

RULES
FOR THE CLASSIFICATION OF
SHIPS

PART 13 – AUTOMATION
January 2020

CROATIAN REGISTER OF SHIPPING

Hrvatska (Croatia) • 21000 Split • Marasovićeve 67 • P.O.B. 187
Tel.: (...) 385 (0)21 40 81 11
Fax.: (...) 385 (0)21 35 81 59
E-mail: tech.coord@crs.hr
web site: www.crs.hr

By the decision of the General Committee to the Croatian Register of Shipping,

RULES FOR THE CLASSIFICATION OF SHIPS
Part 13 – AUTOMATION
edition January 2020

have been adopted on 20th December 2019 and shall enter into force on 1st January 2020

REVIEW OF AMENDMENTS IN RELATION TO PREVIOUS EDITION OF THE RULES

RULES FOR THE CLASSIFICATION OF SHIPS *Part 13 – AUTOMATION*

All major changes in respect to the Rules for the classification of ships, Part 13 – Automation, edition July 2017 throughout the text are shaded (if any).

Items not being indicated as corrected have not been changed.

The grammar and print errors, have been corrected throughout the Rules and are not subject to above indication of changes.

This Part of the Rules includes the requirements of the following international Organisations:

International Maritime Organization (IMO)

Conventions: International Convention for the Safety of Life at Sea 1974 (SOLAS 1974) and all subsequent amendments to and including amendments (MSC.216(82))
Protocol of 1988 relating to the International Convention for the Safety of Life at Sea 1974, as Amended (SOLAS PROT 1988)

International Association of Classification Societies (IACS)

Unified Requirements (UR):

M27 (1976), M29 (1997), M30 (1997), M31 (1978), M35 (Rev.8 Jan. 2019), M36 (Rev.6 Dec. 2018),
M43 (1982), M47 (1983)

Contents

Pages

| | | |
|----------|---|-----------|
| 1 | GENERAL REQUIREMENTS..... | 1 |
| 1.1 | APPLICATION | 1 |
| 1.2 | DEFINITIONS AND EXPLANATIONS..... | 1 |
| 1.3 | SCOPE OF SUPERVISION..... | 1 |
| 1.4 | TECHNICAL DOCUMENTATION..... | 2 |
| 1.5 | TESTING OF CONTROL AND MONITORING SYSTEMS..... | 2 |
| 2 | CONTROL AND MONITORING SYSTEMS..... | 3 |
| 2.1 | GENERAL PROVISIONS | 3 |
| 2.2 | ENGINE ROOM ALARM SYSTEM..... | 3 |
| 2.3 | MONITORING SYSTEMS..... | 4 |
| 2.4 | SAFETY SYSTEMS | 4 |
| 2.5 | REMOTE CONTROL AND AUTOMATIC REMOTE CONTROL SYSTEMS | 5 |
| 3 | PROGRAMMABLE ELECTRONIC SYSTEMS | 7 |
| 3.1 | GENERAL REQUIREMENTS | 7 |
| 3.2 | SCOPE OF SURVEY | 7 |
| 3.3 | TECHNICAL REQUIREMENTS FOR PES - HARDWARE..... | 7 |
| 3.4 | TECHNICAL REQUIREMENTS FOR PES - SOFTWARE | 8 |
| 3.5 | LOCAL AREA NETWORK | 8 |
| 3.6 | INSTALLATION OF PES ON BOARD | 8 |
| 4 | REQUIREMENTS FOR AUTOMATION ON SHIPS HAVING AUTOMATION MARK AUT 2..... | 9 |
| 4.1 | GENERAL REQUIREMENTS | 9 |
| 4.2 | MACHINERY ALARM SYSTEMS | 16 |
| 4.3 | MACHINERY SAFETY SYSTEMS | 17 |
| 4.4 | MACHINERY REMOTE CONTROL AND AUTOMATIC REMOTE CONTROL SYSTEMS | 17 |
| 4.5 | INSTALLATIONS WITH MAIN INTERNAL COMBUSTION ENGINES..... | 17 |
| 4.6 | INSTALLATIONS WITH MAIN STEAM TURBINES..... | 18 |
| 4.7 | OIL FIRED BOILERS..... | 18 |
| 4.8 | ELECTRIC GENERATING PLANT | 18 |
| 4.9 | REFRIGERATING PLANTS..... | 19 |
| 4.10 | BILGE LEVEL ALARM SYSTEM | 19 |
| 4.11 | EQUIPMENT OF MAIN CONTROL STATION | 19 |
| 4.12 | EQUIPMENT OF BRIDGE CONTROL..... | 20 |
| 4.13 | DEAD MAN ALARM..... | 20 |
| 5 | REQUIREMENTS FOR AUTOMATION ON SHIPS HAVING AUTOMATION MARK AUT 1..... | 21 |
| 5.1 | GENERAL REQUIREMENTS | 21 |
| 5.2 | MAIN CONTROL STATION | 21 |
| 5.3 | EQUIPMENT OF BRIDGE CONTROL STATION..... | 21 |
| 5.4 | OFFICER ON DUTY ALARM..... | 21 |
| 6 | REQUIREMENTS FOR AUTOMATION ON SHIPS HAVING AUTOMATION MARK AUT 3..... | 23 |
| 6.1 | GENERAL REQUIREMENTS | 23 |
| 6.2 | REQUIREMENTS FOR AUTOMATED SYSTEMS | 24 |
| 6.3 | REQUIREMENTS FOR SHIPS OF LESS THEN 30 M IN LENGTH..... | 24 |

1 GENERAL REQUIREMENTS

1.1 APPLICATION

1.1.1 This part of the *Rules* applies to the automation equipment used in ships that, in addition to the notation of the main machinery, are assigned the automation mark AUT 1, AUT 2, or AUT 3 and also to the system of remote automated control of the main machinery and propellers irrespective of the automation mark.

1.1.2 Automation mark AUT 2 applies to the ships having the unattended engine room and permanent watch keeping at main control station.

1.1.3 Automation mark AUT 1 applies to the ships having the unattended engine room and without watch keeping at main control station.

1.1.4 Automation mark AUT 3 applies to the ships, which comply with requirements 1.1.3 (AUT 1) and also meet the conditions of 6.1.1 and 6.1.2.

1.1.5 For ships with electric or nuclear propulsion plant, the degree of automation required for an individual automation mark shall be agreed with the *Register* in compliance with its requirements.

1.1.6 This part of the *Rules* specify the technical requirements to be fulfilled for the automation equipment referred to in 1.1.1. and define the extent of the remote automated control, protection, alarm and monitoring system.

1.1.7 The automation equipment, systems and arrangements used in ships without distinguishing automation marks in the notation shall also comply with the requirements of the relevant sections of the *Rules*.

1.2 DEFINITIONS AND EXPLANATIONS

Definitions and explanations relating to general terminology of this part of the *Rules* are given in the *Rules, Part 1 - General requirements*, Chapter 1 – General Information.

For the purpose of this part of the *Rules*, the following definitions have been adopted:

1.2.1 Automated machinery – a propulsion engine, boiler plant, ship's systems and other machinery fitted with systems and devices for automatic control, monitoring and protection.

1.2.2 Remote automated control – is a system that enables the desired working range of the machinery to be set remotely by operating a control element (e.g. control level, handle) with all subsequent intermediate steps performed automatically.

1.2.3 Alarm system – is a system intended to give warning whenever the controlled parameters reach the inadmissible limit values.

1.2.4 Protection system – is a system designed to automatically intervene in the operation of machinery under control order to prevent emergency or limit its consequences.

1.2.5 Monitoring system – is a system designed to provide information on certain physical parameters or conditions.

1.2.6 Automated system – system that is the combination of the elements and devices so arranged to form a structural and functional unit, capable of performing certain preset actions of control and monitoring.

1.2.7 Automated device – is a part of a control or monitoring system consisting of elements that form a structural and functional unit.

1.2.8 Component of the automatic system – is the simplest structurally independent item (e.g., amplifier, transmitter, relay, logic element, etc.) used in automated system.

1.2.9 Call – the request for contact, assistance and/or action from an individual to another person or group of persons, i.e. the complete procedure of signalling and indicating this request

1.2.10 Accept – manually acknowledgement receipt of an alarm or call.

1.2.11 Cancel – manual stopping of an alarm or call after the cause has been eliminated.

1.2.12 Alarms grouping – term meaning:

- 1 the arrangement of individual alarms on alarm panels or individual indicators on indicating panels;
- 2 the combining of individual alarms to provide one alarm at a remote position;
- 3 the arrangements of alarms in terms of their priority (i.e. critical alarms, non-critical alarms).

1.2.13 Fail to safe – the automation system design principle asking that the most probable failures, e.g. loss of power, are to result in the least critical extent of any possible new conditions.

1.3 SCOPE OF SUPERVISION

1.3.1 General provisions covering the classification procedure, supervision of the ship under design and construction, manufacture of ship's equipment and details the scope of surveys as well as the necessary technical documentation to be submitted to the *Register*, for approval of the ship as a whole, are set forth in the *Rules, Part 1 - General requirements*.

1.3.2 The following automated systems and remote control systems shall be subjected to the supervision during their manufacture and on board applying to:

1. Main propulsion machinery,
2. Controllable pitch propeller,
3. Steam generating plant,
4. Electric generating plant,
5. Auxiliary machinery,
6. Bilge and ballast systems,
7. Air compressors,
8. Cargo and ballast pumps,

9. Evaporating and distilling systems,
10. Fire detection system,
11. Incinerators,
12. Inert gas system,
13. Oil fuel system (oil fuel tanks, oil fuel transfer system, purifiers and oil heaters),
14. Oil water separators,
15. Valve position indicating system,
16. Control desks,
17. Miscellaneous systems, (where alarm, control and safety systems are specified by the *Rules of the Register*).

1.4 TECHNICAL DOCUMENTATION

1.4.1 Prior to the installation of automated equipment on board ship, the documentation referred to in the *Rules, Part 1 - General requirements, Chapter 2 – Supervision during construction, 2.10*, shall be submitted to the *Register* for approval.

1.4.2 On a ships with automation mark **AUT 1**, an original, approved and stamped copy of the "Maintenance and testing program for automation" is to be kept onboard. Program is to show in detail how components (indicators, alarms and safety protection equipment) are to be tested.

1.5 TESTING OF CONTROL AND MONITORING SYSTEMS

1.5.1 All systems and elements referred to in 1.3.2 except those under number 16 shall be type approved by the *Register*.

1.5.2 Automated systems, device and components are subject to type approval in accordance with the "Instructions for Type Testing of the Electric and Electronic Equipment" and in compliance with the test program approved by the *Register*.

1.5.3 Survey of automated system in workshop shall be carried out in accordance with the manufacturer's program approved by the *Register*.

The relevant testing shall be carried out provided that the system has been already type approved.

1.5.4 Testing of the automated systems on board ship during the mooring and sea trials shall be carried out in accordance with a program made by a shipyard or a ship owner approved by the *Register*.

1.5.5 Systematic maintenance and functional testing of automation system is performed and documented and necessary test equipment is kept on board.

1.5.6 Minimal equipment to perform maintenance and testing of automation system consists of:

- a) pressure sensors test equipment,
- b) temperature sensors test equipment,
- c) fire detectors test equipment.

2 CONTROL AND MONITORING SYSTEMS

2.1 GENERAL PROVISIONS

2.1.1 Where electrically driven machinery or installations for essential services, are to be supplied from both the main and the emergency power sources (in accordance with the requirements of *Part 12 - Electrical Equipment*, 2.14) the associated control systems shall be fed accordingly from these two sources. Change-over from the main feeder to the emergency shall take place automatically with appropriate signal operated at the same time.

2.1.2 The control systems of the essential engines shall be supplied by two separate feeders.

One of the feeders shall be connected to the main switchboard and the other may be connected to the nearest distributing board for essential consumers. Change-over from the main feeder to the standby one shall take place automatically with appropriate signal operated at the same time.

2.1.3 To supply alarm and protection systems, an independent standby source of power (e.g., accumulator battery) shall be provided. The standby source of power shall come into operation automatically with an alarm operated on change-over.

Alarms for failure of the standby source of power shall be also provided. Alarm systems standby source shall be capable to supply system for at least 30 min.

2.1.4 In case of voltage failure in the supply circuit of the running machinery, the automatic start-up of the standby unit shall be provided. Such an automatic change over shall be provided with an appropriate alarm.

2.1.5 The electrical and electronic systems for control and monitoring shall have proper safety system that provides electrical separation of the interior circuits of automatic devices from the ship's electrical circuits.

2.1.6 The electrical and electronic systems of the automation plant in the exterior circuits shall comply with the requirements of *Part 12 - Electrical Equipment*.

2.1.7 The choices of cables for interconnection of the electrical and electronic devices of automation plant, their installation and fastening, shall meet the requirements of *Part 12 - Electrical Equipment*.

2.1.8 Casing and protection screens of electrical and electronic devices as well as metal sheathing of cables shall be earthen. The earthing shall be made according to the requirements of *Part 12 - Electrical Equipment*.

Departure from these requirements may be admitted on agreement with the *Register* in such cases when earthing affects the functioning of the system.

2.1.9 Precautions shall be taken to prevent malfunction of the control and monitoring systems due to the interferences from magnetic and electric fields.

2.1.10 The hydraulic and pneumatic control systems shall be fed from two power sources. The standby unit shall be

connected at pressure loss and shall be provided with the appropriate signals.

2.1.11 Pneumatic systems shall comply with the requirements of the *Part 8 - Piping*.

2.1.12 Hydraulic systems shall comply with the requirements of the *Part 8 - Piping*.

2.2 ENGINE ROOM ALARM SYSTEM

2.2.1 Depending on the degree of automation and survey procedure adopted for the machinery, the alarm system shall give warning signals at:

- .1 the parameters exceeding permissible values,
- .2 operation of (protective) safety system,
- .3 power failure of separate control or monitoring system,
- .4 deviation from the values of other parameters or operating conditions specified by this part of the *Rules*, and shall comply with the requirements 2.2.2 to 2.2.15.

2.2.2 The alarm system is to be designed to function independently of control and safety systems so that a failure or malfunction in these systems will not prevent the alarm system from operating.

2.2.3 The alarm system for machinery or other equipment that are controlled, independently of the central control alarm system, shall be provided at the post from which the relevant machinery or equipment is remotely controlled.

2.2.4 The alarm system shall be capable to give visual and audible signals. Following shall be provided:

- a) In case of individual alarms, the visual alarm shall indicate the particular fault condition and its location within the machinery space.
- b) If arrangements are fitted to silence audible alarms they are not to extinguish visible alarms.
- c) The alarm system is to be so arranged that acknowledgment of visual alarms is clearly noticeable.
- d) Cancelling of the visual signal shall be possible only after the fault condition has been cleared.

2.2.5 In case of transient alarm, alarm condition should not be cancelled automatically after the fault has been rectified without manual alarm acknowledgment.

2.2.6 Acknowledgment of alarms at the navigating bridge or another position where alarm is transferred, shall not cancel the audible and visual signals at the central control station and in the machinery space.

2.2.7 Machinery alarms should be clearly distinguishable from other audible alarms, (i.e., fire, general alarm CO₂, flooding).

2.2.8 Irrespective of the number of existing alarms, every new alarm shall be indicated in accordance with 2.2.4 and 2.2.5.

2.2.9 Provision shall be made for the alarm system to enable testing of internal and external circuits.

Each malfunction in the system shall be clearly indicated. Where practicable, means are to be provided at convenient and accessible positions, to permit the sensors to be tested without affecting the operation of the machinery.

2.2.10 Disconnection of alarm system or of any part of the system shall be clearly indicated.

2.2.11 Alarms may be grouped when transferred to remote positions.

In this case provision shall be made for at least two groups where the critical alarms shall be separated from the non-critical alarms. Critical and non-critical alarms shall not be in the same group.

A group of critical alarms shall be provided with red signals. Mandatory critical alarms are specified in the list (see Table 4.1).

2.2.12 The alarm system should be designed with self-monitoring properties. In so far as practicable, any fault in the alarm system should cause it to fail to the alarm condition.

2.2.13 If an alarm has been acknowledged and a second fault occurs before the first is rectified, then audible and visual alarms are to operate again.

2.2.14 One video display with a panel may not be the only means of communication with the alarm system. Reserve means of communication shall be supplied from the emergency source of alarm system supply.

2.3 MONITORING SYSTEMS

2.3.1 Monitoring system shall be so designed that the attending personnel can get the required information in those measuring units which are in accordance with the international standards for measurement of physical parameters, without any recalculation.

2.3.2 Where an automatic recording unit is used for monitoring of the parameters, the recording speed shall be determined, taking into account the duration between changes of the parameter values.

2.3.3 Where an automatic recording unit is fitted, it shall be so designed that the possible fault in its circuit will not impede the operation of alarm system.

2.3.4 In addition to information on alarm position, the recording units shall simultaneously record time and date, so that time of occurrence and completion of fault is clearly visible.

2.3.5 In combined recording units, alarm conditions shall be clearly distinguished (e.g. colour) from the normal ones.

2.4 SAFETY SYSTEMS

2.4.1 Safety systems shall operate automatically at faults that might cause damage or destruction of the machinery being protected. The safety system shall be such that it provides not only the safety of the machinery or machinery installation concerned, but also the safety of the ship as a whole.

Safety system shall comply with the requirements 2.4.2 to 2.4.13.

2.4.2 Safety system shall operate so that:

- .1 normal operating conditions are restored (e.g. by the starting of standby machinery in case of loss of oil pressure drop),
- .2 the operation of the machinery is temporarily adjusted to the prevailing conditions (e.g. by reducing the output of machinery),
- .3 The machinery or machinery installation being protected are stopped.

2.4.3 Where the automatic operating of the safety system may endanger the safety of the ship as a whole, provision shall be made to switch off the safety system.

Red visual signal without dimmer shall light as long as the safety system is switched off.

The safety system shall not be switched off accidentally.

2.4.4 Provision shall be made for self-monitoring of the safety system, in case of faults in the system (such as short-circuit, earth connection, fuse melting, circuit break-off etc.), the alarm shall be activated.

2.4.5 Safety system shall be completely independent of the control and alarm system and provision shall be made for the separated sensors.

Common sensors for control, alarm and automatic safety functions can be accepted if intended for starting of stand by units or for safety reduction of the machinery output power – slow down.

2.4.6 Safety systems for different items of the machinery or machinery installation shall be arranged independently, i.e. the failure of the safety system of one part of the machinery shall not interfere with the operation of the another safety system.

2.4.7 When the safety system is activated, means shall be provided to trace the cause of its action.

2.4.8 When the safety system has stopped a unit, this unit shall not be restarted automatically after the failure is removed, before a manual reset has been carried out.

2.4.9 Failures or break of the power supply to the safety system shall not stop or change the operating conditions of a machinery or equipment being protected. Any departure from this requirement shall be specially agreed with the *Registrar*.

2.4.10 Failure of the main or emergency power supply to a safety system shall operate alarms at all remote control stations.

2.4.11 When a safety system is activated, alarms shall be given at every control station and also through the engine room alarm system, if provided.

2.4.12 In order to avoid undesirable interruption in the operation of machinery, the system is to intervene sequentially after the operation of alarm system by:

- starting of standby units,
- load reduction or shutdown, such that the least drastic action is taken first.

2.4.13 The system should be designed to 'fail safe.' The characteristics of 'fail safe' of a system is to be evaluated on the basis not only of the safety system itself and its associated machinery, but also on the inclusion of the whole machinery installation as well as the ship.

2.5 REMOTE CONTROL AND AUTOMATIC REMOTE CONTROL SYSTEMS

2.5.1 General requirements

2.5.1.1 Automatic remote control systems of individual machinery or equipment shall be independent.

2.5.1.2 In case of simultaneous remote control of several machinery installations or equipment (e.g., propulsion machinery, aggregates, boilers, etc.), the inter connected control shall be permitted, but it shall be agreed with the *Register* in each particular case.

2.5.1.3 Remote control systems including automatic operation of machinery or equipment shall have such characteristics that comply with their dynamically properties and shall function reliably within their operating ranges. Also they shall be of such designs that during their normal operation no overloading of machinery or equipment being under control is permitted.

2.5.1.4 Provision shall be made for the efficient change-over from automatic to manual control in such a way that a failure in automatic system shall not cause unsafe operation of manual control both from main control station or local control position

2.5.1.5 Every local control position shall have a possibility to cancel remote or automatic control.

2.5.1.6 When a machinery may be remotely controlled from several places, provision shall be made for the appropriate signalization indicating from which location the control is carried out. Remote control shall not be possible from different locations simultaneously.

Control position shall be changed over only from the main control station.

2.5.1.7 The remote control shall be provided with the appropriate number of instruments and indicators showing the correct operation of the system and ensuring the safe control of machinery or equipment.

2.5.1.8 Remote control station shall be provided with the supply voltage failure alarm and automatic change-over to the emergency source of supply (if fitted).

2.5.1.9 Actual control is not to be transferred before acknowledged by the receiving command location. Transfer of control is to give audible and visual pre-warning. The main control station is to be able to take control without acknowledgement.

2.5.2 Bridge control of the propulsion machinery

2.5.2.1 Under all sailing conditions, including manoeuvring, the speed, direction of thrust and, if applicable, pitch of the propeller shall be fully controllable from the navigating bridge.

2.5.2.2 The bridge control for main propulsion machinery shall include in addition to the requirements of the *Rules, Part 7 - Machinery installation*, 1.8, the following:

- .1 group alarms or propulsion machinery failure alarm,
- .2 remote control failure special alarm,
- .3 remote control supply failure alarm,
- .4 communication system with the engine control station,
- .5 shut down signalization,
- .6 slow down signalization,
- .7 possibility of override of shut-down and slow-down,
- .8 emergency run signalization,
- .9 starting failure signalization,
- .10 testing of visual and audible warning signalization.

2.5.2.3 All alarms, signals and lights referred to in 2.5.2.2, except those under 2.5.2.2.4, shall not be totally dimmed.

2.5.2.4 Communication system with the main control station shall include the following:

- .1 direct telephone communication independent of the ship's supply system,
- .2 telegraph apparatus (which may be integral to the automatic remote control),
- .3 signals to indicate the location from which the control has been carried out,
- .4 signals for transfer of control.

2.5.2.5 The requirements referred to in 2.5.2.2 shall be also applicable to the main control station.

2.5.2.6 Override of emergency stop, emergency runs and shut down shall be so designed that they cannot be activated incidentally.

2.5.2.7 In principle the remote control mentioned under 2.5.2.1 is to be performed by a single control device for each independent propeller, with automatic performance of all associated services, including, where necessary, means of preventing overload and prolonged running in critical speed ranges of the propelling machinery.

2.5.2.8 The bridge control system is to be independent from the other transmission system; however, one control lever for both systems may be accepted.

2.5.2.9 Operations following any setting of the bridge control device including reversing from the maximum ahead service speed in case of emergency are to take place in an automatic sequence and with time intervals acceptable to the machinery.

2.5.2.10 The main propulsion machinery shall be provided with an emergency stopping device on the navigating bridge and independent from the bridge control system.

Emergency stopping process is to be completely independent of normal operation and is to be supplied from a separate power source.

2.5.2.11 Remote starting of the propulsion machinery is to be automatically inhibited if conditions exist which may hazard the machinery, e.g. shaft turning gear engaged, drop of lubricating oil pressure.

2.5.2.12 For steam turbines a slow-turning device should be provided, which operates automatically if the turbine is stopped longer than admissible. If a possibility of remote control is provided, automatic operation shall not be required.

2.5.2.13 The design of the bridge control system shall be such that in case of its failure an alarm is given. In this case the speed and direction of the propeller thrust are to be maintained until local control is in operation, unless this is considered impracticable. In particular, lack of power (electric, pneumatic, hydraulic) should not lead to major and sudden change in propulsion power or direction of propeller rotation.

2.5.2.14 The number of automatic consecutive attempts that fail to produce a start shall be limited to maintain sufficient starting air pressure. An alarm shall be provided at an air pressure level, which still permits main engine starting operation.

2.5.2.15 The control system shall include means to prevent the propelling thrust from altering significantly when transferring control from one control to another.

2.5.2.16 Propulsion machinery orders from the navigation bridge shall be indicated in the main machinery control room and at the manoeuvring platform.

2.5.2.17 Indicators shall be fitted on the navigation bridge, the main machinery control room and at the manoeuvring platforms for the propeller speed and direction of rotation in the case of fixed pitch propellers.

2.5.2.18 Indicators shall be fitted on the navigation bridge, the main machinery control room and at the manoeuvring platform for the propeller speed and pitch position in the case of controllable pitch propellers.

2.5.3 Requirements for ships of less than 30 m in length

2.5.3.1 Requirements of this chapter shall apply to all ships of less than 30m in length which due to specific construction cannot fulfil main requirements (engine room height, noise, illumination, ventilation, temperature) concerning protection and stay of the engine room duty personnel.

2.5.3.2 The subject requirements shall apply to:

- a) new ships irrespective of intended purpose,
- b) existing ships which are under reconstruction (purpose change, main engine exchange and wheelhouse control place reconstruction),
- c) existing ships after owners request for automation mark AUT 3.

2.5.3.3 The owner shall submit the documentation for approval with the scheme covering remote control, alarm system and indication system.

2.5.3.4 Monitoring system on the bridge panel in the wheelhouse shall include the following (visual and audible) alarms:

- .1 main engine low lubrication oil pressure (all engines over 33kW),
- .2 clutch low oil pressure (hydraulic or other which is lubricated under pressure),
- .3 main engine high cooling water temperature,
- .4 daily tank low fuel oil level (or indication),
- .5 main engine low cooling water level in gravitation (expansion) tank,
- .6 high bilge level,
- .7 engine room fire detection.

2.5.3.5 The following indication shall be ensured to monitor machinery on the bridge control panel:

- .1 number of main engine revolutions,
- .2 main engine lubrication oil pressure,
- .3 main engine cooling water pressure,
- .4 rudder blade deflection,
- .5 starting batteries charging indicator,
- .6 clutch condition (forward, neutral, reverse) or rpm and sense of propeller shaft rotation.

2.5.3.6 The independent means for remote stopping of the main engine in emergency on the navigating bridge remote control station shall be provided.

2.5.3.7 The provision shall be made for control (checking) the functioning of audible and visible signalling as well as setting switch for light intensity of the instruments and signalling means.

2.5.3.8 Protection system shall be provided:

- excessive number of revolutions - overspeed (for engines of power output 220 [kW] and over),
- main engine very low oil pressure (for engine of power output 150 [kW] and over).

2.5.3.9 In case of emergency means shall be provided to ensure the communication between navigating bridge control station (position) and local control station in the engine room.

2.5.3.10 All external high pressure fuel delivery lines between the high pressure fuel pumps and fuel injectors are to be protected with a jacketed piping system capable of containing fuel from a high pressure line failure.

System is to provide an arrangement for alarm to be given of a fuel line failure.

Engines of power output of less than 375 kW may use as an alternative to the jacketed piping system a suitable enclosure of high pressure fuel pipes and pump.

2.5.3.11 Means for indicating number of revolution and lubricating oil pressure indicator shall be fitted on the main engine.

3 PROGRAMMABLE ELECTRONIC SYSTEMS

3.1 GENERAL REQUIREMENTS

3.1.1 The present requirements apply to the programmable electronic systems (PES) based control, alarm or safety systems being supervised by the *Register*.

These requirements are stated also in the *Rules, Part 12. – Electrical equipment*, item 2.10.

3.1.2 The performance properties and safety integrity of a PES based control, alarm or safety system are to be carefully assessed and documented in relation to functional requirements. Special attention is to be given to minimizing the risk of common mode failures affecting automatic control, alarm and safety functions.

3.1.3 The on-line operation of a PES serving important functions such as propulsion, power generation, steering, fire detection and extinction, draining and bilge pumping, blasting or anchoring and mooring, is not to depend on the operation of disk drives or the other magnetic bulk storage devices.

3.1.4 The time needed to bring a PES back in operation upon a fault condition, shall be adapted to the redundancy requirements imposed on the system served.

3.1.5 No failure in the PES operation shall endanger the associated equipment or the ship's safety.

3.2 SCOPE OF SURVEY

3.2.1 General requirements of survey are specified in the *Rules, Part 1 - General Requirements, Chapter 5 - Surveys of ships in service*.

3.2.2 The PES is to be Type Approved by the *Register*. Alternatively, previous satisfactory marine service experience may be accepted as evidence of the equipment's suitability for use on board.

3.2.3 If not agreed otherwise, the PES is to be subject to factory approval test in the presence of the surveyor of the *Register* before installation on board.

The test is to be based on approved test program and is to include function testing as well as fault simulation of internal and external faults.

3.3 TECHNICAL REQUIREMENTS FOR PES - HARDWARE

3.3.1 Control, alarm and safety shut-down function are to be arranged such that a single failure or malfunction of the electronic equipment will not affect more than one of these functions. This may be achieved by dedicated equipment for each of these functions within a single system, or by the provision of standby equipment, or by suitable means. In the case of PES having safety functions that are not backed up by hard-wire systems a consequence analysis is to be carried out to

demonstrate that the programmable system is at least reliable as a hard-wire system.

3.3.2 Where standby equipment is provided the changeover arrangements are to be such to prevent malfunctions of the standby electronic system and the machinery under control.

3.3.3 The system is to be designed with self-monitoring facilities and any fault causing failure of the system to carry out its intended functions is to initiate an alarm. Both operating and standby equipment (if fitted) is to be monitored.

3.3.4 The system is to be such as to operate automatically from an alternative power supply in the event of a failure of the normal power supply.

Program and data held in the PES are to be protected from damage by loss of power.

3.3.5 Failure of any power supply to the PES is to initiate an alarm.

3.3.6 When an alarm is released, the alarm message is to be given priority over any other information presented on the visual display unit. The latest alarm should preferably be listed first in the alarm list.

3.3.7 The fault monitoring is to:

- detect system failures which may result in an immediate, unacceptable degradation of system performance or reduce safety margins below an acceptable level;
- give warning to operating personnel;
- provide unambiguous identification of failed part of the system.

3.3.8 Memory space for data and application programs is to be protected or monitored, to prevent the memory contents from being corrupted due the hardware or software faults.

3.3.9 An integrated computer control system intended for controlling:

- Propulsion and auxiliary machinery,
- Cargo and ballast systems,

are each to be provided with a minimum of two operators terminals comprising a monitor, operator keyboard or equivalent, and any necessary pointing device. Secondary monitoring positions need only to be provided with one operator terminal which may be of the portable plug-in type.

3.3.10 Panels having dedicated functions, given in 3.3.9, are to be connected to the system via duplicated, totally independent interfaces.

3.3.11 Monitors at the station in control and if fitted, in the duty engineer's accommodation are to provide immediate display of new alarm information regardless of the information display page currently selected. This may be achieved by provision of a dedicated alarm monitor, a dedicated area of screen for alarms or other suitable means.

3.3.12 Alarms are to be displayed in the order in which they occur. Alarms requiring shutdown or slowdown action are to be given visual prominence.

3.3.13 Unacknowledged alarms are to be distinguished by either flashing text or a flashing marker adjacent to the text.

A change of colour will not in itself be sufficient to distinguish between acknowledged and unacknowledged alarms.

3.3.14 The size, colour and density of text and graphic information displayed is to be such that it may be easily read from the normal operator position under all operational lighting conditions.

3.3.15 Symbols used in mimic diagrams are to be standardised throughout the system's displays.

3.3.16 Means are to be provided for the manual adjustment of brightness of each monitor, however, it should not be possible to darken the display to such an extent that it becomes illegible.

3.3.17 The keyboard is to be divided logically into areas enabling rapid access to the desired function. Alpha numeric, paging and specific system keys are to be grouped separately and grouping is to be identical at all terminals.

3.3.18 Where date and time information is required by the system this is to be provided by means of a battery backed clock with restricted access for alteration.

3.4 TECHNICAL REQUIREMENTS FOR PES - SOFTWARE

3.4.1 Control of the access to the data and programs shall be ensured.

3.4.2 Alternation of parameters which may affect system performance, are only to be performed by authorized personnel, by means of a key switch, keycard, password, or some other approved method.

3.4.3 Access to the PES operating system is to be highly restricted, and any modification of application programs or data which may affect system safety, and which are not part of the normal operation and maintenance of the system, are subject to approval prior to modification.

3.4.4 Software design, coding, modification, integration and testing should be performed according to a recognized national or international quality assurance standard.

3.5 LOCAL AREA NETWORK

3.5.1 The network topology is to be such that in the event of failure between nodes, the system on the network continue to operate and data transmission between other nodes is maintained.

3.5.2 Protocols are to ensure the integrity of data flowing on the network. In addition, the software in computers sharing network is to be designed to carry out limit checking to prevent the acceptance of corrupted data at the receiving node.

3.5.3 The data rate and bandwidth are to be sufficient to allow for adequate up-dating of all sensors available. Furthermore, time delays are not to impair the quality of the sensor information and control data carried by the network.

Guidance:

Careful evaluation should be given to the time delays imposed by the network if it is to be used for carrying out the time critical

functions (e.g. closed loop real time control, alarm and safety shut down). In order to avoid potential problems, it is recommended to keep time critical functions segregated from the network, unless it can be demonstrated that the network latency is insignificant in relation to the response time required to perform the required function.

3.5.4 Network must be such that in the event of a network controller failure, main functions of the automation system served by a network, are saved.

3.5.5 Means are to be provided to ensure insertion and separation of nodes without interrupting the normal network operation.

3.5.6 The network is to allow for redundant communication links between nodes when important functions (as mentioned in 3.1.3), can be affected by a failure in single communication link.

Redundant communication links shall be adequately separated from the other ones as to ensure that an incident, e.g. fire will not cause a failure of both links.

3.5.7 Means are to be provided to monitor the usage of the network, the occurrence of faults and other parameters necessary for assessing its performance. Alarms are to be operated in the event of a network fault.

3.6 INSTALLATION OF PES ON BOARD

3.6.1 The hardware equipment and communication links in local network shall be adequately designed and protected against climatic, mechanical, electromagnetic and thermal influence, liable to damage or change their characteristics beyond acceptable limits.

As far as possible, communication links shall be led separately in the local network.

Description of protection of a.m. influences shall be a part of system documentation and shall be approved by the *Register*.

4 REQUIREMENTS FOR AUTOMATION ON SHIPS HAVING AUTOMATION MARK AUT 2

The Table 4.1 specifies:

- controlled of parameters,
- location of measuring points,
- alarm (if required),
- description of protective action
- indication (if required).

4.1.2 Main control station is to be located within the machinery space.

4.1 GENERAL REQUIREMENTS

4.1.1 Requirements of this Section apply to ships having automation mark AUT 2.

Table 4.1

| No. | Controlled parameter | Location of measuring point | Alarm activation | Protective action | Remote Indication | Remarks |
|------------|--|-----------------------------|------------------|--|-------------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | CROSS-HEAD DIESEL ENGINES | | | | | |
| 1.1 | Fuel oil system | | | | | |
| 1.1.1 | Fuel oil pressure | After filter (engine inlet) | Min. | Automatic start of standby pump | On call | |
| 1.1.2 | Fuel oil viscosity/temp. | Before injection pumps | Max./Min. | | | |
| 1.1.3 | Leakage from high pressure pipes | Slop tank | Alarm | | | Also see the <i>Rules Part 9 – Machinery</i> |
| 1.1.4 | Level of fuel oil in daily service tank | Daily service tank | Min. | | | High-level alarm is also required if no suitable overflow arrangement is provided |
| 1.1.5 | Common rail fuel oil pressure | | Min | | | |
| 1.2 | Lubricating oil system | | | | | |
| 1.2.1 | Main bearing and thrust bearing lub. oil pressure | | Min. | Automatic start of standby pump. Slow down. Shut down. | Cont. | |
| 1.2.2 | Crosshead bearing lub. oil pressure | | Min. | Automatic start of standby pump. Slow down. Shut down. | Cont. | If separate lub. oil system is installed |
| 1.2.3 | Camshaft lub. oil pressure | | Min. | Automatic start of standby pump. Shut down. | | If separate lub. oil system is installed |
| 1.2.4 | Lub. oil to camshaft temp. | | Max. | | | If separate lub. oil system is installed |
| 1.2.5 | Lub. oil inlet temp. | At inlet | Max. | | | – |
| 1.2.6 | Thrust bearing pads temp. or bearing outlet temp. | | Max. | Slow down. Shut down. | | – |
| 1.2.7 | Activation of oil mist detection arrangements (or activation of the temperature monitoring systems or equivalent devices of: - the engine main, crank and crosshead bearing oil outlet; or - the engine main, crank and crosshead bearing) | | Max. | Slow down. | | When required by IACS UR M10.8 or by SOLAS Reg. II-1/47.2 |
| 1.2.8 | Flow rate cylinder lubricator | | Min. | Slow down. | | Each apparatus |

Table 4.1 (continued)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|------------|--|------------------------------|-------|---|---------|---|
| 1.2.9 | Lubricating oil level | Lubricating oil tanks | Min. | | | Where separate lubricating oil system is installed (e.g. crankshaft, rocker arms, etc.), individual level alarms are required for each tank |
| 1.2.10 | Common rail servo oil pressure | | Min. | | | |
| 1.3 | Turbocharge system | | | | | |
| 1.3.1 | Turbocharger lub. oil inlet pressure | At inlet | Min. | | | Unless provided with a self-contained lub. oil system integrated with the turbocharger |
| 1.3.2 | Turbocharger lub. oil outlet temp. | At outlet of each bearing | Max. | | | Where outlet temp. from each bearing cannot be monitored due to the engine/turbocharger design alternative arrangement may be accepted |
| 1.3.3 | Speed of turbocharger | | Max | | Cont. | Required only for turbochargers of Cat. B & C – see IACS UR M73.5 |
| 1.4 | Piston cooling system | | | | | |
| 1.4.1 | Piston coolant pressure | At inlet | Min. | Slow down. Automatic start of standby pump | | The slowdown is not required if the coolant is oil taken from the main cooling system of the engine |
| 1.4.2 | Piston coolant temp. | At outlet of the each piston | Max. | Slow down | | |
| 1.4.3 | Piston coolant flow | For each cylinder | Min. | Slow down | | Where outlet flow cannot be monitored due to engine design, alternative arrangement may be accepted |
| 1.4.4 | Level of piston coolant | In expansion tank | Min. | | | |
| 1.5 | Sea water cooling system | | | | | |
| 1.5.1 | Sea water pressure | After cooling pump | Min. | Automatic start of standee | Cont. | – |
| 1.6 | Cylinder fresh cooling water system | | | | | |
| 1.6.1 | Cylinder water inlet pressure | At inlet | Min. | Slow down. Automatic start of standby pump. | Cont. | Pressure monitoring may be substituted by monitoring of flow rate |
| 1.6.2 | Cylinder water temp. | At each cylinder outlet | Max. | Slow down | On call | Where one common cooling space without individual stop valves is employed for all cylinder jackets, water outlet temp. (general) may be taken |
| 1.6.3 | Oil contamination of engine cooling water system | | Alarm | | | Where main engine cooling water is used in fuel and lubricating oil heat exchangers |
| 1.6.4 | Cylinder cooling water level | Expansion tank | Min. | | | |

Table 4.1 (continued)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-------------|---|------------------------------|-----------|--|---------|---|
| 1.7 | Starting and control air systems | | | | | |
| 1.7.1 | Starting air pressure | Before main shut-off valve | Min. | | Cont. | Auto-start of compressor for automation mark AUT1 or AUT2 |
| 1.7.2 | Control air pressure | | Min. | | | |
| 1.7.3 | Safety air pressure | | Min. | | | |
| 1.8 | Scavenging air system | | | | | |
| 1.8.1 | Scavenging air pressure | At scavenger receiver | | | Cont. | |
| 1.8.2 | Scavenging air box temp. (fire) | At scavenger receiver | Max. | Slow down. | | |
| 1.8.3 | Scavenging air water level | At scavenger receiver | Max. | | On call | |
| 1.9 | Exhaust gas system | | | | | |
| 1.9.1 | Exhaust gas temp. | After each cylinder | Max. | Slow down. | On call | |
| 1.9.2 | Exhaust gas temp. - deviation from average | After each cylinder | Max. | | | |
| 1.9.3 | Exhaust gas temp. | Before each T/C | Max. | | On call | |
| 1.9.4 | Exhaust gas temp. | After each T/C | Max. | | On call | |
| 1.10 | Fuel valve coolant | | | | | |
| 1.10.1 | Pressure of fuel valve coolant | At inlet | Min. | Automatic start of standby pump | Cont. | |
| 1.10.2 | Temp. of fuel valve coolant | At outlet | Max. | | On call | – |
| 1.10.3 | Level of fuel valve coolant | In expansion tank | Min. | | | |
| 1.11 | Engine speed/direction of rotation | | | | Cont. | – |
| 1.11.1 | Wrong way | | Alarm | | | |
| 1.12 | Engine overspeed | | | Shut down | | |
| 1.13 | Control Safety-Alarm system power supply failure | | Alarm | | | |
| 2 | TRUNK-PISTON DIESEL ENGINES | | | | | |
| 2.1 | Fuel oil system | | | | | |
| 2.1.1 | Fuel oil pressure | Before filter (engine inlet) | Min. | Automatic start of standby pump | On call | – |
| 2.1.2 | Fuel oil viscosity/temperature | Before injection pumps | Max./Min. | For heavy fuel oil burning engines only. | | |
| 2.1.3 | Leakage from high pressure pipes | Slop tank | Alarm | | | Also see the <i>Rules, Part 9 – Machinery</i> |
| 2.1.4 | Level of fuel | Daily service tank | Min. | | | High-level alarm is also required if no suitable overflow arrangement is provided |
| 2.2 | Lubricating oil system | | | | | |
| 2.2.1 | Main bearing and thrust bearing, lub. oil pressure | | Min. | Automatic start of standby pump. Shut down | Cont. | |
| 2.2.2 | Lub. oil filter differential pressure | On filter | Max. | | Cont. | |

Table 4.1 (continued)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-------------|--|---------------------------|-------|---|---------|---|
| 2.2.3 | Lub. oil temp. | At inlet | Max. | | On call | |
| 2.2.4 | Activation of oil mist detection arrangements (or activation of the temperature monitoring systems or equivalent devices of: - the engine main and crank bearing oil outlet; or - the engine main and crank bearing) | | Max. | Shut down (see note) | | Note 1 |
| 2.2.5 | Cylinder lub. oil flow | At lubricator | Min. | Slow down | | Each apparatus |
| 2.2.6 | Common rail servo oil pressure | | Min. | | | |
| 2.3 | Turbocharger system | | | | | |
| 2.3.1 | Turbocharger lub. oil pressure | At inlet | Min. | | On call | If with external lub. oil system |
| 2.3.2 | Turbocharger lub. oil temp. | At outlet of each bearing | Max. | | | |
| 2.3.3 | Speed of turbocharger | | Max | | Cont. | Required only for turbochargers of Cat. B & C – see IACS UR M73.5 |
| 2.4 | Sea water cooling system | | | | | |
| 2.4.1 | Sea water pressure | After cooling | Min. | Automatic start | Cont. | – |
| 2.5 | Cylinder fresh cooling water system | | | | | |
| 2.5.1 | Cylinder cooling water pressure or flow | At inlet | Min. | Slow down. Automatic start of standby pump. | Cont. | – |
| 2.5.2 | Cylinder cooling water temp. | At outlet | Max. | Slow down | On call | Two separate sensors are required for alarm and slow down |
| 2.5.3 | Level of cylinder cooling water | Expansion tank | Min. | | | |
| 2.6 | Starting and control air systems | | | | | |
| 2.6.1 | Starting air pressure | Before main | Min. | | Cont. | Auto-start of compressor for automation mark AUT1 or AUT2 |
| 2.6.2 | Control air pressure | | Min. | | Cont. | |
| 2.7 | Scavenging air system | | | | | |
| 2.7.1 | Scavenging air temp. | At scavenger receiver | Max. | | | |
| 2.8 | Exhaust gas system | | | | | |
| 2.8.1 | Exhaust gas temp | After each cylinder | Max. | Slow down. | On call | For engine power more than 500 kW/cyl. |
| 2.8.2 | Exhaust gas temp. (Deviation from average) | After each cylinder | Max. | | | For engine power more than 500 kW/cyl. |
| 2.9 | Engine speed | | | | Cont. | |
| 2.10 | Engine overspeed | | Alarm | Shut down. | | |
| 2.11 | Control Safety-Alarm system power supply failure | | Alarm | | | |
| 3 | Steam turbines | | | | | |
| 3.1 | Lub-oil pressure | After cooler | Min. | Shut down. | Cont. | – |
| 3.2 | Differential pressure in lub oil system | At filter | Max. | – | Cont. | – |
| 3.3 | Lub oil temperature | At each bearing outlet | Max. | – | Cont. | – |

Table 4.1 (continued)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|----------|--|---|---------------|------------|---------|---|
| 3.4 | Lub oil level | Gravity tank | Min. | – | Cont. | – |
| 3.5 | Steam pressure | Before manoeuvring valves for the ahead and astern turbines | – | | | |
| 3.6 | Steam pressure | At bleeders | – | – | On call | – |
| 3.7 | Steam temperature | Before manoeuvring valves | Max./Min. | – | On call | – |
| 3.8 | Steam pressure | End glands | Max. | – | Cont. | – |
| 3.9 | Steam pressure | Condenser | Max. | Shut down. | Cont. | – |
| 3.10 | Pressure | Deaerator | Max. | – | On call | – |
| 3.11 | Water level in condenser | Condense | Max. | – | On call | When installed in the same plane as the low-pressure turbine |
| 3.12 | Water pressure of condensate pump | At condensate pump outlet | Min. | – | On call | – |
| 3.13 | Salinity of condensate | After condenser | Max. | – | On call | – |
| 3.14 | Vibration of turbine | Turbine casing | Max. | Shut down | | – |
| 3.15 | Axial displacement of rotor | – | Max. | Shut down | | – |
| 3.16 | Sea water pressure | On circulating pump outlet | Min. | – | Cont. | – |
| 3.17 | Failure of main boiler or excessive reduction of stem pressure | – | – | Shut down | – | – |
| 4 | Gas turbines | | | | | |
| 4.1 | High pressure turbine r.p.m | – | Max. | – | Cont. | – |
| 4.2 | Low pressure turbine r.p.m | – | Max. | Shut down | Cont. | – |
| 4.3 | Gas temperature | After high-pressure turbine | Max. | Shut down | Cont. | – |
| 4.4 | Air temperature | Before high-pressure compressor | Max. | – | On call | – |
| 4.5 | Lub oil pressure | At inlet | Min. | Shut down | Cont. | – |
| 4.6 | Lub oil temperature | At inlet | Max. | – | On call | – |
| 4.7 | Temperature of bearings or oil temperature at bearing outlet | At outlet | Max. | – | On call | – |
| 4.8 | Cooling water temperature | At outlet | Max. | – | On call | – |
| 4.9 | Fuel pressure (for pilot burners also) | At inlet | Min. | – | On call | – |
| 4.10 | Fuel temperature (where fuel is heated up) | At inlet | Min./Max. | – | On call | |
| 4.11 | Flame | – | Flame failure | Shut down | | |
| 4.12 | Vibration of turbine | Turbine casing | Max. | Shut down | | |
| 4.13 | Exhaust gas temperature | | Max. | Shut down | Cont. | |
| 5 | Main and aux. boilers | | | | | |
| 5.1 | Steam pressure | Boiler drum or at superheater outlet | Min./Max. | Shut down | Cont. | Low pressure alarm, only for auxiliary boiler of essential service. Shut down and low pressure alarm for main boiler is not required. |

Table 4.1 (continued)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|----------|---|-----------------------|---------------|-----------|---------|---|
| 5.2 | Steam temperature | At superheater outlet | Max. | – | On call | – |
| 5.3 | Steam temperature | At cooler outlet | Max. | – | On call | – |
| 5.4 | Water level | Boiler drum | Min./Max. | Shut down | Cont. | For main boiler shut down for high level is not required |
| 5.5 | Feed water pressure | Pump outlet | Min. | Shut down | Cont. | Shut down required only for boiler with forced circulation |
| 5.6 | Fuel pressure | Before burner | Min. | Shut down | On call | |
| 5.7 | Fuel viscosity (or temperature) | Before burner | Max./Min. | Shut down | On call | For main boiler shut down is not required. |
| 5.8 | Combustion air pressure | At furnace inlet | Min. | Shut down | On call | For main boiler shut down is not required |
| 5.9 | Salinity of feed water | Feed pump outlet | Max. | – | On call | – |
| 5.10 | Flame | – | Flame failure | Shut down | – | – |
| 5.11 | Oil fuel level | Daily service tank | Min. | – | On call | – |
| 5.12 | Oil fuel temperature | Daily service tank | Max. | – | On call | If heating arrangements are provided |
| 5.13 | Electrical power supply | Power supply unit | Failure | Shut down | – | – |
| 5.14 | Water level | Hot well | Min. | – | – | – |
| 6 | Electric generating plant | | | | | |
| 6.1 | Voltage | Main switchboard | Min. | – | Cont. | If the main switchboard is located at the main control station, alarms and indication may be fitted |
| 6.2 | Current | Main switchboard | Max. | – | Cont. | – |
| 6.3 | Frequency | Main switchboard | – | – | Cont. | – |
| 7 | Generators driven by diesel engines | | | | | |
| 7.1 | Lub oil pressure | At inlet | Min. | Shut down | On call | – |
| 7.2 | Lub oil temperature | At inlet | Max. | – | On call | – |
| 7.3 | Temperature of cooling water or cooling air | At inlet | Max. | – | On call | – |
| 7.4 | Pressure or flow of cooling water | At inlet | Min. | – | On call | If operating with heavy fuel, also for cooling system of fuel valves |
| 7.5 | Starting air pressure | At starting valve | Min. | – | On call | – |
| 7.6 | Oil fuel level | Daily service tank | Min. | – | – | If operating with heavy fuel, the fuel viscosity or temperature to be monitored |
| 7.7 | Fuel oil leakage from high-pressure piping | Fuel leakage tank | Alarm | – | – | – |
| 7.8 | Cooling water level | Expansion tank | Min. | – | – | If not connected to the main system |

Table 4.1 (continued)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-----------|--|-----------------------|----------|--------------------------------------|---------|---|
| 7.9 | Activation of oil mist detection arrangements (or activation of the temperature monitoring systems or equivalent devices of: - the engine main and crank bearing oil outlet; or - the engine main and crank bearing) | | Max | Shut down ¹ (see note) | | Note 1. |
| 7.10 | Overspeed activated | | | Shut down | – | – |
| 7.11 | Heavy fuel viscosity / temp. | Before injection pump | Min./Max | – | – | For heavy fuel oil burning engines only |
| 7.12 | Exhaust gas temperature | After each cylinder | Max | – | – | For engine power above 500kW/cyl. |
| 7.13 | Common rail fuel oil pressure | | Min | | | |
| 7.14 | Common rail servo oil pressure | | Min | | | |
| 7.15 | Speed of turbocharger | | Max | | Cont. | Required only for turbochargers of Cat. B & C – see IACS UR M73.5 |
| 8 | Steam turbines driving generators | | | | | |
| 8.1 | Luboil pressure | Oil cooler outlet | Min. | Shut down | On call | In case of gravity lubrication, alarm of low level in gravity tank to be provided |
| 8.2 | Lub oil temperature | Bearing outlet | Max. | – | On call | – |
| 8.3 | Steam pressure | Condenser | Max. | Shut down | On call | – |
| 8.4 | Steam pressure | Turbine inlet | Min. | – | On call | – |
| 8.5 | Water level | Condenser | Max. | – | – | – |
| 8.6 | Axial displacement of rotor | – | Max. | Shut down | – | – |
| 9 | Shafting, CP - propellers | | | | | |
| 9.1 | Shaft r.p.m. indicator | – | – | – | Cont. | – |
| 9.2 | Luboil temperature | Thrust bearing | Max. | – | On call | – |
| 9.3 | Luboil temperature | Sliding bearing | Max. | – | On call | Common signal for permitted water cooled bearings |
| 9.4 | Lubrication of stern bush bearing | – | No. lub. | – | On call | – |
| 9.5 | Stern bush lub. oil level | Stern bush. oil tank | Min. | – | – | For oil lubricated stern bush bearing |
| 9.6 | Blade position (pitch and turn position) | – | – | – | Cont. | – |
| 9.7 | Pitch hydraulic system pressure | Hydraulic pump outlet | Min. | – | Cont. | – |
| 9.8 | Pitch hydraulic oil supply level | Tank | Min. | – | On call | – |
| 9.9 | Temperature of stern bush bearings | – | Max. | – | On call | For oil lubricated stern bush bearing |
| 9.10 | Temperature of stern bush lub. oil | – | Max. | – | On call | – |
| 10 | Reduction gears and coupling | | | | | |
| 10.1 | Lub. oil temperature | Each bearing outlet | Max. | – | On call | Common alarm is permitted |
| 10.2 | Lub oil pressure | Coupling inlet | Min. | Disengagement or shut down of engine | Cont. | – |
| 10.3 | Pressure in lub. oil system of reduction gear | At inlet | Min. | – | Cont. | – |

Table 4.1 (continued)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-----------|--|----------------------------|-----------|------------------|---------|----------------------------|
| 10.4 | Temperature of reduction gear lub. oil | At outlet | Max. | – | – | – |
| 10.5 | Oil level | At tank | Min. | – | – | – |
| 11 | Compressed air system | | | | | |
| 11.1 | Air temperature | Compressor outlet | Max. | – | – | – |
| 11.2 | Lub. oil pressure | Compressor inlet | Min. | Shut down | On call | – |
| 11.3 | Cooling water temperature | | Max. | Shut down | | |
| 12 | Bilge system | | | | | |
| 12.1 | Bilge level | Bilge wells | Max./Min. | | | At remote control location |
| 13 | Fuel and lub. oil purifying systems | | | | | |
| 13.1 | Water and fuel (or lub. oil) temperature | Purifier inlet | Max./Min. | – | On call | – |
| 13.2 | Fuel and water flow | In purifier | Min. | – | On call | – |
| 13.3 | Vibrations | Purifier casing | Max. | Shut down | – | – |
| 14 | Inert gas system | | | | | |
| 14.1 | Inert gas pressure | Gas generating unit outlet | Min. | – | – | – |
| 14.2 | Inert gas temperature | Gas generating unit outlet | Max. | Burner shut down | – | – |
| 14.3 | Combustion air pressure | Combustion chamber inlet | Min. | Burner shut down | – | – |
| 14.4 | Fuel oil pressure | Burner inlet | Min. | – | – | – |
| 14.5 | Fuel oil temperature | Burner inlet | Max. | – | – | For heavy fuel oil |
| 14.6 | Flame and ignition | – | Failure | Fuel flow break | – | – |
| 14.7 | Low pressure or low speed of purifier cooling water flow | Purifier inlet | Min. | – | – | – |
| 14.8 | Oxygen percentage | – | Max. | – | – | – |
| 14.9 | Low water level | Deck water seal | Min. | | | |
| 15 | Cargo and ballast pumps in hazardous spaces | | | | | |
| 15.1 | Bearing temperature | – | Max. | – | – | – |
| 15.2 | Pump casing temperature | – | Max. | – | – | Cargo pumps only |
| 15.3 | Bulkhead gland temperature | – | Max. | – | – | |
| 16 | Other items | | | | | |
| 16.1 | Refrigerating plant | Failure in system | – | – | – | Common alarm |

Note:

1 When required by IACS UR M10.8 or by SOLAS Reg. II-1/47.2; for each engine, one oil mist detector (or engine bearing temperature monitoring system or equivalent device) having two independent outputs for initiating the alarm and shut-down would satisfy the requirements for independence between alarm and shut-down systems.

4.2 MACHINERY ALARM SYSTEMS

4.2.1 The alarm system shall be provided to indicate the machinery fault conditions. The system shall comply with the requirements specified in 2.2.

4.2.2 If the bridge navigating officer on watch is the sole watch keeper then, in the event of a machinery fault being monitored at the control location for machinery, the alarm system is to be such that this watch keeper is informed:

- (i) a machinery fault has occurred,
- (ii) the machinery fault is being detected
- (iii) the machinery fault has been rectified.

Alternative means of communication between the bridge area, the accommodation for engineering personnel and the machinery spaces may be used for this function.

4.2.3 The system is to be so designed that the engineering personnel on duty are made aware that a machinery fault has occurred.

4.2.4 A system of alarm displays and controls is to be provided which readily ensures identification of faults in the machinery and satisfactory supervision of related equipment. This may be provided at a main control station or, alternatively, at subsidiary control stations. In the latter case, a master alarm display is to be provided at the main control station showing which of the subsidiary control stations is indicating a fault condition.

4.2.5 The main control station shall be also provided with following alarms:

- .1 fire alarm in the machinery space,
- .2 power failure in the safety system, main engine emergency stop device, alarm system and main engine remote control system.

4.2.6 In case of operation of all engines located in the machinery space, provision shall be made to ensure that the activation of alarm system and internal communication system shall reliably be noticed. Warring signal shall be audible and visible.

4.2.7 Where no watch keeping is ensured at the main control station when the ship is at port, alarms shall be provided for the machinery at work, fire and critical level in bilges in machinery space.

Such signalization is to be located in the spaces where watch keeping is ensured, during ship's stay in port

4.3 MACHINERY SAFETY SYSTEMS

4.3.1 An alarm system is to be provided in accordance with 2.4.

4.3.2 Automatic start of standby pumps – slow down, is to be accompanied by a suitable alarm.

4.3.3 If overriding device of the required automatic reduction of power is provided, it is to be so arranged as to preclude inadvertent operation, and a suitable alarm is to be operated by its activation.

4.3.4 If overriding device of the required automatic stops – shut down is provided, it is to be so arranged as to preclude inadvertent operation, and a suitable alarm is to be operated by its activation. When the engine is stopped automatically, restarting after restoration of normal operating conditions is to be possible only after manual reset, e.g. by-passing the control lever through the 'stop' position. Automatic restarting is not permissible.

4.3.5 The emergency stop device of main engine shall be fully independent of the engine control and alarm systems and if electrically operated, it shall be fed from a source of power independent of the ship's main.

4.4 MACHINERY REMOTE CONTROL AND AUTOMATIC REMOTE CONTROL SYSTEMS

4.4.1 Remote control system of main propulsion engines is to be provided at navigation bridge and main control station in accordance with 2.5.2

4.4.2 All systems in the machinery space shall be designed for unattended operation in accordance with requirements of 2.5. Systems that need not operate continuously for 12 hours may be exempted from these requirements on agreement with the *Register*.

4.4.3 Main control station and bridge remote control shall be equipped with the control instruments, means of communication and other devices in accordance with the *Rules, Part 7 - Machinery installation*, 1.8, and stopping de-

vices referred to in the *Rules, Part 12 - Electrical equipment*, items 5.2 and 5.3 (in addition to the stopping devices arranged outside the machinery casing).

Control devices shall be constructed in accordance with the *Rules, Part 7 - Machinery installation*, 1.7.

4.4.4 The automation systems shall be so designed that in case of any failure of the system, provisions shall be made to ensure local or remote manual control and to retain the safety degree of a ship as on ships without automation mark.

4.5 INSTALLATIONS WITH MAIN INTERNAL COMBUSTION ENGINES

4.5.1 In ships propelled by internal combustion engines automation shall provide for:

- .1 control and monitoring of main engines in accordance with the *Rules, Part 7 - Machinery installation*, 1.7, 1.8, 1.9 and 1.10, as well as with the *Rules, Part 9 - Machines*, 2.11 and 2.12;
- .2 remote starting and stopping of auxiliaries necessary for uninterrupted operation of main engines from the main control stations;
- .3 automatic start of standby pumps, necessary for uninterrupted operation of main engine, which, if not started, may cause shutdown or slowdown.
Switch-on time of standby pump shall be such as to ensure safe running of the main engine;
- .4 remote or automatic replenishing of receivers for the starting air, pneumatic control systems and the whistles.
Means shall be provided for water and oil to be automatically drained in compressor. In addition to automatic replenishing of the receivers, it shall be also possible to start the compressor remotely from the main control station;
- .5 automatic starting of the hydraulic standby pump in case of pressure drop in the hydraulic control system. The suitable alarm operating at the main control station shall be provided. Provision shall be also made for the manual remote control from the main control station;
- .6 automatic control of water, lub. oil and fuel temperature at the engine inlet, in the service daily tanks and at separation,
- .7 indication, monitoring and protection in accordance with Table 4. 1.

4.5.2 The main internal combustion engines designed for operation by the remote automatic control shall be provided with the infinitely variable speed governor.

4.5.3 The remote automatic control of the internal combustion main engines, besides having to comply with requirements of 2.5.2, shall provide also:

- .1 starting of the engine prepared to start, speed setting, stopping, reversing (in case

- of the fixed propellers) and automatic performing of the intermediate steps,
- .2 stable operation within the working r.p.m. range,
- .3 quick automatic passing through all restricted speed ranges, regardless of the engine speed setting (critical r.p.m.),
- .4 to avoid the uncontrolled consumption of the starting air, the number of unsuccessful attempts to start the engine shall be limited to three. The next shall cause the blocking of the starting air supply and activation of the starting failure alarm. In this case there shall be a sufficient air in the air receiver for six starting attempts from both main control stations or local post.

4.5.4 Installations with two or more internal combustion engines shall be so designed that, with one engine shut-down or when the safety system is activated, the others continue running without being overloaded.

4.6 INSTALLATIONS WITH MAIN STEAM TURBINES

4.6.1 In ships propelled by steam turbines, automation shall provide for:

- .1 control, monitoring, automatic protection and interlocking of the geared turbine set in accordance with the *Rules*.
- .2 remote starting and stopping of the auxiliaries serving main turbines from the main control station,
- .3 automatic start of standby lub. oil pumps at fault condition of the running pumps. Pumps that are running shall be switched off (within a relevant period with the suitable alarm at the main control station). The time required to activate a standby pump shall not exceed 10 sec.;
- .4 remote and automatic replenishing of the air receivers for pneumatic control system and typhoon supply with automatic separating of water from oil;
- .5 automatic and remote starting of the standby pump for supplying the hydraulic control system in case of pressure drop, activating the alarm at the main control station;
- .6 indication, signalling and protection shall be in accordance with Table 4. 1.

4.6.2 Automatic remote control of the main turbine set (which complies with general requirements of 2.5) shall provide for:

- .1 starting to operation of the prepared turbine set, speed variation stopping, reversing and automatic performing of the intermediate steps,
- .2 stable operation within the operating range,
- .3 quick automatic passing through the speed ranges with excessive vibrations,

- .4 prevention of taking the on load if the turbine is not prepared for start.
- .5 Opening of the astern guarding valve as soon as the control handle is moved into "stop" position and simultaneous starting of the circulating pump.

4.7 OIL FIRED BOILERS

4.7.1 The automation system of main and auxiliary boilers shall provide for:

- .1 automatic control of continuous steam supply to essential consumers in all working conditions;
- .2 complying with the *Rules, Part 10 - Boilers, heat exchangers and pressure vessels*, Sections 4 and 5;
- .3 remote starting and stopping of the pumps serving the main boilers from the main control station;
- .4 automatic start of standby feeding pump and boiler ventilator (taking into account requirements for stopping, starting and signalling in compliance with 4.6.1);
- .5 indication, alarms and protection in accordance with Table 4.1.

4.7.2 Oil burning equipment shall atomize the fuel into the boiler furnace providing:

- .1 normal water level in the boiler,
- .2 the viscosity of fuel oil such that adequate atomization is assured,
- .3 the boiler furnace has been pre-ventilated with sufficient number of air changes.

4.7.3 Remote-operated shutdown of oil burning installation from the main control station shall be provided.

4.7.4 Provision shall be made for interlocking arrangements which will prevent automatic or remote starting of the boiler in case of protective action required in the Table 4.1. The starting of boiler from cold condition shall be carried out from a boiler local control station only.

4.7.5 In case of flame failure re-ignition is permitted providing that requirements of the *Rules, Part 10-Boilers, heat exchangers and pressure vessels*, 5.3 are complied with.

4.7.6 Provision shall be made to control or check the boiler safety system when the boiler is in operation and without bringing controlled parameters to the limit values.

4.7.7 Each boiler shall have at least two independent water level transducers fitted at different locations, one of which shall be used solely for protective purposes.

4.8 ELECTRIC GENERATING PLANT

4.8.1 The shipboard electric generating plant shall meet the following requirements:

- .1 control of the generator prime movers shall be in accordance with the *Rules, Part 9 - Machines*, and that of the generators in accordance with the *Rules, Part 12 - Electrical equipment*,

- 2 Electric generating sets shall be continuously maintained in standby condition,
- 3 Provision shall be made for remote starting of the prime movers of electric generating plant from the main control station, with automatic synchronizing, loading and load sharing. Where the main switchboard is located at the main control station, synchronizing, loading and load sharing may be effected manually from the main switchboard.
Where the standby electric generating set is arranged for automatic start when the running machines become overloaded, provision shall be made for automatic synchronizing loading and load sharing
- 4 Where the electric power is supplied by one generator only and in case of generator blackout, automatic starting and connecting stand by one to the main switchboard within not more than 45 sec. shall be provided.
Also subsequent re-starting of essential machinery necessary for propulsion steering and safety of the ship that has been in operation prior to blackout, shall be provided.
In case of blackout of the generator under running condition caused by short circuits in the main switchboard busbars the possibility of repeated switching on as well as the starting of the standby generator shall be blocked.
A special alarm shall operate in such a case.
- 5 signalling, indication and protection shall be in compliance with Table 4.1.

4.8.2 Where electric generating sets are started automatically a device shall be fitted to provide their sequential connection to the main switchboard busbars.

4.8.3 Automatic arrangements for load sharing shall include provision to prevent the disconnection at temporary load variations.

4.8.4 Where provision is made for auxiliaries essential for propulsion and navigation of the ship to be automatically started after blackout, the starting shall be controlled by a program precluding overloading of the ships generating plant. Steering gear hydraulic oil pump and lub. oil pump shall be started first.

4.8.5 If the electric power is normally supplied by two or more generating sets operating in parallel in case one of them comes out of operation provisions shall be made to prevent the overload of the remaining generators which may cause the complete black out. This shall be carried out by disconnection of non-essential consumers (in accordance with the *Rules, Parts 12 - Electrical equipment*, 8.2.3) to ensure the safe propulsion, steering as well as the safety of the ship.

4.8.6 If the ship electric generating plant incorporates the generator driven by the main propulsion machinery that fully covers the consumption of electric energy under normal conditions, then a reliable transfer to electric power supply from generators driven by auxiliary engines and vice versa

shall be assured. During this transfer no interruption of power supply from the main switchboard shall be permitted. All operations needed for such a transfer may be effected manually.

4.9 REFRIGERATING PLANTS

4.9.1 The refrigerating plants shall be fitted with control monitoring and protection facilities in accordance with the *Rules, Part 11 - Refrigerating plant*, 7.2.8.

4.9.2 A classed refrigerating plant shall be provided with instruments at the main control station indicating whether the refrigerating plant units are operating or stopped as well as the average temperature of refrigerated spaces.

4.9.3 At the main control station provision shall be made for a refrigerant leak alarm activated by gas detectors fitted in accordance with the *Rules, Part 11 - Refrigerating plant*.

4.10 BILGE LEVEL ALARM SYSTEM

4.10.1 Alarm system is to be provided for detecting a rise of water in the machinery space bilges or bilge wells above predetermined level. This level is to be such to prevent liquid from overflowing from the bilges onto the tank top and bilge wells are to be large enough to assure normal drainage during the unattended period. The number and location of wells and detectors are to be such that accumulation of liquids may be detected at all normal angles of heel and trim.

4.10.2 Where the bilge pumps start automatically, means shall be provided to indicate if the influx of liquid is greater than the pump capacity or if the pump is operating more frequently than would normally be expected. In this case, smaller bilge wells to cover a reasonable period of time may be permitted. Where automatically controlled bilge pumps are provided, special attention shall be given to oil pollution prevention requirements.

4.10.3 Alarm is to be given at the main control station, engineers' accommodation area and at the bridge.

4.11 EQUIPMENT OF MAIN CONTROL STATION

4.11.1 Main control station shall be in general, of the enclosed type, sound-proof and protected against penetration of oil and fuel vapours and equipped with the air-conditioning facilities.

4.11.2 In case the requirements referred to in 4.11.1 cannot be complied with, the *Register* may require more rigorous criteria to be applied to climatic conditions as well as mechanical protection for the equipment installed at such a place.

4.11.3 The main switchboard shall in general be fitted at the main control station or adjacent to it (visibility range).

4.11.4 If the main switchboard is located beyond the visibility range of main control station, provisions shall be made for the signalling devices at the main control station to indicate the "on" / "off" positions of the generator circuit breakers.

4.11.5 Where the provision is made for controlling main engine from the main control station by means of mechanical linkage (in accordance with the *Rules, Part 7 - Machinery installation*, 1.8) the engine room control desk may be considered as a local post.

Where other control facilities (pneumatic, electrical or combination thereof) are used for remote control the remote control in the wheel house shall be fully independent from remote control in the main control station.

4.11.6 The main control station of the main machinery or controllable pitch propellers shall be considered to have priority with respect to the wheelhouse remote control.

A local control station is similarly given priority as compared with the main control station. The same applies to the auxiliary machinery.

In case of control transfer of the propulsion machinery and controllable pitch propeller to control location having priority signalization shall be activated at the location from which the control has been effected first.

4.11.7 The main control station shall be equipped with indication of operation sequences determined from the bridge.

4.14.2 In passenger ships, these requirements shall be at least equivalent to those of machinery spaces normally attended.

4.12 EQUIPMENT OF BRIDGE CONTROL

4.12.1 The remote control in the wheelhouse shall be equipped in accordance with the *Rules, Part 7 - Machinery installation*, 1.8.1 and item 2.5.2 of this part of the Rules.

4.12.2 In addition to the alarms referred to in 4.1 special alarms shall be provided for: fire in machinery space, high bilge level in engine room, engine room alarm system being switched off and "deadman" alarm.

4.13 DEAD MAN ALARM

4.13.1 The main control station shall be provided with a device giving an alarm on the wheelhouse in case of not being activated by an officer on duty within determined time intervals.

Audible signalling shall be provided at the control station in machinery space to warn the officer on duty to activate the device mentioned before, prior to proceed the alarm to the wheelhouse.

4.14 ADDITIONAL REQUIREMENTS FOR MEANS OF CONTROL IN PERIODICALLY UNATTENDED MACHINERY SPACES

4.14.1 For periodically unattended machinery spaces, special consideration to maintaining the fire integrity of the machinery spaces, the location and centralization of the fire extinguishing system controls, the required shutdown arrangements (e.g. ventilation, fuel pumps, etc.) and that additional fire-extinguishing appliances and other fire-fighting equipment and breathing apparatus is required.

5 REQUIREMENTS FOR AUTOMATION ON SHIPS HAVING AUTOMATION MARK AUT 1

5.1 GENERAL REQUIREMENTS

5.1.1 Ships having in the notation the automation mark AUT 1, shall be equipped with control and monitoring systems to such extent that in case of losing the mark AUT 1 they can be adequately operated by the personnel at the main control station i.e. with the automation mark AUT 2.

5.1.2 Requirements referred to in Section 4 with amendments of this section apply to the ships having the automation mark AUT 1.

5.1.3 Machinery space shall be equipped with such machinery and systems which can properly operate without attendance and without remote control at the main control station in the wheelhouse or other places and which are monitored only by means of common alarm system.

5.1.4 Engine room alarm system is to be in accordance with the requirements referred to in 2.2 with the following additions:

- .1 The officer on duty alarm shall be fitted in accordance with 5.4.
- .2 When within the determined time interval (agreed with the *Register* depending on the type and size of a ship) alarm is not acknowledged at the main control station alarm system shall activate the engineers alarm required in accordance with the *Rules, Part 12 - Electrical equipment*, 7.8.1.

5.1.5 Provision shall be made for automatic start-up of all standby machinery for essential services associated with propulsion machinery in case of failure of the running machinery, including standby machinery of the hydraulic or pneumatic control systems.

5.1.6 Provision shall be made for self-monitoring of control, alarm and safety systems of main machinery as well as fire detection and bilge alarm systems of machinery space.

Machinery alarm system change-over from the main to emergency source of supply shall be automatic.

5.1.7 In particular cases, to improve reliability of automation equipment, the *Register* may require that certain components of control and monitoring system to be duplicated.

5.1.8 Provision shall be made for an automatic starting of the standby generating set in case of black out in accordance with 4.8.1.4 as well as at overload of the generator at work with automatic synchronizing, loading and load sharing.

Where there is a possibility to connect automatically consumers of such a power that might overload, the main protection shall be made for an automatic device which permits a consumer to be connected only if there is a sufficient available power on busbars. If there is not enough power left

on the busbars the standby generator shall be automatically started including the automatic synchronizing load sharing and only after the completion of the afore mentioned the consumer shall be connected to the busbars.

Stopping of the auxiliary generators due to the safety system operation (except the over speed device and low-low oil pressure) shall be possible only after connecting and loading of a standby generator set of adequate capacity.

5.1.9 Bilge level alarm of bilge wells in holds and machinery space shall be led on the wheelhouse and other spaces intended for the personnel servicing the machinery (engineer's accommodations).

While at port signalling shall be led to space for watch keeping. Level alarm warning that a pump put in action automatically has not sufficient capacity shall be actuated by special transducer.

5.1.10 Provision shall be made for automatic starting of compressor in the event of pressure drop in air receivers of starting and control systems including the typhoon as well as for the automatic starting of standby compressor at failure or shortage of the working pressure.

5.1.11 Where the remote automation control includes several programs for the main engine operating sequences (manoeuvring transition, full load conditions etc.), in addition to these programs an emergency program assuring manoeuvring in hazardous situation with simultaneous override of main engine protection shall be provided.

5.2 MAIN CONTROL STATION

5.2.1 A main control station on the ships having automation mark AUT 1 shall be of enclosed type and shall comply with the requirements in 4.11.1.

5.2.2 On agreement with the *Register* main control station may be located outside the machinery space.

5.3 EQUIPMENT OF BRIDGE CONTROL STATION

5.3.1 The bridge control station shall be equipped in accordance with 4.12 of this part of the Rules. Apart from the requirements referred to in 4.12 the bridge control station shall be fitted with the following alarms and signalling:

- .1 Common fire detection alarm referred to in the *Rules, Part 12 - Electrical equipment*, 7.5 and the *Rules, Part 17 - Fire protection*, 4.2.1 if the fire detection station is located outside the wheelhouse;
- .2 Common alarm from the central alarm system of engine room in accordance with 5.4;
- .3 High bilge level alarm in engine room.

5.4 OFFICER ON DUTY ALARM

5.4.1 All alarms of main engine alarm system shall be led to the following locations:

- .1 navigating bridge;
- .2 chief engineer's cabin;

- .3 cabin of engineer on duty;
- .4 officers day room and dining room;
- .5 location with permanent watch keeping when in port.

5.4.2 All alarms shall be led in at least two groups:

- .1 critical alarms which require immediate action with regard to the safety of a ship, machinery or cargo. This group shall include alarms of voltage failure, of main engine remote control alarms referred to in Table 4.1 and alarms that safety system has been activated;
- .2 non critical alarms which do not require immediate action.

The grouping of alarms shall be permitted provided that critical and non-critical alarms shall not be in the same group.

5.4.3 The continuous alarm transfer shall be assured on the navigation bridge, chief engineer's accommodation and engineer's dining and mess rooms while for the officer on duty accommodation a selector switch shall be used at the main control station.

5.4.4 Provision shall be made on the navigation bridge and in the chief engineer's accommodation to inform which of the engineer is on duty.

In addition each engineer's accommodation shall be provided with the signalization to inform who is on duty.

5.4.5 Each remote control location shall be such as to activate intermittent light and continuous audible alarm in the event of alarm.

Acceptance of the alarm at the local station shall change visual intermittent signal to steady and the audible shall be cancelled.

5.4.6 Provision shall be made on the navigation bridge and chief engineer's accommodation to inform that the failure alarm has been accepted on the main control station.

5.4.7 The facilities for testing correctness of visual and audible signalling shall be provided.

6 REQUIREMENTS FOR AUTOMATION ON SHIPS HAVING AUTOMATION MARK AUT 3

6.1 GENERAL REQUIREMENTS

6.1.1 Requirements of this section apply to ships in which:

- .1 the main internal combustion engines are arranged with all essential auxiliaries driven by them;
- .2 the electric generating plant is simplified with respect to the supply of essential consumers or the generator is driven by main engine.
- .3 a main control station if available is not fully equipped as specified in the Section 4 and which is compensated by an increase of monitoring in the navigation bridge;
- .4 short distance and a communication between navigation bridge, engine room and engineers accommodation are such that they assure easy survey of machinery operation and quick detection of faults.

6.1.2 As a rule the requirements of the present Section apply to ships having the propulsion power of not more than 1500 kW.

On agreement with the *Register* the requirements of the present Section may also apply to ships having the propulsion power of 1500 kW and more if these ships meet the requirements referred to in 6.1.1.

6.1.3 All the equipment fitted in machinery space shall be arranged for unattended operation. Specific services of short duration shall be permitted if they are covered by the maintenance instructions of the machinery and if not performed more frequently than once every 12 hours.

6.1.4 Ships equipped in compliance with the requirements of this section shall have the automation systems sufficient to assure control of the main machinery effected from the navigation bridge and enabling reliable manoeuvring of the ship.

6.1.5 Provisions, shall be made in the navigation bridge for:

- .1 control and communication means and other devices specified in the *Rules, Part 7-Machinery installation*, item 1.8 and 1.9 respectively.
The control devices shall be designed also in accordance with the *Rules, Part 7-Machinery installation*, 1.7 as well as 4.4.3 of this part of the Rules;

Table 6.1

| No. | Controlled parameter | Limit value alarm | Protective action | Remarks |
|-----------|---|-------------------|-----------------------------------|-------------------------------------|
| 1 | 2 | 3 | 4 | 5 |
| 1. | Main internal combustion engine | | | |
| 1.1 | Lub. oil pressure | Min. | Shut down | – |
| 1.2 | Lub. oil temperature | Max. | – | – |
| 1.3 | Cooling water pressure (sea and fresh) | Min. | – | – |
| 1.4 | Cooling water temperature (at each cylinder outlet for engines 270 kW and over) | Max. | – | – |
| 1.5 | Engine overload | Max. | – | Mandatory for the CP-propellers. |
| 1.6 | Oil fuel level in daily tank | Min. | | – |
| 1.7 | Pressure of starting air and pneumatic control system | Min. | Automatic starting of compressor. | |
| 2. | Auxiliary internal combustion engine | | | In accordance with Table 4.4. |
| 3. | Compressed air system | | | |
| 3.1 | Air temperature after compressor | Max. | – | – |
| 3.2 | Compressor lub. oil pressure | Min. | Compressor shut down | – |
| 3.3 | Cooling water temperature | Max. | Shut down | Cooling water flow. |
| 4. | Bilge system | | | |
| 4.1 | Bilge level in machinery space and in shaft tunnel | – | – | Separate alarm on navigation bridge |

- .2 instruments indicating pressure in starting air receivers of main engines, pressure of working medium for the remote control (air, oil) or voltage for the electric power supply of the remote control system;
- .3 common alarm of all parameters specified in the Table 6.1. Individual alarms shall be provided for the parameters at which the protection devices operate either by shut-down or slowdown of the engine.

6.1.6 All alarms specified in the Table 6.1 shall be individually provided in engine room, close to the main switchboard or the main control station, if any.

During equipping of the main control station, if any, all alarms specified in Table 6.1, shall be individually provided.

During equipping of the main control station or control desk, the requirements stated in 4.11 and 5.2 shall be regarded.

6.2 REQUIREMENTS FOR AUTOMATED SYSTEMS

6.2.1 For non-reversible propulsion engines fitted with reverse reduction gearing, it is permitted to use one control device to change the direction of shaft rotation and speed, while the other control device is used to start and stop the engine.

In case of engines of up to 110 kW, control system need not be automated.

6.2.2 Provision shall be made for automatic replenishing of starting air receivers in case the air is used for starting and control of main engine. The compressors shall be provided with automatic means of water and oil drainage.

6.2.3 Provision shall be made for automatic temperature control of water, oil or fuel in systems serving the main and auxiliary engines.

6.2.4 Control, alarm, protection and indication systems shall comply with the requirements of Section 2 of this part of the Rules.

6.2.5 The automatic equipment of auxiliary boiler shall comply with the requirements of 4.7. In addition, provision shall be made on the navigation bridge for boiler fuel pumps to be remotely stopped.

6.2.6 Where water heating boilers exist, provision shall be made for:

- .1 automatic start-up and shut off of the fuel oil supply depending on water temperature in the boiler;
- .2 automatic boiler purging for 30 sec or at rate not less than 8 air exchanges in the furnace;
- .3 automatic ignition of fuel supplied into furnace;
- .4 automatic shutdown of fuel supply in case of flame failure or absence of fuel ignition;
- .5 automatic shutdown of fuel supply in case boiler pressure exceeds the permissible

value (for boiler- with closed heating system);

- .6 automatic fuel shut-off (by means of second valve in the burner line) in case of loss of power supply, stopping of fuel pump or drop of fuel pressure below the working pressure;
- .7 common signal in the navigation bridge warning that the controlled parameters specified on the Table 4.1 are not within the limit values. All signals shall be displayed individually in engine room.

6.2.7 If the electrical power of a ship is supplied in normal sailing condition by one or more diesel generators, the requirements of 4.8 of this part of the Rules shall be complied with.

6.2.8 When a ship with fixed propeller is supplied in normal sailing condition by an electric generator driven from the main engine or shafting, the supply of essential consumers necessary for propulsion and safety of navigation of the ship shall not be interrupted during manoeuvring of the ship.

6.2.9 For the survey of installations, provision shall be made for indicating devices in accordance with Table 6.1.

For all tabulated parameters (except for 1.5, 1.6, 1.7) indicating devices shall be mounted on the special desk referred to in 6.1.6 or directly on the engines in immediate visibility from the desk .

6.2.10 Common alarm of all monitored parameters referred to in Table 6.1 as well as fire-detection alarms of machinery space shall be led to the engineers accommodations (mess. room, cabins, etc.).

6.2.11 For ships which propulsion is independent from the ship's mains, main engine remote control system (if electrical) shall be supplied from the emergency source of power.

6.2.12 For ships which propulsions and steering are independent from the ship's power plant there are no requirements for automation of the ship's electrical power plant.

6.3 REQUIREMENTS FOR SHIPS OF LESS THEN 30 M IN LENGTH

6.3.1 The requirements of this chapter shall apply to all new ships of less than 30 m in length.

6.3.2 The subject requirements shall apply to all existing ships after owners request for automation mark **AUT 3**.

6.3.3 In order to satisfy chapter 6.3 requirements, it is necessary to fulfil all items from item 2.5.3.3 to item 2.5.3.11.

6.3.4 After technical documentation approval and survey performed, it is allowed to issue ships automation mark **AUT 3**.