

## **PART 8**

### **MACHINERY INSTALLATIONS**

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## **MACHINERY INSTALLATIONS**

### **Section 8.1 – General requirements (main propulsion)**

- 8.1.1 The requirements for main propulsion are based on the installation of diesel powered units using fuel oil with a flash point of not less than 60°C. In all cases the engine power is to be in accordance with engine Manufacturer's rating to ISO/DIN Standards.
- 8.1.2 Machinery installations are also to comply with MSN 1770(F).
- 8.1.3 Attention is drawn to Chapter 11 of the Code, "Clean Seas", regarding prevention of pollution.
- 8.1.4 Machinery and pressure vessels are to be of a design and construction adequate for the service for which they are intended. Due regard is to be given to moving parts, hot surfaces and other hazards.
- 8.1.5 It is the responsibility of the Shipbuilder to ensure that all relevant information required by both Seafish and MCA is submitted in good time to enable their early consideration.
- 8.1.6 Main engines are to be identified by stamping of tally plate permanently attached to the engine. Details are to include model, serial, power rating and date of manufacture.
- 8.1.7 On vessel completion, a certificate of maximum engine and details of any de-rating and the procedure used is to be supplied by the engine Manufacturer/Supplier.
- 8.1.8 Where risk from over-speeding of machinery exists, provisions are to be made to ensure that the safe speed is not exceeded.
- 8.1.9 Machinery systems using main propulsion engines of 250kW capacity and above are to be provided with particulars of torsional vibration calculations. The calculations are to be carried out by recognised techniques for the full dynamic range of the propulsion system likely to be encountered in service.
- 8.1.10 Machinery installations are to be arranged with due regard to the safety of crew members, and be so installed and protected as to reduce to a minimum any danger to persons during normal movement about the engine room.
- 8.1.11 Attention is to be given to moving parts, walking areas, hot surfaces and maintenance accessibility. Passageways between main engines, auxiliary sets and switchboards are to be of a sufficient width, and are to be not less than 600mm.
- 8.1.12 All exposed moving parts are to be fitted with suitable protective guards.

- 8.1.13 Machinery spaces are to be designed to provide safe and free access to all parts of the machinery that may require servicing at sea.
- 8.1.14 Main and auxiliary machinery essential for the propulsion and safety of the vessel is to be provided with effective means of control. The machinery is to be capable of being brought into operation from the 'deadship' condition. Machinery spaces that will be periodically unattended at sea are to be provided with proper alarm, detection and machinery control systems.

### **Section 8.2 – Escape arrangements**

- 8.2.1 Two means of escape from the machinery space are to be provided, separated as far apart as practical, and be diagonally opposed where possible. Escape routes are to be clearly marked and be provided with steel ladders or rungs and hand rails for easy access.
- 8.2.2 Each hatch is to have a minimum clear opening of 600mm x 600mm and each doorway a minimum clear opening width of 600mm. Escape routes should be kept clear of obstacles as far as is practicable.
- 8.2.3 Escape hatches and doors are to be constructed of steel or other approved material to A30 fire rating standards, and are to be provided with handles or clips which are operable from both sides. Consideration will be given to the provision of central spindle or linked operating arrangements to escape hatch door clips to enable them to be quickly opened in an emergency.

### **Section 8.3 – Control spaces**

- 8.3.1 Main engines controlled from the engine room should also be controlled from a separate area, soundproofed and insulated from the engine room, and accessible without entering the engine room.
- 8.3.2 The wheelhouse is considered to be an area that meets the requirements of Paragraph 8.3.1.
- 8.3.3 To ensure safety of personnel, arrangements are to be provided to start and stop the main engine(s) from the engine room, in addition to any wheelhouse control.

### **Section 8.4 – Engine starting**

- 8.4.1 Main or essential auxiliary engines are to be capable of being started from the deadship condition without external aid. Such means should be hydraulic, air, hand or electric starting or other means acceptable to the Certifying Authority.
- 8.4.2 Main engine starting arrangements are to be adequate to start the main engine, or engines not less than six times in succession.

- 8.4.3 When the sole means of starting is by battery, provision is to be made, via a changeover switch, to make available an alternative battery as a safeguard for starting. Charging facilities are to be available for the batteries in accordance with the requirements of Paragraph 10.4.12.
- 8.4.4 Vessels in which machinery essential for the propulsion and safety of the vessel are required to be started, operated or controlled solely by compressed air, should be provided with an efficient air system including an adequate number of air compressors and air storage receivers, and are to be so arranged as to ensure that an adequate supply of compressed air is available under all foreseeable service conditions.
- 8.4.5 Air pressure systems are to be designed, constructed and pressure tested to the satisfaction of the Certifying Authority.
- 8.4.6 Means are to be provided to prevent excess pressure in any part of compressed air systems.
- 8.4.7 The main engine starting air arrangements are to be adequately protected against the effects of backfiring and internal explosion in the starting air pipes.
- 8.4.8 All discharge pipes from starting air compressors are to lead directly to the starting air receivers, and all starting pipes from the air receivers to main or auxiliary engines are to be entirely separate from the compressor discharge pipe system.
- 8.4.9 Provision is to be made to reduce to a minimum the entry of oil into the air pressure system and to drain these systems. Air receivers are to be fitted with drain valves at the lowest point.

### **Section 8.5 – Engine controls and instruments**

- 8.5.1 In vessels where the engine room is to be unattended, and the main engine and auxiliary machinery essential for propulsion and safety is by the electric start method, each engine is to be capable of being started and stopped from the wheelhouse control position and from the engine room.
- 8.5.2 An effective means of communication between the wheelhouse and engine room is to be provided, along with an override system to prevent accidental machinery starting and injury to crew members who may be working on the machinery.
- 8.5.3 The main engine emergency stop should be completely independent from all instrumentation and alarms.

8.5.4 The minimum recommended alarms are as follows:-

Monitor	Item	Alarm
RPM	Engine revolution counter	(Overspeed protection device)
Oil pressure	Engine lubricating oil system	Alarm / low pressure
Oil pressure	Gearbox lubricating oil system	Alarm / low pressure (where applicable)
Temperature	Engine cooling water	Alarm / high temperature
Running time	Engine hour meter	(Incorporated RPM counter)
Charge / discharge	Engine start batteries	Alarm / ammeter / indicator
Charge / discharge	Service / emergency batteries	Alarm / ammeter / indicator
Air pressure	Starting air receivers	Alarm / low pressure
Capacity	Daily service O/F tank	Alarm / high / low level
Temperature	Engine exhaust gas	Indication gauges only

8.5.5 The instruments and gauges are to be clearly marked to indicate abnormal conditions. Where alarms are applicable they should be both audible and visual.

8.5.6 In vessels where controllable pitch propellers are fitted, a propeller pitch indicator is to be installed at the helm position.

8.5.7 Engine stop facility and speed/ahead and astern controls are to be fitted at the helm position.

### Section 8.6 – Engine seatings, mounting and installation

8.6.1 The seatings are to be suitable to withstand the maximum thrust and dynamic forces appropriate to the intended service of the vessel and hold the engine in place during all operating conditions.

8.6.2 Engine and shaft alignment is to be as stated by the Manufacturer.

8.6.3 Where the engine is installed on flexible mountings, a flexible coupling is to be fitted between the engine/gearbox coupling and the propeller shafting. Care is to be taken to ensure that all connections to the engine are also flexible and will not be damaged by engine vibration and movement.

8.6.4 Engine mountings are to be protected from the possible detrimental effects of oil.

8.6.5 Solid mounting and alignment may be carried out using solid metal chocks under engine and gearbox feet and holding down bolt positions, or by the use of approved resin compounds.

8.6.6 Solid steel chocks are to be fitted by hand or machine grinding and be not less than 20mm in thickness. Pourable chocking compounds are to be used by approved personnel and to the Manufacturer's requirements.

- 8.6.7 Records of alignment of shaft/coupling face to gearbox face tolerances are to be kept by the Installer.

### **Section 8.7 – Exhaust arrangement**

- 8.7.1 Exhaust pipes and silencers of all engines are to be adequately cooled or lagged. Oil and fuel pipes are to be kept as clear as practicable from exhaust pipes and turbochargers.
- 8.7.2 Exhaust systems are to be lagged with an approved fireproof material, and where the lagging may be oil absorbing or may permit the penetration of oil, the lagging is to be encased in thin gauge sheet metal or an equivalent protection. The lagging insulation is to be sufficient to prevent contact burn injury to personnel.
- 8.7.3 When dry type engine exhaust piping is fitted outside of machinery spaces or enclosed steel trunkings, contact with flammable materials is to be carefully avoided. The pipework is to be properly lagged and sealed to prevent accelerated corrosion, and all fixings and brackets are to be insulated to prevent the spread of heat to other surfaces.
- 8.7.4 Main engine and auxiliary set exhausts are to be fitted with the minimum number of bends possible, and the pipe is to be of a diameter as required by the engine Manufacturers. All joints are to be gas tight, and the piping system including silencer is to be adequately supported by hangers or brackets designed to allow for expansion and contraction.
- 8.7.5 The exhaust gas is to be dispersed so that it does not detrimentally affect the air cleaner function, the permitted maximum machinery space temperature, and the system must be so arranged as to prevent the entrance of water into the engine or turbo charger.
- 8.7.6 The exhaust pipe connection to the engine is to be made by the use of a flexible bellows arrangement, which may be mounted vertically or horizontally provided it is installed in a straight run of pipe without bends or offset.
- 8.7.7 Wet exhaust systems are to be cooled by the engine's circulating sea water, and are to be self-draining directly overboard. The pipe end is to be fitted with a corrosion-resistant shut-off flap arrangement to prevent water back-flooding the space or entering the engine exhaust manifold. In addition, a water trap or inverted 'U' bend type muffler arrangement is to be fitted in the system.
- 8.7.8 The wet exhaust pipework is to be of an approved flexible type heat and acid-resistant rubber hose, adequately supported to the hull structure.
- 8.7.9 The exhaust outlet is to be sufficient distance from all intakes and exhaust ventilation positions to prevent exhaust gasses from re-entering the machinery space.

## **Section 8.8 – Machinery space ventilation**

- 8.8.1 The ventilation of the machinery space is to be adequate for all conditions of operation of the vessel and its machinery without the need for doors or escapes to be opened, and is to meet the requirements of the engine Manufacturers. Ventilation is to provide air both for combustion and cooling requirements. When auxiliary machinery is fitted, additional ventilation is to be provided to ensure sufficient air capacity for the efficient running of all items of machinery.
- 8.8.2 It is essential that the airflow is adequate and properly directed, with the air supply trunked or directed to as low a point as practical in the machinery space, and exhausted from ventilators positioned directly above the main heat sources. Supply air should not be directed towards hot engine components.
- 8.8.3 Where engine starting and lighting batteries are located in the machinery space, they are to be installed in adequate boxes ventilated to outside atmosphere in accordance with Part 3 of these Standards. IEE Regulations apply to all electrical installations (see Electrical section).
- 8.8.4 Ventilation arrangements are to meet the mandatory requirements of the Code, with respect to closing arrangements for fire protection purposes and coaming heights, and closing for weathertight integrity.
- 8.8.5 When electric supply/extract fans are fitted, adequate means are to be provided for stopping the fans and closing the main inlet and outlet openings of the ventilation systems from a position outside the machinery space. A manual reset button is to be provided at each fan position to prevent accidental restarting from the control position when crew may be working in the vicinity of, or be maintaining, the ventilation fans.

## **Section 8.9 – Engine drive arrangements**

- 8.9.1 Where power 'take-offs' are fitted direct to main propulsion engines and gearboxes for the use of auxiliary driven equipment, the power to be taken off is not to exceed the engine or gearbox Manufacturers' permitted limits. Where clutch arrangements are fitted, they are to be of adequate capacity for the purpose intended and be operable from the engine control position.
- 8.9.2 Power take-off drives fitted to flexibly mounted engines are also to be flexibly mounted and positioned on seatings which are integral with the engine. A flexible coupling of adequate strength is to be fitted between the engine take-off shaft coupling and the driven shaft arrangement, except where the drive is integral with the engine.
- 8.9.3 Where a lay shaft is driven by a pulley and belt arrangement, the driven shaft is to be fitted with bearings of each side of the driver pulley. Drive arrangements to side shafts are to comply with the engine Manufacturer's requirements for permissible side loads.

- 8.9.4 Belt drives are to be arranged with a method of readily adjusting the belt tension; a separate tensioning arrangement is to be provided for each driven item.
- 8.9.5 All driven equipment is to be considered when the engine Manufacturer carries out torsional vibration analysis.

### **Section 8.10 – Auxiliary engines**

- 8.10.1 Auxiliary engines are to be fitted to the best marine practice and with system requirements generally as required for main propulsion engines.
- 8.10.2 Auxiliary engines coupled to electrical generators are to be capable of developing the continuous power and speed required to drive the generator at the fully rated output (kW), and of developing an overload power requirement according ISO/DIN Standards.
- 8.10.3 Each auxiliary engine is to be fitted with an overspeed protection device limiting the engine speed to no more than 15% above the normal running speed.
- 8.10.4 A separate fuel supply arrangement complete with approved duplex filters is to be provided for each auxiliary engine. A separate exhaust system is to be fitted for each engine and be installed as described for the main propulsion engine.
- 8.10.5 Equipment, which is belt driven from an auxiliary engine, is to have suitable arrangements to enable the belt tension to be adjusted for each item of driven equipment. When the driven equipment is not required to be continuously running, a clutch is to be fitted with local control. When the driven equipment is considered essential for safety and control of the vessel, the clutch arrangement should also be capable of remote control from the helm position.

### **Section 8.11 – Propeller, stern gear and shafting**

- 8.11.1 Details of the propeller shaft and intermediate shaft diameters, materials, and installation, are not to be less than that recommended by the stern gear and engine Manufacturer, but in no case less than that required by the formula contained in Paragraph 8.11.9.
- 8.11.2 Propeller shaft bearings, where not of the water lubricated type, are to be fitted with suitable greasing or oiling points positioned for easy access.
- 8.11.3 The distance between the shaft bearings must not be greater than that specified by the formula contained in Paragraph 8.11.11.
- 8.11.4 Where a shaft penetrates a watertight bulkhead, the watertight integrity and strength of the bulkhead is to be maintained.

- 8.11.5 The propeller is to be designed to permit the engine to run at its continuous rating without overload, and with tip clearance to Manufacturer's requirements.
- 8.11.6 The pitch control is to incorporate a stop to prevent over-pitching of the propeller blades at the maximum permitted revolutions and engine power. Where an adjustable pitch propeller is fitted, easy access to the adjustment point should be provided.
- 8.11.7 Suitable arrangements are to be provided for safe access to the stern gland and bearings. Adequate provision is to be made for renewal of stern gland packing.
- 8.11.8 Header tanks for oil-filled stern tubes are to be located in an accessible position, and be complete with level indication or contents gauge.
- 8.11.9 The propeller shaft diameter is to be to the engine Manufacturer's requirements for the engine maximum continuous rating, but in no case less than the minimum diameter required by the following formula:-

$$\text{Required shaft diameter } dp = 100k\sqrt[3]{f}$$

$$\text{where } f = \frac{P}{R} \times \left( \frac{560}{t + 160} \right)$$

$$k = 1.22 \quad \text{where:-}$$

- (i) the propeller is keyless or attached to an integral flange on the shaft; and
- (ii) the shaft is fitted with a continuous liner, or is made from corrosion-resistant material, or is oil lubricated and sea water is excluded from the shaft.

$$k = 1.26 \quad \text{where the propeller is keyed and where note (ii) applies.}$$

$$k = 1.30 \quad \text{where the shaft is of non corrosion-resistant material.}$$

$$P = \text{power transmitted by the shaft in kW.}$$

$$R = \text{revolutions per minute of the propeller shaft.}$$

$$t = \text{specified minimum tensile strength of the material in N/mm}^2.$$

- 8.11.10 In the case of vessels with long shaft lines, (e.g. with engine sited forward) requiring intermediate shafts to be fitted, the diameter of the intermediate shaft is to be calculated by the formula above excepting that:-

$$k = 1.0 \quad \text{for shafts with integral couplings, flanges or shrunk-on couplings.}$$

$$k = 1.0 \quad \text{for shafts with splines where 'd' is to be the diameter at the root of the splines.}$$

$$k = 1.10 \quad \text{for shafts with keyways.}$$

$$k = 1.20 \quad \text{for shafts with longitudinal slots having a length of not more than } 1.4d \text{ and a width of not more than } 0.2d, \text{ where 'd' is determined taking 'k' as 1.0.}$$

8.11.11 The distance between the propeller shaft supports (bearings) must not be greater than that specified given by the following formula:-

$$S = 0.142 \times \sqrt[3]{d^2}$$

where 'S' = distance between bearing centres in metres  
'd' = diameter of shaft in millimetres.