RULES
FOR THE CLASSIFICATION AND CONSTRUCTION OF HIGH SPEED CRAFT

PART VI
MACHINERY AND SYSTEMS

October
2014

GDAŃSK

RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF HIGH SPEED CRAFT

developed and issued by Polski Rejestr Statków S.A., further referred to as PRS, consist of the following parts:

Part I – Classification Regulations
Part II – Hull
Part III – Hull Equipment
Part IV – Buoyancy, Stability and Subdivision
Part V – Fire Protection
Part VI – Machinery and Systems
Part VII – Electrical Installations and Control Systems

With respect to materials and welding, the requirements specified in the *Rules for the Classification and Construction of Sea-Going Ships*, *Part IX –Materials and Welding*, apply.

Part VI – Machinery and Systems – October 2014 was approved by the PRS Board on 15 October 2014 and enters into force on 20 October 2014.

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1 GENERAL

1.1 Application

1.1.1 Requirements of this Part – Machinery and Systems (further referred to as the Rules), apply to high-speed craft, defined in *Part I – Classification Regulations*.

1.1.2 Materials used for the manufacture of the below defined machinery and systems as well as their welds shall generally comply with the requirements of the *Rules for the Classification and Construction of Sea-going Ships, Part IX – Materials and Welding.*

1.2 Symbols and Definitions

1.2.1 Symbols and definitions are given in Part I – Classification Regulations, Part II – Hull and Part V – Fire Protection..

1.2.2 The following definitions are introduced in *the Rules*:

Failure mode and effects analysis (FMEA) – an examination, in accordance with Annex 4 of the *International Code for Safety of High-Speed Craft* (*HSC Code*) *2000*, of the craft's systems and equipment to determine whether any reasonably probable failure or improper operation can result in a hazardous or catastrophic effect.

Datum – a watertight deck or on equivalent structure of a non-watertight deck covered by a weathertight structure of adequate strength to maintain the weathertight integrity and fitted with weathertight closing appliances.

Machinery spaces – spaces and trunks to such spaces containing internal combustion engines with an aggregate total power output of more than 110 kW, generators, oil fuel units, propulsion machinery, major electrical machinery and similar spaces and trunks to such spaces.

Auxiliary machinery spaces – spaces and trunks to such spaces containing internal combustion engines of a power output up to and including 110 kW, driving generators, sprinkler, drencher or fire pumps, bilge pumps, etc., oil filling stations, switchboards of aggregate capacity exceeding 800 kW, similar spaces and trunks to such spaces.

Flashpoint – a flashpoint determined by a test using the closed-cup apparatus referenced in the *International Maritime Dangerous Goods* (*IMDG*) *Code*.

1.3 Technical Documentation of the Craft

Prior to the craft construction, technical documentation within the scope given in subchapter 1.3 of *Part VI – Machinery Installations and Refrigerating Plants* of the *Rules for the Classification and Construction of Sea-going Ships*, shall be submitted to PRS HO for consideration and approval.

1.4 Scope of Survey

The principles for survey of manufacture and construction of craft machinery, mechanisms and systems are specified in subchapter 1.4 of *Part VI – Machinery Installations and Refrigerating Plants* of the *Rules for the Classification and Construction of Sea-going Ships.*

1.5 Pressure Tests

Pressure tests are described in subchapter 1.5 of *Part VI – Machinery Installations and Refrigerating Plants* of the *Rules for the Classification and Construction of Sea-going Ships.*

1.6 General Requirements for Piping Systems

General requirements for piping systems are given in subchapter 1.16 (except 1.16.1) of *Part VI – Machinery Installations and Refrigerating Plants* of the *Rules for the Classification and Construction of Sea-going Ships.*

2 MACHINERY

2.1 General

2.1.1 The machinery, associated piping systems and fittings relating to main machinery and auxiliary power units shall be of a design and construction adequate for the service for which they are intended and shall be so installed and protected as to reduce to a minimum any danger to persons on board, due regard being paid to moving parts, hot surfaces and other hazards. The design shall have regard to materials used in construction, the purpose for which the equipment is intended, the working conditions to which it will be subjected and the environmental conditions on board.

2.1.2 All surfaces with temperatures exceeding 220°C where impingement of flammable liquids may occur as a result of a system failure shall be insulated. The insulation shall be impervious to flammable liquids and vapours.

2.1.3 Special consideration shall be given to the reliability of single essential propulsion components. A separate source of propulsion power sufficient to give the craft a navigable speed, especially in the case of unconventional arrangements, may be required.

2.1.4 Means shall be provided whereby normal operation of propulsion machinery can be sustained or restored even though one of the essential auxiliaries becomes inoperative. Special consideration shall be given to the malfunctioning of:

- **.1** a generating set which serves as a main source of electrical power;
- **.2** the fuel oil supply systems for engines;
- **.3** the sources of lubricating oil pressure;
- **.4** the sources of cooling agent pressure;
- **.5** air compressors and receivers for starting or control air;
- **.6** the hydraulic, pneumatic or electrical means for control in main propulsion machinery, including controllable-pitch propellers.

However, having regard to overall safety considerations, a partial reduction in propulsion capability from normal operation may be accepted.

2.1.5 Means shall be provided to ensure that the machinery can be brought into operation from the dead craft condition without external aid.

2.1.6 All parts of machinery, hydraulic, pneumatic and other systems and their associated fittings which are under internal pressure shall be subjected to appropriate tests including a pressure test before being put into service for the first time.

2.1.7 Provision shall be made to facilitate cleaning, inspection and maintenance of main propulsion and auxiliary machinery, including boilers and pressure vessels.

2.1.8 The reliability of machinery installed in the craft shall be adequate for its intended purpose.

2.1.9 PRS may accept alternative machinery where it has been previously used satisfactorily in a similar application, provided that it is satisfied:

.1 that the design, construction, testing, installation and prescribed maintenance are together adequate for its use in a marine environment; and

.2 that an equivalent level of safety will be achieved.

2.1.10 A failure mode and effect analysis (FMEA) shall include machinery systems and their associated controls.

2.1.11 Such information as is necessary to ensure that machinery can be installed correctly regarding such factors as operating conditions and limitations shall be made available by the manufacturers.

2.1.12 Main propulsion machinery and all auxiliary machinery essential to the propulsion and the safety of the craft shall, as fitted in the craft, be designed to operate when the craft is upright and when inclined at any angle of list up to and including 15° either way under static conditions and 22.5° under dynamic conditions (rolling) either way and simultaneously inclined by dynamically (pitching) 7.5° by bow or stern. PRS may permit deviation from these angles, taking into consideration the type, size and service conditions of the craft.

2.1.13 All boilers, and pressure vessels and associated piping systems shall be of a design and construction adequate for the intended purpose and shall be so installed and protected as to minimise danger to persons on board. In particular, attention shall be paid to the materials used in the construction and the working pressures and temperatures at which the item will operate and the need to provide an adequate margin of safety over the stresses normally encountered in service. Every boiler, pressure vessel and associated piping systems shall be fitted with adequate means to prevent over-pressures in service and be subjected to a hydraulic test before being put into service, and where appropriate at subsequent specified intervals, to a pressure suitably in excess of the working pressure.

2.1.14 Arrangements shall be provided to ensure that, in the event of failure in any liquid cooling system, it is rapidly detected and alarmed (visual and audible). Means shall also be instituted to minimise the effects of such failures on machinery serviced by the system.

2.2 Main Engine

2.2.1 The engines shall be fitted with adequate safety monitoring and control devices in respect of speed, temperature, pressure and other operational functions. Control of the machinery shall be from the craft's operating compartment. The machinery installation shall be suitable for operation as in an unmanned machinery space, including fire detection system, bilge alarm system, remote machinery instrumentation and alarm system. Where the space is continuously manned, this requirement may be waived after PRS consideration.

2.2.2 The engines shall be protected against overspeed, loss of lubricating oil pressure, loss of cooling medium, high temperature, malfunction of moving parts and overload. Safety devices shall not cause complete engine shutdown without prior warning, except in case where there is a risk of complete breakdown or explosion. Such safety devices shall be capable of being tested in operation.

2.2.3 At least two independent means of stopping the engines quickly from the operating compartment under any operating conditions shall be available. Duplication of the actuator fitted to the engine shall not be required.

2.2.4 The major components of the engine shall have adequate strength to withstand the thermal and dynamic conditions of normal operation. The engine shall not be damaged by a limited operation time at a speed or at temperatures exceeding the normal values but within the range of the protective devices.

2.2.5 The design of the engine shall be such as to minimise the risk of fire or explosion and to enable compliance with the fire precaution requirements.

2.2.6 Provision shall be made to drain all excess fuel and oil to a safe position so as to avoid a fire hazard.

2.2.7 Provision shall be made to ensure that, whenever practical, the failure of systems driven by the engine shall not unduly affect the condition of the major safety components.

2.2.8 Any engines shall be so installed as to avoid excessive vibration within the craft.

2.3 Diesel Engines

2.3.1 All external high-pressure fuel delivery lines between the high-pressure fuel pumps and fuel nozzles shall be protected with a jacketed tubing system capable of containing fuel from a high-pressure line failure. The jacketed tubing system shall include a means for collection of leakages and arrangements shall be provided for an alarm to be given of a fuel line failure.

2.3.2 Engines of a cylinder diameter of 200 mm and more or a crankcase volume of 0.6 m3 and above shall be provided with crankcase explosion relief valves of an approved type with sufficient relief area. The relief valves shall be arranged or equipped with means to ensure that discharge from them is directed so as to minimise the possibility of injury to personel.

2.3.3 The lubrication system and arrangements shall be efficient at all running speeds, and capable of maintaining suction and avoiding the spillage of oil in all allowable conditions and degrees of list and trim of the craft.

2.3.4 Arrangements shall be provided to ensure that visual and audible alarms are activated in the event of either lubricating oil pressure or lubricating oil level falling below a safe level, considering the rate of circulation of oil in the engine. Such events shall also cause automatic reduction of engine speed to a safe level, but automatic shutdown shall only be activated by conditions leading to a complete breakdown, fire or explosion.

2.3.5 Where diesel engines are arranged to be started, reversed or controlled by compressed air, the arrangement of the air compressors, air receivers and air starting system shall be such as to minimise the risk of fire or explosion.

2.4 Gas Turbines

2.4.1 Gas turbines shall be designed to operate in the marine environment and shall be free from surge or dangerous instability throughout its operating range up to the maximum steady speed approved for use. The turbine installation shall be arranged to ensure that the turbine cannot be continuously operated within any speed range where excessive vibration, stalling, or surging may be encountered.

2.4.2 The gas turbines shall be designed and installed such that any reasonably probable shedding of compressor or turbine blades will not endanger the craft, other machinery, occupants of the craft or any other persons.

2.4.3 Requirements of 2.2.6 shall apply to gas turbines in respect of fuel which might reach the interior of the jet pipe or exhaust system after a false start or after stopping.

2.4.4 Turbines shall be safeguarded as far as practicable against the possibility of damage by ingestion of contaminants from the operating environment. Information regarding the maximum concentration of contamination shall be made available. Provision shall be made for preventing the accumulation of salt deposits on the compressors and turbines and, if necessary, for preventing the air intake from icing.

2.4.5 In the event of a failure of a shaft or weak link, the broken end shall not pose hazard to the occupants of the craft, the craft itself or its systems. Where necessary, guards may be fitted to achieve compliance with these requirement.

2.4.6 Each turbine shall be provided with an emergency overspeed shutdown device connected, where possible, directly to each rotor shaft.

2.4.7 Where an acoustic enclosure is fitted which completely surrounds the gas generator and the high-pressure oil pipes, a fire detection and extinguishing system shall be provided for the acoustic enclosure.

2.4.8 Details of the manufacturers' proposed automatic safety devices to guard against hazardous conditions arising in the event of malfunction in the turbine installation shall be provided together with the failure mode and effect analysis.

2.4.9 The manufacturers shall demonstrate the soundness of the casings. Intercoolers and heat exchangers shall be hydraulically tested on each side separately.

2.5 Propulsion System

2.5.1 Any main diesel propulsion system shall have satisfactory torsional vibration and other vibrational characteristics verified by individual and combined torsional and other vibration analyses for the system and its components from power unit through to propulsor.

2.5.2 The transmission shall be of adequate strength and stiffness to enable it to withstand the most adverse combination of the loads expected in service without exceeding acceptable stress levels for the used structural material.

2.5.3 The design of shafting, bearings and their mounts shall be such that hazardous rotational vibrations and excessive other vibration could not occur at any speed up to 105% of the shaft speed attained at the designed overspeed trip setting of the prime mover

2.5.4 The strength and fabrication of the transmission shall be such that the probability of hazardous fatigue failure under the action of the repeated loads of variable magnitude expected in service is as low as possible throughout its operational life. Compliance shall be demonstrated by suitably conducted tests, and by designing the transmission for sufficiently low stress levels, combined with the use of fatigue resistant materials and suitable detail design. Torsional vibration or oscillation likely to cause failure may be acceptable if it occurs at transmission speeds which would not be used in normal craft operation, and it is recorded in the craft operating manual.

2.5.5 Where a clutch is fitted in the transmission, normal engagement of the clutch shall not cause excessive stresses in the transmission or driven items. Inadvertent operation of any clutch shall not produce dangerously high stresses in the transmission or driven item.

2.5.6 Provision shall be made such that a failure in any part of the transmission, or of a driven component, will not cause damage which might hazard the craft or its occupants.

2.5.7 Where failure of lubricating fluid supply or loss of lubricating fluid pressure could lead to hazardous conditions, provision shall be made to enable such failure to be indicated to the operating crew in adequate time to enable them as far as practicable to take the appropriate action before the hazardous condition arises.

2.6 Propulsion and Lift Devices

2.6.1 The requirements of this section are based on the assumption that:

.1 Propulsion arrangements and lift arrangements may be provided by separate devices, or be integrated into a single propulsion and lift device. Propulsion devices may be air, or water propellers or water jets. The requirements apply to all types of craft;

.2 Propulsion devices are those which directly provide the propulsive thrust and include machinery items and any associated ducts, vanes, scoops and nozzles, the primary function of which is to contribute to the propulsive thrust;

.3 The lift devices are those items of machinery which directly raise the pressure of the air and move it for the primary purpose of providing lifting force for an air-cushion vehicle.

2.6.2 The propulsion and lift devices shall be of adequate strength and stiffness. The design data, calculations and trials, where necessary, shall establish the ability of the device to withstand the loads which can arise during the operations for which the craft is to be certificated, so that the possibility of catastrophic failure is minimised.

2.6.3 The design of propulsion and lift devices shall pay due regard to the effects of allowable corrosion, electrolytic action between different metals, erosion or cavitation which may result from operation in environments in which they are subjected to spray, debris, salt, sand, etc.

2.6.4 The design data and testing of propulsion and lift devices shall pay due regard, as appropriate, to any change of pressure which could be developed as a result of a duct blockage, to steady and cyclic loadings, to loadings due to external forces and to the use of the devices in manoeuvring and reversing and to the axial location of rotating parts.

2.6.5 Appropriate arrangements shall be made to ensure that:

.1 ingestion of debris or foreign matter is minimised;

.2 the possibility of injury to personnel from shafting or rotating parts is minimised; and

.3 where necessary, inspection and removal of debris can be carried out safely in service.

3 AUXILIARY SYSTEMS

3.1 General

3.1.1 Fluid systems shall be constructed and arranged so as to assure a safe and adequate flow of fluid at a prescribed flow rate and pressure under all conditions of craft operation. The probability of a failure or a leakage in any one fluid system, causing damage to the electrical system, a fire or an explosion hazard shall be as low as possible. Attention shall be paid to the avoidance of impingement of flammable liquid on hot surfaces in the event of leakage or fracture of the pipe.

3.1.2 The maximum allowable working pressure in any part of the fluid system shall not be greater than the design pressure, having regard to the allowable stresses in the materials. Where the maximum allowable working pressure of a system component, such as a valve or a fitting, is

less than that computed for the pipe, the system pressure shall be limited to the lowest of the component maximum allowable working pressures. Every system which may be exposed to pressures higher than the system's maximum allowable working pressure shall be safeguarded by appropriate relief devices.

3.1.3 Tanks and piping shall be pressure-tested to a pressure that will assure a safety margin in excess of the working pressure of the item. The test on any storage tank or reservoir shall take into account any possible static head in the overflow condition and the dynamic forces arising from craft motions.

3.1.4 Materials used in piping systems shall be compatible with the fluid conveyed and selected giving due regard to the risk of fire. Non-metallic piping material may be permitted in certain systems provided the integrity of the hull and watertight decks and bulkheads is maintained.

3.2 Tanks and Systems of Oil Fuel, Lubricating Oil and Other Flammable Oil

3.2.1 General

3.2.1.1 The use of fuel with a flashpoint below 43°C is not recommended. However, fuel with a lower flashpoint, but not lower than 35°C, may be used in gas turbines only subject to compliance with the provisions specified in 3.2.1.2 to 3.2.1.7.

3.2.1.2 Tanks containing fuel and other flammable fluids shall be separated from passenger, crew and baggage compartments by vapour-proof enclosures or cofferdams which are suitably ventilated and drained.

3.2.1.3 Fuel oil tanks shall not be located in, or be formed by any part of the structural boundary of, areas of major fire hazard. However, flammable fluids of a flashpoint not less than 60°C may be located within such areas provided the tanks are made of steel or other equivalent material. The use of aluminium in lubricating oil sump tanks for engines, or in lubricating oil filter housings fitted integral with the engines, is accepted.

3.2.1.4 Every fuel oil pipe which, if damaged, would allow oil to escape from a storage, settling or daily service tank shall be fitted with a cock or valve directly on the tank capable of being closed from a position outside the space concerned in the event of a fire occurring in the space in which such tanks are situated.

3.2.1.5 Pipes, valves and couplings conveying flammable fluids shall be made of steel or such alternative material satisfactory to a requirements in respect of strength and fire integrity having regard to the working pressure and the spaces in which they are installed. Wherever practicable, the use of flexible pipes shall be avoided.

3.2.1.6 Pipes, valves and couplings conveying flammable fluids shall be arranged as far from hot surfaces, air intakes of engine installations, electrical appliances and other potential sources of ignition as is practicable and be located or shielded so that the likelihood of fluid leakage coming into contact with such sources of ignition is kept to a minimum.

3.2.1.7 Fuel with a flash point below 35°C shall not be used. In every craft in which fuel with a flashpoint below 43°C is used, the arrangements for the storage, distribution and utilization of the fuel shall be such that, having regard to the hazard of fire and explosion which the use of such fuel may entail, the safety of the craft and of persons on board is preserved. The arrangements shall comply, in addition to the requirements of 3.2.1.2 to 3.2.1.6, with the following provisions:

.1 tanks for the storage of such fuel shall be located outside any machinery space and at a distance of not less than 760 mm inboard from the shell side and bottom plating, and from decks and bulkheads;

.2 arrangements shall be made to prevent overpressure in any fuel tank or in any part of the oil fuel system, including the filling pipes. Any relief valves and air or overflow pipes shall discharge to a position which, in the opinion of PRS, is safe;

.3 the spaces in which fuel tanks are located shall be mechanically ventilated, using exhaust fans providing not less than six air changes per hour. The fans shall be such as to avoid the possibility of ignition of flammable gas-air mixtures. Suitable wire mesh guards shall be fitted over inlet and outlet ventilation openings. The outlets for such fans shall discharge to a safe position. 'No Smoking' signs shall be posted at the entrance to such spaces;

.4 earthed electrical distribution systems shall not be used, with the exception of earthed intrinsically safe circuits;

.5 suitable certified safe type electrical equipment shall be used in all spaces where fuel leakage could occur, including the ventilation system. Only electrical equipment and fittings essential for operational purposes shall be fitted in such spaces;

.6 a fixed vapour-detection system shall be installed in each space through which fuel lines pass, with alarms provided at the continuously manned control station;

.7 every fuel tank shall, where necessary, be provided with "savealls" or gutters which would catch any fuel which may leak from such tank;

.8 safe and efficient means of ascertaining the amount of fuel contained in any tank shall be provided. Sounding pipes shall not terminate in any space where the risk of ignition of spillage from the sounding pipe might arise. In particular, they shall not terminate in passenger or crew spaces. The use of cylindrical gauge glasses is prohibited, except for cargo craft where the use of oil-level gauges with flat glasses and self-closing valves between the gauges and fuel tanks may be permitted by PRS. Other means of ascertaining the amount of fuel contained in any tank may be permitted if such means do not require penetration below the top of the tank, and providing their failure or overfilling of the tank will not permit the release of fuel;

.9 during bunkering operations, no passenger shall be on board the craft or in the vicinity of the bunkering station, and adequate 'No Smoking' and 'No Naked Lights' signs shall be posted. Vessel-to-shore fuel connections shall be of closed type and suitably grounded during bunkering operations;

.10 the provision of fire detection and extinguishing systems in spaces where non-integral fuel tanks are located shall be such as for machinery spaces considered areas of major and moderate fire hazard, in accordance with requirements of 2.11 of *Part V – Fire Protection*; and

.11 refuelling of the craft shall be done at the approved refuelling facilities, detailed in the route operational manual, at which the following fire appliances are provided:

- a suitable foam applicator system consisting of nozzles and foam-making branch pipes capable of delivering foam solution at a rate of not less than 500 *l* /min for not less than 10 min;
- dry powder extinguishers of a total capacity not less than 50 kg; and
- carbon dioxide extinguishers of a total capacity not less than 16 kg.

3.2.1.8 Oil fuel, lubricating oil and other flammable oil lines shall be screened or otherwise suitably protected to avoid, as far as practicable, oil spray or oil leakages onto hot surfaces, into machinery air intakes or other sources of ignition. The number of joint in such piping systems shall be kept to a minimum. Flexible pipes carrying flammable liquids shall be of an approved type.

3.2.1.9 Fuel oil, lubricating oils and other flammable oils shall not be carried forward of public spaces and crew accommodation.

3.2.2 Oil Fuel Systems

3.2.2.1 In a craft in which oil fuel is used, the arrangements for the storage, distribution and utilisation of the oil fuel shall be such as to ensure the safety of the craft and persons on board and shall at least comply with the following provisions.

3.2.2.2 As far as practicable, all parts of the oil fuel system containing heated oil under pressure exceeding 0.18 MPa shall not be placed in a concealed position such that defects and leakage cannot readily be observed. The machinery spaces in way of such parts of the oil fuel system shall be adequately illuminated..

3.2.2.3 Location of fuel tanks shall be in accordance with 3.2.1.3.

3.2.2.4 No oil fuel tank shall be situated where spillage or leakage therefrom can constitute a hazard by falling on heated surfaces. Reference is made to the fire safety requirements specified in 3.2.1.2 – 3.2.1.7.

3.2.2.5 Oil fuel pipes shall be fitted with cocks or valves in accordance with 3.2.1.4.

3.2.2.6 Every fuel tank shall, where necessary, be provided with "savealls" or gutters to catch any fuel which may leak from such tanks.

3.2.2.7 Safe and efficient means of ascertaining the amount of oil fuel contained in any oil fuel tank shall be provided.

3.2.2.7.1 Where sounding pipes are used, they shall not terminate in any space where the risk of ignition of spillage from the sounding pipe might arise. In particular, they shall not terminate in public spaces, crew accommodation or machinery spaces. Terminations shall be provided with a suitable means of closure and provision to prevent spillage during refuelling operations.

3.2.2.7.2 Other oil-level gauges may be used in place of sounding pipes. Such means are subject to the following conditions:

.1 in passenger craft, such means shall not require penetration below the top of the tank and their failure or overfilling of the tank will not permit release of fuel.

.2 the use of cylindrical gauge glasses shall be prohibited. In cargo craft, PRS may permit the use of oil-level gauges with flat glasses and self-closing valves between the gauges and fuel tanks. Such other means shall be acceptable to PRS and shall be maintained in the proper condition to ensure their continued accurate functioning in service.

3.2.2.8 Provision shall be made to prevent overpressure in any oil tank or in any part of the fuel system, including the filling pipes served by craft pumps. Air and overflow pipes and relief valves shall discharge to a position where there is no risk of fire or explosion from the emergence of oils and vapour, and shall not lead into crew spaces, passenger spaces, special category spaces, ro-ro spaces (other than open ro-ro spaces), machinery spaces or similar spaces. For fuel of flashpoint less than 43°C, such air and overflow pipes and relief valves shall terminate with wire mesh.

3.2.2.9 Oil fuel pipes and their valves and fittings shall be made of steel or other approved material, except that restricted use of flexible hoses shall be permissible in positions where they are necessary. Such flexible hoses shall be PRS type-approved and their connections approved by PRS.

3.2.3 Lubricating Oil Arrangements

3.2.3.1 The arrangements for the storage, distribution and utilisation of oil used in pressure lubrication systems shall be such as to ensure the safety of the craft and persons on board. The arrangements made in machinery spaces and, whenever practicable, in auxiliary machinery spaces shall at least comply with the provisions of 3.2.2.2 and 3.2.2.4 to 3.2.2.8, except that:

.1 this does not preclude the use of sight-flow glasses in lubricating systems provided they are shown by test to have a suitable degree of fire resistance;

.2 sounding pipes may be permitted in machinery spaces if fitted with appropriate means of closure; and

.3 lubricating oil storage tanks with a capacity of less than 500 *l* may be permitted without remote operated valves as required in 3.2.2.5.

3.2.4 Arrangements for Other Flammable Oils

3.2.4.1 The arrangements for storage, distribution and utilisation of other flammable oils employed under pressure in power transmission systems, control and activating systems and heating systems shall be such as to ensure the safety of the craft and persons on board. In locations where means of ignition are present, such arrangements shall at least comply with the provisions of 3.2.2.4 and 3.2.2.7 and with the provisions of 3.2.2.8 and 3.2.2.9 in respect of strength and construction.

3.2.5 Arrangements within Machinery Spaces

In addition to the requirements of 3.2.1.1 to 3.2.4.1, the oil fuel and lubricating oil systems shall comply with the following:

3.2.5.1 Where daily service fuel tanks are filled automatically or by remote control, means shall be provided to prevent overflow spillages.

3.2.5.2 Other equipment which treats flammable liquids automatically, such as oil fuel purifiers, which, whenever practicable, shall be installed in a special space reserved for purifiers and their heaters, shall have arrangements to prevent overflow spillages.

3.2.5.3 Where daily service oil fuel tanks or settling tanks are fitted with heating arrangements, a high-temperature alarm shall be provided if the flashpoint of the oil can be reached due to failure of the thermostatic control means.

3.3 Bilge Pumping and Drainage System

3.3.1 Arrangements shall be made for draining any watertight compartment other than the compartments intended for permanent storage of liquid. Where, in relation to particular compartments, drainage is not considered necessary, drainage arrangements may be omitted, but it shall be demonstrated that the safety of the craft will not be impaired.

3.3.2 Bilge pumping arrangements shall be provided to allow every watertight compartment other than those intended for permanent storage of liquid to be drained. The capacity or position of any such compartment shall be such that flooding thereof could not affect the safety of the craft.

3.3.3 The bilge pumping system shall be capable of operation under all possible values of list and trim after the craft has sustained the postulated damage in Part IV – Buoyancy, Stability and Subdivision. The bilge pumping system shall be so designed as to prevent water flowing from one compartment to another. The necessary valves for controlling the bilge suctions shall be capable of being operated from above the datum. All distribution boxes and manually operated valves

in connection with the bilge pumping arrangements shall be in positions which are accessible under ordinary circumstances. The spindles of manually operated valves shall be easily accessible and all valves shall be clearly marked

3.3.4 The power operated self-priming bilge pumps may be used for other duties such as fire fighting or general service but not for pumping fuel or other flammable liquids.

3.3.5 Each power operated bilge pump shall have capacity sufficient for pumping water through the bilge pipe of required diameter at a speed of not less than 2 m/s.

3.3.6 The diameter (d) of the bilge main shall be calculated according to the following formula, except that the actual internal diameter of the bilge main may be rounded off to the nearest size:

$$d = 25 + 1.68\,[L(B + D)]^{0.5} \qquad (2.3.6\text{-}1)$$

where:

d – the internal diameter of the bilge main, [mm];
L – the length of the craft, [m];
B – for monohull craft, the breadth of the craft, [m],
for multi-hull craft, the breadth of a hull at or below the design waterline, [m]; and
D – the moulded depth of the craft to the datum, [m].

Note: Definitions *L*, *B*, *D* see *Part II – Hull.*

3.3.7 Internal diameters of suction branches shall meet the requirements of the *Rules for the Classification and Construction of Sea-going Ships*, *Part VI – Machinery Installations and Refrigerating Plants*, Chapter 6, but shall not be less than 25 mm. Suction branches shall be fitted with effective strainers.

3.3.8 An emergency bilge suction shall be provided for each machinery space containing a propulsion prime mover. This suction shall be led to the largest available power pump other than a bilge pump, propulsion or fuel oil pump.

3.3.9 The spindles of the sea inlet valves shall extend well above the machinery space floor plates.

3.3.10 All bilge suction piping up to the connection to the pumps shall be independent of other piping.

3.3.11 Spaces situated above the water level in the worst anticipated damage conditions may be drained directly overboard through scuppers fitted with non-return valves.

3.3.12 Any unattended space for which bilge pumping arrangements are required shall be provided with a bilge alarm.

3.3.13 For craft with individual bilge pumps, the total capacity of the bilge pumps for each hull shall not be less than 2.4 times the capacity of the pump defined in 3.3.5 and 3.3.6.

3.3.14 In bilge pumping arrangements where a bilge main is not provided, in each compartment, with the exception of the spaces forward of public spaces and crew accommodation, at least one fixed submersible pump shall be provided. In addition, at least one portable pump shall be provided supplied from the emergency supply, if electric, for use in individual spaces. The capacity of each submersible pump Q_n shall not be less than:

$$Q_n = Q/(N - 1) \text{ with a minimum of } 8 \text{ [t/h]},$$

where:

N – number of submersible pumps
Q – total capacity as defined in 3.3.13.

3.3.15 Non-return valves shall be fitted in the following components of bilge pumping system:

.1 bilge valve distribution manifolds;
.2 bilge suction hose connections where fitted directly to the pump or to the main bilge suction pipe; and
.3 direct bilge suction pipes and bilge pump connections to main bilge suction pipe.

3.4 Ballast System

3.4.1 Water ballast shall not in general be carried in tanks intended for oil fuel. In craft in which it is not practicable to avoid putting water in oil fuel tanks, oily-water separating equipment shall be fitted, or other alternative means such as discharge to shore facilities shall be provided for disposing of the oily-water ballast. The provisions of this paragraph are without prejudice to the provisions of the International *Convention for the Prevention of Pollution from Ships* (*MARPOL*) in force.

3.4.2 Where a fuel-transfer system is used for ballast purposes, the system shall be isolated from any water ballast system and meet the requirements for fuel systems of the *International Convention for the Prevention of Pollution from Ships* (*MARPOL*) in force.

3.5 Cooling System

The cooling arrangements provided shall be adequate to maintain all lubricating and hydraulic fluid temperatures within the manufacturers' recommended limits during all operational conditions for which the craft is to be certificated.

3.6 Engine Air Intake Systems

Arrangements shall provide sufficient air to the engine and shall give adequate protection against damage, as distinct from deterioration, due to ingress of foreign matter.

3.7 Ventilation Systems

3.7.1 General

3.7.1.1 The main inlets and outlets of all ventilation systems shall be capable of being closed from outside the spaces being ventilated. Additionally, if the above openings lead to areas of major fire hazard, they shall be capable of being closed from the continuously manned control station.

3.7.1.2 All fans shall be capable of being closed from outside of the spaces where they are installed and the spaces they serve. Fans serving the areas of major fire hazard shall be also capable of being controlled from continuously manned control stadion. Means provided for shutting off mechanical ventilation of machinery space shall be separate of the means provided for stopping ventilaton of other spaces.

3.7.2 Arrangement of Ventilation Ducts

3.7.2.1 Areas of major fire hazard and spaces serving as assembly stations shall have independent ventilation systems and ventilation ducts. Ventilation ducts for areas of major fire hazard shall not pass through other spaces, unless they are contained within a trunk or in an extended machinery space or casing insulated in accordance with tables contained in *Part V – Fire Protection*. Ventilation ducts of other spaces shall not pass through areas of major fire hazard.

Ventilation outlets from areas of major fire hazard shall not terminate within a distance of 1 m from any control station, evacuation station or external escape route. Exhaust ducts from galley ranges shall be fitted with:

.1 a grease trap readily removable for cleaning unless an alternative approved grease removal system is fitted;

.2 a fire damper located in the lower end of the duct which is automatically or remotely operated, and in addition a remotely operated fire damper located in the upper end of the duct;

.3 a fixed means for extinguishing a fire within the duct;

.4 remote control arrangements for shutting off the exhaust fans and supply fans, for operating the fire dampers mentioned in .2 and for operating the fire-extinguishing system, which shall be placed in a position close to the entrance to the galley. Where a multi-branch system is installed, means shall be provided to close all branches exhausting through the same main duct before an extinguishing medium is released into the system; and

.5 suitably located hatches for inspection and cleaning.

3.7.2.2 Where a ventilation duct passes through a fire-resisting division, a fail safe automatic closing fire damper shall be fitted adjacent to the division. The duct between the division and the damper shall be of steel or other equivalent material and insulated to the same standard as required for the fire-resisting division. The fire dampers may be omitted where ducts pass through spaces surrounded by fire-resisting divisions without serving those spaces, providing that the duct has the same structural fire protection time as the divisions it penetrates. Where a ventilation duct passes through a smoke-tight division, a smoke damper shall be fitted at the penetration unless the duct which passes through the space does not serve that space.

3.7.2.3 Where ventilation systems penetrate decks, the arrangements shall be such that the effectiveness of the deck in resisting fire is not thereby impaired and precautions shall be taken to reduce the likelihood of smoke and hot gases passing from one between-deck space to another through the system.

3.7.2.4 All dampers fitted on fire-resisting or smoke-tight divisions shall also be capable of being manually closed from each accesible side of the division in which they are fitted, except for those dampers fitted on ducts serving spaces not normally manned such as stores and toilets that may be manually operated only from outside the served spaces. All dampers shall also be capable of being remotely closed from the continuously manned control station.

3.7.2.5 Ducts shall be made of non-combustible or fire-restricting material. Short ducts, however, may be made of combustible materials subject to the following conditions:

.1 their cross-section area does not exceed 0.02 m^2;

.2 their length does not exceed 2 m;

.3 they may only be used at the terminal end of the ventilation system;

.4 they shall not be situated less than 600 mm from an opening in a fire-resisting or fire-restricting division; and

.5 their surfaces have low flame-spread characteristics.

3.7.3 Ventilation of Special Category Spaces and Ro-ro Spaces[1]

3.7.3.1 Special category spaces and ro-ro spaces shall be provided with an efficient mechanical ventilation ensuring at least 10 air changes per hour during voyage and at least 20 air changes during vehicles loading and unloading. The ventilation system of spaces referred to above shall be

[1] For definitions refer to *Part V – Fire Protection.*

separate from other ventilation systems and shall be in operation at all times when vehicles are in the spaces. Ventilation ducts serving such spaces shall be effectively sealed and shall be separate for each such space. The system shall be capable of being controlled from a position outside such spaces.

3.7.3.2 The ventilation system shall be so constructed as to ensure uniform air circulation in the space and to prevent the formation of air pockets.

3.7.3.3 Means shall be provided in the operating compartment to indicate any loss or reduction of the required ventilating capacity.

3.7.3.4 Arrangements shall be provided to permit a rapid shutdown of the fans and effective closure of the ventilation ducts in case of fire, taking into account weather conditions and sea state.

3.7.3.5 Ventilation duct, including fire dampers shall be made of steel or other equivalent material. Ducts carried inside the space they serve may be made of non-combustible or fire restricting material.

3.7.4 Ventilation System of Machinery Spaces

3.7.4.1 Machinery spaces shall be adequately ventilated so as to ensure that when machinery therein are operating at full power in all weather conditions including heavy weather, adequate supply of air is maintained to the spaces for the safety and comfort of personnel and the operation of machinery. Auxiliary machinery space shall be adequately ventilated appropriately to the purpose of that machinery space. The ventilation arrangements shall be adequate to ensure that the safe operation of the craft is not put at risk.

3.7.4.2 Ventilation of machinery spaces shall be sufficient under normal conditions to prevent accumulation of oil vapour.

3.7.4.3 Ventilation arrangements In machinery space shall be efficient in all anticipated service conditions. Used arrangements shall ensure, where appropriate, forced ventilation of enclosed engine compartments to atmosphere to ensure engine start.

3.8 Drainage of Deck Sewage, Bilge Pumping and Drainage of Open Ro-ro Spaces[1)]

3.8.1 In view of the serious loss of stability which could arise due to large quantities of water accumulating on the deck or decks consequent to the operation of the fixed water-spraying system, water pumping and drainage arrangements shall be fitted so as to ensure that such water is not accumulating and is rapidly discharged directly overboard. When it is required to maintain watertight or weathertight integrity, as appropriate, the scuppers shall be arranged so that they can be operated from outside the space protected.

3.8.2 Water drainage system shall be such that:

- **.1** when calculating the amount of water to be drained, the capacity of both the water spraying system pumps and required number of fire hose nozzles shall be taken into account;
- **.2** the drainage system shall have a capacity of not less than 125% of the capacity specified in .1;
- **.3** bilge wells shall be of sufficient holding capacity and shall be arranged at the side of the craft at a distance from each other of not more than 40 m in each watertight compartment.

1) For definitions refer to *Part V – Fire Protection.*

3.8.3 Open ro-ro spaces provided with water spraying system shall comply with requirements of 3.8.1.

3.8.4 For the parts of ro-ro spaces which are fully open on the top, compliance with requirement of 3.8.1 is not required. Continuous fire patrol or television surveillance shall, however, be maintained.

3.9 Exhaust Gas System

3.9.1 All engine exhaust systems shall be adequate to ensure the correct functioning of the machinery and that safe operation of the craft is not put at risk.

3.9.2 Exhaust systems shall be so arranged as to minimise the intake of exhaust gases into manned spaces, air-conditioning systems, and engine air intakes. Exhaust systems shall not discharge into air-cushion intakes.

3.9.3 Pipes through which exhaust gases are discharged through the hull in the vicinity of the waterline shall be fitted with erosion-/corrosion-resistant shut-off flaps or other devices on the shell or pipe end and PRS approved arrangements made to prevent water flooding the space or entering the engine exhaust manifold.

3.9.4 Gas turbine engine exhausts shall be arranged so that hot exhaust gases are directed away from areas to which personnel have access, either on board the craft or in the vicinity of the craft when berthed.

4 ADDITIONAL REQUIREMENTS

4.1 Passenger Craft – Mark PASSENGER

4.1.1 The arrangements shall be such that at least one power bilge pump shall be available for use in all flooding conditions which the craft is required to withstand as follows:

.1 one of the required bilge pumps shall be an emergency pump of a reliable submersible type having an emergency source of power; or

.2 the bilge pumps and their sources of power shall be so distributed throughout the length of the craft that at least one pump in an undamaged compartment will be available.

4.1.2 On multihull passenger craft, each hull shall be provided with at least two bilge pumps.

4.1.3 Distribution boxes, cocks and valves in connection with the bilge pumping system shall be so arranged that, in the event of flooding, one of the bilge pumps may be operative in any compartment. In addition, damage to a pump or its pipe connecting to the bilge main shall not put the bilge system out of action. When, in addition to the main bilge pumping system, an emergency bilge pumping system is provided, it shall be independent of the main system and so arranged that a pump is capable of operating in any compartment under flooding conditions as specified in 3.3.3. In that case only the valves necessary for the operation of the emergency system need be capable of being operated from above the datum.

4.1.4 All cocks and valves referred to in 4.1.3 which can be operated from above the datum shall have their controls at their place of operation clearly marked and shall be provided with means to indicate whether they are open or closed.

4.1.5 Each safe zone of public spaces shall be served by ventilation system independent of ventilation systems of other zones. Fans provided in each zone of public spaces shall additionally be capable of being independently controlled from the continuously manned control station.

4.2 Category A Passenger Craft – Mark PASSENGER CATEGORY A

4.2.1 At least two power bilge pumps connected to the bilge main shall be fitted onboard passenger craft of category A; one of which may be driven by the main propulsion machinery. Alternatively, arrangements in accordance with 3.3.14 may be applied.

4.3 Category B Passenger Craft – Mark PASSENGER CATEGORY B

4.3.1 Additionally to provisions of 2.2.1, the passenger craft of category B shall be provided with additional control arrangements fitted in machinery room or in its vicinity.

4.3.2 At least three power bilge pumps connected to the bilge main shall be fitted onboard passenger craft of category B, one of which may be driven by the main propulsion machinery. Alternatively, arrangements in accordance with 3.3.14 may be applied.

4.3.3 Category B craft shall be provided with at least two independent means of propulsion so that the failure of one engine or its support systems would not cause the failure of the other engine or engine systems and with additional machinery controls fitted in or close to the machinery space.

4.3.4 Category B craft shall be capable of maintaining the essential machinery and control devices so that, in the event of a fire or other casualties in any one compartment on board, the craft can return to a port of refuge under its own power.

4.3.5 In monohull craft, propeller shaft and bearings of at least one main engine, when passing through the aft machinery space, are to be protected as follows:

- **.1** steel shaft bearings by water spray;
- **.2** shafts made of composite material (FRP), either by:
  - **.2.1** passive fire protection for 60 minutes duration, or
  - **.2.2** a water spray system able to transmit the full torque of the propulsion engine after a standard fire test of 7 minutes.

4.4 Vessels Designed to Transport Offshore Support Personnel (Crew Boats) – Mark CREW BOAT

4.4.1 On a vessel designed for the transport of the offshore support personnel, at least two power bilge pumps connected to the bilge main shall be fitted. Arrangements for draining each watertight compartment other than spaces for permanent storage of liquids, shall be provided. Where draining of particular spaces can be dispensed with and that does not affect the craft safety, then draining arrangements can be omitted, upon PRS consent.