
Breadth moulded	71ft 0in (21.64m)	Capacity (grain)	770,000ft ³ (21,803m ³)
Depth moulded (to UD) ..	38ft 3in (11.66m)	(bale)	700,700ft ³ (19,812m ³)
(to MD)	28ft 3in (8.61m)	Power output	5,400 b.h.p. @ 135 r.p.m.
Draught (scantling)	28ft 2in (8.59m)	Service speed	14 knots
(tonnage)	20ft 4½in (7.13m)		

The vessel will be built to the requirements of Lloyd's Register class ∇ 100.A1 and is arranged for the carriage of heavy cargoes with No. 3 hold (deep tank) empty. The hull is flush-decked with a raked stem and transom stern, and has straight-line sheer forward and aft, while the 'tween deck has neither sheer or camber.

Floors are spaced at 30in (76mm) centres except forward under No. 1 hold, where they are closed to 27in (68mm), and at the ends in the peak spaces where they are further closed to 24in (61mm). A double bottom extends over the whole length, is made deeper under No. 1 hold and the engine room, and is used for water ballast, fuel oil and feed water; while fresh water, diesel oil, lub. oil, etc., is carried in tanks on the 'tween deck aft. Liquid capacities are as follows:—

Water ballast (@ 35ft ³ /ton)	
Fore peak	245 tons
Double bottom (including 440 tons in dual purpose tanks)	1,500 tons
After peak	65 tons
Deep tank	1,930 tons
Total	3,740

Oil fuel (@ 39ft ³ /ton)	
Double bottom (including 380 tons in dual purpose tanks)	790 tons
Settling tanks—fuel oil	44 tons
—diesel oil	20 tons
'Tween decks—diesel oil	110 tons
Total	964

Fresh water (@ 36ft ³ /ton)	
Double bottom (feed water)	75 tons
'Tween decks (fresh water)	65 tons
Total	140 tons

The tank top can support fork lift trucks with an all-up weight of 17 tons, and the 'tween deck up to 4 tons.

Five cargo holds are arranged forward, and while the 'tween deck spaces are generally of equal length, the lower hold of No. 3 is shortened and that of No. 2 made correspondingly longer. The hatches are closed by pontoon covers, hinged and flush fitting in the 'tween deck, except at No. 3 lower lower hold, which is arranged as a deep tank and is closed by a hinged watertight plate. Partial centre line bulkheads are fitted in the lower holds clear of the hatch square.

The hinged 'tween deck covers are vertically positioned to act as grain bulkheads, and wood boards are provided to fill the space between them and bulkheads. No ceiling is provided for the tank top, which is increased in thickness as per Rule requirement; while the 'tween deck is vertically sparred, and the lower hold horizontally sparred, with whitewood battens. In the deep tank 2in x ½in convex steel rod is welded to the frames. Natural ventilation to the cargo spaces is by four cowl or mushroom type units to each hold, all provided with effective means of closing.

Cargo handling gear comprises two 6-ton derricks with 12ft (3.66m) outreach at each hatch, stepped from pairs of samson posts and the bridge face, each provided with individual cargo and topping winches. Each pair of electric cargo winches has Ward Leonard control set and a pull of 3 tons at 100ft (30.48m)/min. Deck machinery comprises a windlass with warping ends to take 2½in cable, and a warping winch with a pull of 5 tons at 56ft (17.07m)/min; both electric powered. Ground tackle supplied consists of three 84½cwt bower anchors and 20 shackles of 2½in cable, for towing there is 109 ft of 5½in 37-strand F.S.W.R., and for mooring four 98ft of 3½in 24-strand F.S.W.R. complete with reels.

Accommodation provided includes suites for the master and chief engineer, and single cabins for 12 officers, a pilot, two apprentices, four petty officers and 15 crew, ventilated by a conventional mechanical system with steam heater to maintain an internal temperature of 70°F in ambient conditions of 30°F.

Bulkheads and linings throughout are faced with hard plastic, but the engine room casing, galley, pantry, and all bathrooms and toilets are unlined internally. Furniture in public rooms and officers' cabins are of chipboard faced with a suitable veneer, while stained and varnished gaboon plywood is used for the petty officers' and crews' messrooms and accommodation. All tables, drawers and desks have plastic tops; and all floors laid with 2mm vinyl except in bathrooms, toilets, and the galley, which have tiles.

Fresh and salt water services are operated on the pressure system, comprising three 3-ton/hr pumps: one for each system and the third acting as a common standby. The hot water system

is operated from a thermostatically controlled steam heated calorifier supplied from the F.W. pressure tank, and a draw-off tap placed in the messroom to provide cooled water from the tank in the vegetable room.

The galley is equipped with a range having two ovens, heated bread prover, heated steaming oven, hot water boiler—all electrically worked—stainless steel dough trough, working top, chopping block, etc., and the necessary shelving and storage space. A canopy with a mechanical extraction fan is fitted over the range.

The cool and chilled rooms have the capacities, and are maintained at the temperatures, shown below:—

Cool (vegetable) room	500ft ³	35°F.
Chilled (meat) room	650ft ³	18°F.
Handling room	300ft ³	

uncooled by an electrically powered compressor set operating for not more than 12 hr/day with a sea water temperature of 85°F. and an ambient air temperature of 95°F. The chambers are insulated with glass fibre lined with Oregon pine-faced plywood, and the floor lined with slab cork finished with granolithic cement 1½ in thick and reinforced with expanded metal.

Lifesaving requirements are met by two 24ft (7.31m) glass fibre lifeboats, one powered by a single-cylinder air-cooled diesel engine for a speed of 4 knots, stowed under single-pivot davits, and supplemented by an inflatable life-raft to accommodate 20 persons.

Nautical instruments are provided on the following scale: one standard magnetic compass with 10in bowl and azimuth ring and reflecting prism to the wheelhouse, spare reflector compass bowl and card, six clocks, an aneroid barometer, foghorn, Cherub log, and portable loud hailer; other items are owner's supply. Steering gear is of the 2-ram electric/hydraulic type having two pump units, each with its own motor, and working together move the rudder through 65deg in 28sec at full speed, and in 50sec working individually.

Main propulsion is by a 4-cylinder Doxford type 58J4 turbocharged oil engine with a maximum continuous rating of 6,000 b.h.p. at 140 r.p.m. and designed to operate on fuel oil having a viscosity not exceeding 1,500sec Redwood No. 1 at 100°F. with alternative connections for immediate switching over to diesel oil. This is a new engine in the J range which has a bore of 580mm, a stroke of 1,850mm, and incorporates an exhaust gas turbocharger and auxiliary blower. A feature of the design, as is apparent from the general arrangement, is the short length of engine room. The engine is directly coupled to a solid manganese bronze propeller by solid forged steel

shafting. Controls are situated at the fore end of the engine, to starboard, at bottom platform level.

Electric power at 440V 3-phase 60c/s a.c. is supplied by three 250kW alternators each powered by diesel engines running at 1,200 r.p.m. Low power services for lighting are supplied through three transformers at 220V single-phase a.c. Duplicate circuits are provided for the steering gear, and cable is of the butyl insulated PCP sheathed type or 250V grade as per Rule requirements. Incandescent lighting is arranged throughout the accommodation, passage ways, store spaces, and engine room. Other lighting fittings include a 500W tungsten iodine mast floodlight and connections for two 60W weather deck lights, two 300W and two 100W lifeboat lights and three 60W portable hand lamps for store spares and the steering gear compartment.

In addition to wiring for all specified items, wiring is also run for the following items of owner's supply: gyro compass, communications and D/F equipment, echo sounder, broadcast receiver and four extensions, loud hailer, radar, and searchlight. For emergency purposes a 5kW hand-started alternator set is installed on the lower bridge deck with its own switchboard for emergency circuits to navigation and anchor lights, morse and signalling lamps, boat lights, and 36 selected points on the weather deck and in the accommodation. For shore connection a 200A box is provided.

Steam for auxiliary purposes is generated at 100 p.s.i. in a vertical composite boiler utilising the exhaust gases from the main engine and simultaneously oil-fired by a manually operated system, each section supplying 2,500lb/hr of steam. Starting air at 450 p.s.i. is provided by two 2-stage electric air compressors, each with a capacity of 70ft³/min, and by an emergency compressor at 6ft³/min 350 p.s.i., powered by a single-cylinder diesel engine. Feed water is supplied by two pumps, each with a capacity of 600gal/hr. Air is stored in two vessels each with a capacity of 110ft³ at 450 p.s.i.

The following list of pumps are installed:—

two fresh water (for jacket and upper pistons)	150 tons/hr @ 40 p.s.i.
two fresh water	3 tons/hr @ 20 p.s.i.
two lower piston cooling & lub. oil	100 tons/hr @ 50 p.s.i.
one sea water	275 tons/hr @ 25 p.s.i.
one ballast	275 tons/hr @ 30 p.s.i.
two general service & bilge	90 tons/hr @ 220ft head
one fuel oil transfer	20 tons/hr @ 25 p.s.i.
one fuel oil transfer	5 tons/hr @ 25 p.s.i.
two fuel oil booster	2.2 tons/hr @ 100 p.s.i.

An engineers' workshop is situated to port in the engine room and fitted with one 7in lathe, one 20in vertical driller and a double-ended grinder—all powered by independent electric motors, a steel

workbench with two vices, and a tool cabinet.

The engine room is ventilated by two axial flow electric fans, each with a capacity of 20,000ft³/min, with branches led to the workshop and storerooms, and provided with remote stop push-buttons. All pipe systems are of mild steel, only that for sea water being galvanised.

