BAHRIA CLASSIFICATION SOCIETY

RULES FOR CLASSIFICATION OF STELL SHIPS

Chapter 4-1 Automation

July 2022

This latest edition incorporates all rule changes. The latest revisions are shown with a vertical line. The section title is framed if the section is revised completely. Changes after the publication of the rule are written in red color.

Unless otherwise specified, these rules apply to ships for which the date of contract for construction is on or after July 2022.

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Rules for Classification of Steel Ships – Automation

SECTION 1

GENERAL RULES AND INSTRUCTIONS

A. Scope and Application

1. These Construction rules apply additionally to automated machinery systems on seagoing ships, classified by BCS (**BCS)** which have one of the class notations in the class certificate relating to the machinery system as listed below under E.

2. Approval may be given for designs which differ from the Rules for Constructions if they have been checked for suitability by **BCS** and accepted as being of equivalent design.

3. **BCS** reserve the right to specify additional requirements to the Rules for Construction where these are related to new systems or installations or where they are necessary due to new findings or practical experience.

Deviations from the Rules for Construction may be permitted in particularly justified instances.

B. Definitions

1. Alarms

An alarm gives optical and acoustical warning of abnormal operating conditions.

2. Protective Device for Machinery Plants

A protective device protects a machinery plant at a critical limit-value violation of one measuring point which could lead to complete breakdown, serious damage or explosion in a time so that manual intervention is still possible in case of attended machinery plant.

3. Safety Device for Machinery Plants

A safety device protects a machinery plant at a critical limit-value violation of one measuring point which could lead to complete breakdown, serious damage or explosion rapidly so that manual intervention is not possible also in case of attended machinery plant.

4. Safety systems for Machinery Plants

The safety system of a machinery plant is the subsumption of the protective and safety devices related to this machinery plant.

5. Systems

Systems contain all equipment necessary for monitoring, control and safety including the in- and output devices. Systems cover defined functions including behaviour under varying operation conditions, cycles and running.

C. Documents for Approval

1. Documents for Submission

The following documents are to be submitted for examination in triplicate and in good time so that they can be approved and made available to the surveyor at the start of manufacture or installation of the systems.

2. Newbuildings

2.1 Questionnaire PL-M-CL006 for motor systems.

2.2 For each of the systems listed in Section 2:

- General plan,
- Wiring diagrams,
- Power supply plan,
- Description of functional relationships,
- General arrangement,
- Functional description.

Section 3, E is to be observed additionally for integrated automation systems.

2.3 The list of measure points is to be submitted for the monitoring system.

2.4 Safety programmes giving details of limit values which result in shutdown or reduction are to be submitted for the main propulsion plant and also for other equipment where necessary.

2.5 **BCS** reserve the right to demand other documents where those submitted are not adequate to provide an evaluation of the system.

2.6 Documents are to be marked with the ship's name or the shipyard's newbuilding number and the date of issue.

3. Modifications and Additions

Major modifications which may affect the automation systems on a ship which is under construction or at sea are subject to approval. Documents are to be submitted in time before conversion.

4. Ship Documents

When a vessel is commissioned or following major modifications and additions to the automated machinery installations, the documents listed under C which show the final form of the system are to be provided for onboard use.

D. References to Other Rules and Regulations

1. BCS Rules and Guidelines

1.1 The following additional **BCS** Rules for Construction apply:

- Chapter 4 - Machinery Installations,
- Chapter 5 - Electrical Installations.

1.2 Where requirements in respect of automated machinery systems are not covered by these Rules for Construction, the application of other rules and standards is to be agreed as necessary.

1.3 Further Rules and Regulations, named in the **BCS** Rules are to be observed.

2. National Regulations

If necessary, beside of the **BCS** Rules for Construction national regulations are to be observed as well.

3. International Regulations and Codes

Allowance is made in substance in these Rules for Construction for the provisions of the "International Convention for the Safety of Life at Sea" (SOLAS) where these relate to unattended machinery spaces.

E. Class Notations

Machinery installations which comply with **BCS's** Rules for Construction for automated and /or remotely controlled systems are given the following additions to the class notation:

1. AUT

The machinery installation has been designed to operate in an unmanned machinery space so that no control and maintenance operations are required for at least 24 hours.

Equipment must comply with the conditions laid down in Section 2, A.

2. AUT-nh

This denotes the period during which no control and maintenance operations are necessary, whereby **n**h means that the machinery installation may be left unmanned for **n** hours (h).

Equipment must comply with the conditions laid down in Section 2, B.

3. AUT-C

Applies to machinery systems on ships with a permanently manned machinery control room for centralized control, remote control of the propulsion

plant from the bridge or facilities for manoeuvring the ship from the machinery control room.

Equipment must comply with the conditions laid down in Section 2, C.

4. R Notation

Applies to ships provided with a system for remote control of the main propulsion plant from the bridge.

Equipment must comply with the conditions laid down in Section 5, A.

F. Basic Technical Requirements and Guidance

1. Maintenance

1.1 Access must be provided to automation systems to allow measurements and repairs to be carried out. Facilities such as simulation circuits, test jacks, pilot lamps etc. are to be provided to allow functional checks to be carried out and faults to be located.

1.2 The operational capability of other systems shall not be impaired as a result of maintenance procedures.

1.3 Where maintenance for equipment which is switched on may result in the failure of components or in the critical condition of systems, a warning sign must be fitted to indicate the risk.

As an alternative a statement in the operator manual can be done in order to indicate the risk.

1.4 Circuit boards and plug-in connections must be protected against unintentional mixing up. Alternatively they must be clearly marked to show where they belong to.

2. Spare Parts

2.1 When specifying the amount of spare parts for automation systems, allowance is to be made for the manufacturer’s recommendations.

2.2 The amount of spare parts is to be documented and a corresponding list is to be carried on board.

SECTION 2

RANGE OF CONTROL AND MONITORING EQUIPMENT

Page

A. Machinery with Class Notation AUT

1. The propulsion plant and the auxiliary equipment necessary for operation is to be prepared free of maintenance for 24 hours.

2. Service tanks are to be refilled automatically or are to be so sized that they do not require topping up for 24 hours. A reserve capacity of 15 % is also to be provided.

3. A remote control system for the propulsion plant is to be installed on the bridge in accordance with Section 5, A.

4. A safety system for the propulsion plant is to be installed in accordance with Section 4, E. Engine systems are to be equipped according to Section 5, B. or C. , steam turbine plants according to Section 5,D..

5. A machinery alarm system is to be provided in accordance with Section 4, A. and a duty alarm system in accordance with Section 4, B.

6. An alarm point/data recording device is to be provided in accordance with Section 4, A.14 for propulsion output above 1500 kW; cf Section 8.

7. A communication system is to be installed in accordance with Section 4, G.

8. Boilers and thermal oil systems are to be equipped as described in Section 5, D. and Section 6, D., E.

9. Auxiliary diesels are to be equipped as described in Section 6, B.

10. Auxiliary turbines are to be equipped as described in Section 6, C.

11. Starting air and control air vessels must be filled-up automatically.

12. Purifier systems are to be designed in accordance with Section 6, F.

13. Air compressors are to be designed in accordance with Section 6, G.

14. For essential auxiliary machinery, a stand-by circuit is to be provided in accordance with Section 4, I. and Section 8, I.

15. Where required for system operation, pressures and temperatures are to be controlled automatically.

16. Valves in the shell which are open during machinery operation must be accessible and must be capable of being operated from a safe height above the floor plates.

17. Engine room bilges and bilge wells are to be designed in accordance with Section 6, H.

18. Interruptions in the power supply are to be avoided or overcome in accordance with Section 4, I.2.

19. A fire alarm and detection system is to be provided in accordance with Section 4, H.

20. Approved fire extinguishing equipment is to be provided in the engine and boiler spaces.

21. A remote start system for one of the main fire pumps is to be installed on the bridge and where applicable at the main fire control station. The associated valves are to be equipped with a an instruction table:

"Keep valves open at all times!"

B. Machinery with Class Notation AUT-nh

1. For the range of equipment see A.3. to 21. of this section.

2. The propulsion plant and the auxiliary equipment necessary for operation is to be prepared free of maintenance for at least the length of time in which the machinery spaces may be left unmanned in accordance with their class notation

3. Service tanks are to be refilled automatically or are to be designed so that they do not require topping up during the period in which the machinery space is left unmanned. A reserve capacity of 15 % is also to be provided.

C. Machinery with Class Notation AUT-C

1. Facilities are to be provided so that the propulsion system can be remotely controlled from the bridge as described in Section 5, A or from a central machinery control station to enable the ship to be manoeuvred, without restriction, by one person.

2. The machinery control station is to be installed in a closed machinery control room.

3. All the operating data of the propulsion plant, together with the operating status of the auxiliary machinery essential to the propulsion plant are to be displayed at the control station.

4. For propulsion plants a safety system is to be installed in accordance with Section 4, E. Engine systems are to be equipped according to Section 5, B. or C, steam turbine plants according to Section 5,D.

5. A machinery alarm system is to be fitted in accordance with Section 4, A and Section 8.

6. If the propulsion plant is remotely controlled from the bridge, the machinery alarms listed in Section 8, at least those alarms which require a shut down or a power reduction, are to be announced at the control station as a “stop engines” or “reduce speed or power” group alarm.

7. Boilers and thermal oil systems are to be designed in accordance with Section 5, C, Section 6, D and E. The steam pressure is to be continuously displayed at the control station.

8. The auxiliary machinery which is essential to the main propulsion plant and their standby units must be capable of being started and stopped from the control station. Further details are given in Section 8, I.

9. It must be possible to start and connect the diesel generators from the control station.

10. Purifier systems are to be designed in accordance with Section 6, F.

11. Air compressors are to be designed in accordance with Section 6, G.

12. Where required for system operation, pressures and temperatures are to be controlled automatically.

13. A fire alarm and detection system is to be provided in accordance with Section 4, H.

14. Engine room bilges and bilge wells are to be designed in accordance with Section 6, H.

SECTION 3

BASIC REQUIREMENTS

A. Design and Performance

1. The requirements laid down for each unit and system depend on their intended use and the process-technological conditions. The Construction Rules stipulate the minimum requirements for these.

2. In all circumstances the operation of the ship using automated machinery installations must be at least as safe as operation with a manned machinery installation.

3. If special operating conditions call for a particular system design , **BCS** reserves the right to impose additional requirements depending on the operational and system-specific considerations.

4. Systems must be intelligible and user-friendly and must follow ergonomic principles.

5. The potential risk in the event of break down of safety, protection and monitoring equipment, open and closed loop controls must be limited to a justifiable level of residual risk.

6. As far as required, the following basic requirements shall be observed:

- Compatibility with the environmental and operating conditions,
- Compliance with accuracy requirements,
- Recognizability and constancy of the parameter settings, limiting and actual values,
- Compatibility of the measuring, open and closed loop controls and monitoring systems with the process and its special requirements,
- Immunity of system elements to reactive effects in overall system operation,
- Non-critical behaviour in the event of power failure, restoration and of faults,
- Unambiguous operation,
- Maintainability, the ability to recognise faults and test capability,
- Reproducibility of values.

7. Systems must operate with sufficient speed to allow automatic open and closed loop controls to be carried out promptly in all operating conditions, to provide the user with accurate information in time and to allow commands given by the user to be executed at the right time.

8. Redundant systems shall be individually protected against short circuit and overload and selectively supplied with power.

9. The required drain facilities are either to be automated or of a type which requires no intervention during the period in which the machinery spaces are to be left unmanned in line with their class notation.

10. Automatic interventions shall be provided where damage cannot be avoided by manual intervention.

11. Machinery alarm systems, protection and safety systems, together with open and closed loop control systems for essential equipment shall be constructed in such a way that faults and malfunctions affect only the directly involved function.

This also applies to measuring facilities.

12. For machinery and systems which are controlled remotely or automatically, control and monitoring facilities must be provided to permit manual operation.

12.1 The actual control mode shall be discernible at the concerned control stations.

12.2 The manual operation facilities shall have provisions to override the automated or remote controls. Failure of any part of the automatic or remote control system shall not prevent the manual operation.

12.3 At manual operation influence of the automated or remote mode shall be prevented by technical measures.

13. If danger to persons or the safety of the ship arising from normal operation or from faults or malfunctions in machinery or plant, or in control, monitoring and measuring systems, cannot be ruled out, safety devices or safety measures are required.

14. If danger to machinery and systems arising from faults or malfunctions in control, monitoring and measuring systems cannot be ruled out, protective devices or protective measures are required.

15. Where mechanical systems or equipment are either completely or partly replaced by electric / electronic equipment, the requirements relating to mechanical systems and equipment according to Chapter 4 - Machinery shall be met accordingly.

16. To avoid unnecessary interruption of the operation the respond of stand-by functions, alarm systems and safety systems shall occur in this sequence.

17. Disturbed units which are automatically shut down shall be restarted only directly at the unit after a manual release.

18. Where approved systems are modified, the proper functioning of the system as a whole must be demonstrated.

B. Computer Systems

Where computer systems are used for systems according to Section 2 the requirements relating to hardware and software in accordance Chapter 5 - Electrical Installations, Section 10 shall be fulfilled.

C. Input and Output Units

1. Controls shall correspond to the system being controlled with regard to their position and direction of operation.

2. It shall be possible to control the essential equipment at or near the equipment concerned.

3. Input units located on the bridge shall be individually illuminated where the general lighting is not adequate. The lighting must be adapted non-glare.

4. It shall be possible to adapt the brightness of output units in order to suit the ambient conditions in each case.

5. The use of monochrome displays is permitted if a clear recognition of the signals can be guaranteed.

6. With regard to the use of colour in optical signal equipment, reference is made to Chapter 5 - Electrical Installations, Section 1, J.

D. Open / Closed Loop Control Equipment

1. Open Loop Control Equipment

1.1 Main engines and essential equipment shall be provided with effective means for the control of its operation. All controls for essential equipment shall be independent or designed such that failure of one system does not degrade the performance of other systems, cf. A.6. and E.

1.2 Protection measures shall be provided where incorrect operation would result in serious damage or the loss of essential functions.

1.3 The consequences of control commands shall be indicated at the respective control station.

1.4 Where controls are possible from several control stations, the following shall be observed:

1.4.1 Competitive commands shall be prevented by suitable interlocks.

The control station in operation shall be recognisable as such.

1.4.2 Taking over of command shall only be possible with the authorization of the user of the control station which is in operation.

1.4.3 Precautions shall be taken to prevent changes to desired values due to a change-over in command station.

2. Closed Loop Control Equipment

2.1 Closed loop control equipment shall keep the process variables within the limits specified, under normal conditions.

2.2 Closed loop controls must show the specified reaction over the full control range. Anticipated variations of the parameters must be considered during the planning.

2.3 Defects in one control loop shall not impair the function of other control loops for essential equipment.

2.4 The power supply of operationally essential control loops is to be monitored and power failure must be signalled by an alarm.

E. Integration of Systems for Essential Equipment

1. The integration of functions of independent equipment shall not decrease the reliability of the single equipment.

2. The required independence of conventional alarm, control and safety functions shall be secured by other sufficient measures where two or more of those functions are integrated in one system.

These measures have to be documented and suitable proofs have to be furnished.

3. A defect in one of the subsystems (individual module, unit or subsystem) of the integrated system shall not affect the function of other subsystems.

4. The interrupt of the transfer of datas between connected autarkic subsystems shall not impair their independent functions.

5. Operation of essential equipment shall be possible independently of integrated systems.

6. Networks shall be designed according to international standard.

7. The creation and configuration of a network with regard to the use of:

- Transmission media,
- Topologies,
- Access methods,
- Access speeds,
- Network systems,
- Interfaces,
- Any redundancy which may be required.

shall comply with the system requirement in each case.

8. Standard interfaces shall be used to ensure the exchange of data between different systems.

SECTION 4

AUTOMATION SYSTEMS

A. Machinery Alarm Systems

1. The machinery alarm system shall provide an optical and an audible signal of unacceptable deviations from operating figures, see Section 8.

2. For main engines, 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.

Alarms, remote indications and safeguards listed in Table 8.1 and 8.2 are respectively referred to trunk-piston and cross-head reciprocating internal combustion engines.

The detailed requirements covering communications of alarms from machinery spaces to the bridge area and accommodation for engineering personnel, are contained in BCS - R M 29 “Alarm systems for vessels with periodically unattended machinery spaces”.

3. For trunk-piston reciprocating internal combustion auxiliary diesel engines, all monitored parameters for which alarms are required to identify machinery faults and associated safeguards are listed in Table 8.7.

All these alarms are to be indicated at the control location for machinery as individual alarms; where the alarm panel with individual alarms is installed on the engine or in the vicinity, common alarm in the control location for machinery is required.

For communication of alarms from machinery space to bridge area and accommodation for engineering personnel detailed requirements are contained in BCS-R M 29 “Alarm systems for vessels with periodically unattended machinery spaces”.

4. Alarm delays shall be kept within time limits to prevent any risk to the monitored system in the event of exceeding the limit value.

5. Optical signals shall be individually indicated at a central position. The meaning of the individual indications must be clearly identifiable by text or symbols.

If a fault is indicated, the optical signal must remain visible until the fault has been eliminated. It must be possible to distinguish between an optical signal which has been acknowledged and one that has not been acknowledged.

6. It must be possible to acknowledge audible signals independent from the visual signal.

7. Acknowledgement of optical alarms shall only be possible where the fault has been indicated as an individual signal and a sufficient overview of the concerned process is been given.

8. The acknowledgement of an alarm shall not inhibit an alarm which has been generated by new causes.

9. Alarms must be discernible under all operating conditions. Where this cannot be guaranteed, for example due to the noise level, additional optical signals, e.g. flashing lights must be installed.

10. Transient faults which are self-correcting without intervention shall be memorized and indicated by optical signals which shall only disappear when the alarm has been acknowledged.

11. The audible signal in the machinery space may be switched off during unmanned operation, if the operational readiness of the audible signalling equipment is ensured by appropriate measures during the remaining time.

12. During the port operation, the alarms in the machinery space must be signalled at least in from of a collective alarm in the accommodation and mess areas of the engineering officers or the crew member responsible for the machinery plant.

13. The alarms on the bridge shall be prepared in the form of collective alarms into three groups according to their urgency.

13.1 "Stop" group: alarms signalling faults which require the propulsion system to be shut down immediately.

This alarm is a summarization of the alarms, for which the measurand has to effect a shutdown in accordance with Section 8. This alarm has to be activated before the safety system shuts the engine down.

13.2 "Reduce" group: alarms signalling faults which require a reduction in power of the propulsion system.

This alarm is a summarization of the alarms, for which the measurand has to effect a reduction in accordance with Section 8. In case of automatic reduction, the alarm has to be activated before the engine will be reduced.

13.3 "Common" group: alarms signalling faults which do not require actions as described in 13.1 or 13.2.

14. Alarm systems shall be designed on the closed-circuit or the monitored open-circuit principle. Equivalent monitoring principles are permitted.

15. The alarm system must be supplied from the main power source with battery backup for at least 15 minutes.

The failure of the supply from the main power source is to be alarmed.

16. If limit values are exceeded, this is to be recorded with date and time relating to the occurrence and the clearing of the fault in chronological order. The beginning and end of a fault must be clearly recognisable.

17. In individual cases, **BCS** may approve collective alarm from essential, stand-alone systems which are signaled to the machinery alarm system.

17.1 Each additional new single alarm has to retrigger the collective alarm.

17.2 The individual alarms must be recognizable at the concerned system.

17.3 Collective alarms are to be recorded.

18. The automatic suppression of alarm signals is allowed. The necessary signals are to be monitored for correct function or shall be of redundant type.

19. The failure of the machinery alarm system shall be signalled on the bridge and in the accommodation and mess areas of the engineer officers or the responsible crew members.

20. Machinery alarm systems are subject to mandatory type approval.

B. Duty Alarm Systems

1. General

The duty alarm system sends alarms to the responsible persons in case of incorrect situations whenever the machinery spaces are unattended.

1.1 It shall be possible to choose the person on duty and this must be indicated on the bridge and at the location where the choice was made.

1.2 Where an alarm has not been acknowledged within a preset time at the machinery alarm system, an alarm must be released on the bridge and in the accommodation and mess areas of the engineer officers. The acoustic alarm on the bridge and the accommodation and mess areas of the engineer officers can be acknowledged individually. The reset of the alarm will be done by acknowledging at the machinery alarm system.

1.3 Duty alarm systems are subject to mandatory type approval.

1.4 The duty alarm system must be supplied from the main power source. On failure of the ship's

main power supply of the duty alarm system must be guaranteed for at least 15 minutes. The failure of the supply from the main power source is to be alarmed.

1.5 Failures of the duty alarm system have to be alarmed at an attended location.

1.6 Where the Duty Alarm System is combined with the Engineers' alarm (Engineers' call), an additional means for communication between the engine room or the engine control room and the accommodation area of the technical officers or the crew members responsible for the machinery has to be installed. This might be a telephone system.

2. Hard Wired Duty Alarm Systems

2.1 Alarms have to be given on the bridge and the accommodation and mess areas of the engineer officer.

2.2 The loss of the duty alarm system has to be alarmed at an attended space.

3. Wireless Duty Alarm Systems

Where the alarms for the engineer officers or those of the crew members responsible for the machinery plant according to A.17 designed as a wireless duty alarm system, the following is to be observed:

3.1 The function of the system has to be proved in all areas of the ship.

3.2 The minimum operation time of the mobile units shall be at least 12 hours without intermediate charging. An alarm shall be given in time before the automatic switch off.

3.3 At least two charged reserve units shall be available.

3.4 Alarms shall be set above personnel calls. Calls to persons shall not suppress alarms.

3.5 Watch and alarm functionalities shall be realised as in standard hardwired systems.

3.6 Radio contact between the fixed and mobile units shall be checked regularly automatically. The loss of the contact has to be alarmed.

C. Protective Devices for Machinery Plants

1. Protective devices shall be independent of open and closed loop control and alarm systems and shall be assigned to systems which need protection.

2. When reaching dangerous limits, protective devices shall adapt the operation to the remaining technical capabilities.

3. Protective devices shall be supplied according to the **BCS** Electric Rules (Chapter 5), Section 4, I.7. For battery supply at least 15 minutes have to be safeguarded.

4. Protective devices shall be so designed that potential faults such as, for example, loss of voltage or a broken wire shall not create a hazard to human life, ship or machinery.

5. Where faults which affect the operation of the devices cannot be identified, appropriate test facilities shall be provided which shall be actuated periodically.

6. The monitored open-circuit principle is to be applied to protective devices which can activate an automatic shut-down. Equivalent monitoring principles are permitted.

7. The tripping of a protective device and faults shall be alarmed and recorded. The reason for the tripping shall be identifiable.

8. Disturbed units which are automatically shut-down shall be restarted only directly at the unit after a manual release.

9. The adjustment facilities for protective devices shall be so designed that the last setting is traceable.

10. Protective devices which can activate an automatic shut-down of the main propulsion plant shall be equipped with overriding facilities from the bridge.

11. Protective devices are subject to mandatory type approval.

12. Reductions of the Main Propulsion Plant

12.1 For the protection of the main propulsion plant, reductions according to Section 8 have to be provided.

12.2 Reductions can be initiated automatically or by a request for manual reduction.

12.3 Reductions may be a function of the machinery alarm system.

12.4 Overriding capabilities have to be provided for automatic reductions from the bridge. Where automatic power reductions are provided with overriding arrangements, these shall be safeguarded against accidental operation as to preclude their inadvertent operation, and a suitable alarm is to be activated by their operation. The actuation of overriding arrangements is to be indicated at each control position and recorded.

13. Manual Emergency Stop

13.1 Manual emergency stops are to be protected against unintentional activation.

13.2 The manual emergency stop shall not be automatically cancelled.

13.3 It shall be recognizable which manual emergency stop has been activated.

13.4 The monitored open-circuit principle is to be applied to manual emergency stops. Equivalent monitoring principles are permitted.

D. Safety Devices for Machinery Plants

1. Safety devices shall be independent of open and closed loop control and alarm systems and shall be assigned to systems which need protection.

2. When reaching dangerous limits, safety devices shall initiate an automatic shut-down. See also Section 8.

3. Safety devices shall be supplied according to the **BCS** Electric Rules (Chapter 5), Section 4, I.7. For battery supply at least 15 minutes have to be safeguarded.

4. Safety devices shall be so designed that potential faults such as, for example, loss of voltage or a broken wire shall not create a hazard to human life, ship or machinery.

5. Where faults which affect the operation of the devices cannot be identified, appropriate test facilities shall be provided which shall be actuated periodically.

6. The monitored open-circuit principle is to be applied to safety devices. Equivalent monitoring principles are permitted.

7. The tripping of a safety device and faults shall be alarmed and recorded. The reason for the tripping shall be identifiable.

8. Disturbed units which are automatically shut-down shall be restarted only directly at the unit after a manual release.

9. The adjustment facilities for safety devices shall be so designed that the last setting is traceable.

10. Safety devices of the main propulsion plant may be equipped with overriding facilities. The overspeed protection is excluded.

11. Safety devices are subject to mandatory type testing.

E. Safety Systems

Safety systems shall be independent of open and closed loop control and alarm systems. Faults in one system must not affect other systems.

Deviations from this requirement may be allowed for redundant equipment with the agreement of **BCS** where this would entail no risk to human life and where ship safety would not be endangered.

2. Safety systems shall be assigned to systems which need protection.

3. Where safety systems (required automatic stops) are provided with overriding arrangements, these shall be safeguarded against accidental operation as to preclude their inadvertent operation and a suitable alarm is to be operated by their activation.The actuation of overriding arrangements is to be indicated at each control position and recorded. 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 (see BCS- R M 30.2.8).

4. The monitored open-circuit principle is to be applied to safety systems. Alternatively, the closed circuit principle may be applied where it is demanded by the provisions of national regulations (e.g. boiler and oil-fired systems). Equivalent monitoring principles are permitted. Faults, and also the activation of safety systems shall be alarmed and recorded.

5. On failure of the ship's main power supply, the power supply to a safety system must be guaranteed for at least 15 minutes.

6. The power supply is to be monitored and loss of power is to be indicated by an alarm and recorded.

7. Safety systems shall be designed preferably using conventional technology (hard wired). Alternative technical solutions shall be agreed with **BCS**.

8. Safety systems are subject to mandatory type approval.

9. BCS- R M30 is to be complied with for safety systems for vessels with periodically unattended machinery spaces

F. Communication Systems

Reliable voice communications, e.g. designated telephones, battery-powered telephones or sound-powered communication systems, shall be provided between the machinery control room or the machinery control station, the bridge and the accommodation and mess areas of the engineer officers or the crew members responsible for the machinery.

Cf. Chapter 5 - Electric, Section 9, C.5.1.

G. Fire Detection Systems for Machinery Spaces

1. For general requirements relating to fire alarm systems, see Chapter 5 - Electri, Section 9 and Section 14, G.

2. Fire detection systems shall signal a fire at an early stage.

3. The fire alarm shall be optical and audible recognised on the bridge, in the accommodation and mess areas of the engineer officers or the crew member responsible for the machinery plant and also in the machinery space without any time delay and it must be distinguishable from other alarms.

4. Each detection loop shall not comprise more than one fire subdivision or one watertight compartment or, wherever possible, more than two superimposed decks. Separate detection loops shall be used where facilities are provided for the separate flooding of different machinery spaces with gaseous fire extinguishing media (e.g. CO_2).

This applies only to non-addressable detectors, which do not allow the remote and individual identification of each detector.

5. The position and number of detectors shall be specified under consideration of machinery space ventilation, so that all endangered areas are safely covered. This particularly applies to areas in which boilers, thermal oil systems, waste and sludge incinerators, generators, switchboards, refrigeration machinery and purifiers are installed and also in the engine casing and at the exhaust gas side in exhaust gas-fired thermal oil plants and in exhaust gas-fired boilers with finned pipes.

6. In workshops and rooms where detectors are liable to be actuated, e.g. by welding, they may be temporarily ineffective.

The detectors must automatically become operative again after a preset time.

7. For requirements relating to fixed water-based local application fire fighting systems (FWBLAFFS) see Chapter 5 – Electric, Section 9, D.4.

H. Stand-by Circuits / Automatic Controls

1. General

1.1 Stand-by circuits as described in Section 8, I must automatically start stand-by units, if these are required according to relevant sections of **BCS** Machinery Rules:

- In the case of failure of units in operation,
- To meet the demand of auxiliary machinery with staggered operation.

1.2 Automatic controls must automatically start units as described in Section 8, I.:

- To maintain stored energy (e.g. compressed air),
- Following restoration of the power supply after black-out, due to a failure of the ship's mains.

1.3 A reciprocal operation capability is to be provided for similar units.

1.4 The automatic change-over to another unit is to be signalled by an alarm.

1.5 Where auxiliary machinery is mechanically driven from the propulsion system, stand-by units shall be provided for automatic start-up when carrying out manoeuvres in the lower speed range where the output of the mechanically-driven auxiliary machines is not adequate under these conditions.

1.6 An alarm must not be tripped in the case of machinery installation with mechanically connected pumps, when the independent pumps start up due to normal operation. A suitable alarm is to be activated at the starting of those pumps for which the automatic starting is required.

1.7 The sensors for stand-by circuits have to be independent from other systems.

2. Stand-by Circuits for Generators

2.1 For the stand-by circuits for generators see Chapter 5 - Electric, Section 3, B.5.

2.2 Following a black-out and restoration of the power supply, essential auxiliary machinery must start up again automatically, possibly in staggered formation. See also Section 8, I.

SECTION 5

MAIN PROPULSION PLANT

A. Machinery Controls

1. General

1.1 Main and auxiliary machinery essential for the propulsion, control and safety of the ship shall be provided with effective means for its operation and control. All control systems essential for the propulsion, control and safety of the ship shall be independent or designed such that failure of one system does not degrade the performance of another system. (SOLAS Ch. II-1/31.1 and 31.5.1).

1.2 It shall be possible for all machinery, essential for the safe operation of the ship, to be controlled from a local position, even in the case of failure in any part of the automatic or remote control systems. (SOLAS Ch. II-1/49.4).

1.3 **R** notation may be assigned when requirements given in items 2.3, 2.5, 3.1, 3.2, 4.1 ÷ 4.9 are complied with.

2. Remote Control of Machinery

2.1 The engine room or the engine control room, if provided, is normally the main command location but another permanently attended location may be accepted as a more suitable main command location. It shall be possible at any time to take control of main functions locally at the machinery.

2.2 In general, automatic starting, operational and control systems shall include provisions for manually overriding the automatic controls. Failure of any part of such systems shall not prevent the use of the manual override. (SOLAS Ch. II-1/31.4)

2.3 Indicators shall be fitted on the navigation bridge, the main machinery control room and at the manoeuvring platform, for:

— propeller speed and direction of rotation in the case of fixed pitch propellers, and
— propeller speed and pitch position in the case of controllable pitch propellers.

(SOLAS Ch. II-1/31.2.8 and 31.5.6)

For systems with reversing gears the speed of the propulsion machinery is also to be indicated at navigation bridge.

2.4 Remote starting of the propulsion machinery shall be automatically inhibited if conditions exist which may hazard the machinery, e.g. turning gear engaged.

2.5 The design of the remote control system shall be such that in case of its failure an alarm will be given. Unless the administration considers it impracticable the pre-set speed and direction of thrust of the propeller shall be maintained until local control is in operation. (SOLAS Ch. II-1/31.2.7)

3. Bridge Control of Machinery

3.1 Overload shall be indicated on the bridge if automatic load limitation is not arranged for.

3.2 An alarm shall be initiated on the bridge and in the engine room at starting failure.

4. Bridge Control of Propulsion Machinery

4.1 The speed, direction of thrust and, if applicable, the pitch of the propeller shall be fully controllable from the navigating bridge under all sailing conditions, including manoeuvring. (SOLAS Ch. II-1/31.2.1)

4.2 The control shall 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 of the propulsion machinery Where multiple propellers are designed to operate simultaneously, they may be controlled by one control device. (see SOLAS Ch. II-1/31.2.2 and 31.5.3)

4.3 The main propulsion machinery shall be provided with an emergency stopping device on the navigating bridge which shall be independent of the navigating bridge control system. (SOLAS Ch. II-1/31.2.3)

The emergency stopping device shall not be automatically cancelled and shall be protected against unintentional operation.

Note : *With the consent of* ***BCS*** *, for systems with clutch couplings , the shafting may be disconnected from the bridge as an emergency stop facility . The state of the coupling shall be indicated.*

4.4 Propulsion machinery orders from the navigation bridge shall be indicated in the main machinery control room and at the manoeuvring platform. (SOLAS Ch. II-1/31.2.4)

4.5 Remote control of the propulsion machinery shall be possible only from one location at a time, at such locations interconnected control positions are permitted. At each location there shall be an indicator showing which location is in control of the propulsion machinery. The transfer of control between the navigating bridge and machinery spaces shall be possible only in the main machinery space or the main machinery control room. This system shall include means to prevent the propelling thrust from altering significantly when transferring control from one location to another. (SOLAS Ch. II-1/31.2.5).

Note*: Change-over of control within the bridge area is not required where the control levers at the control stations are mechanically or electrically connected together and with the control unit of the remote control system so that they automatically adopt the same position.*

4.6 It shall be possible to control the propulsion machinery locally, even in the case of failure in any part of the remote control system. It shall also be possible to control the auxiliary machinery, essential for the propulsion and safety of the ship, at or near the machinery concerned. (SOLAS Ch. II-1/31.2.6)

4.7 An alarm shall be provided on the navigating bridge and in the machinery space to indicate low starting air pressure which shall be set at a level to permit further main engine starting operations. If the remote control system of the propulsion machinery is designed for automatic starting, the number of automatic consecutive attempts which fail to produce a start shall be limited in order to safeguard sufficient starting air pressure for starting locally. (SOLAS Ch. II-1/31.2.9)

4.8 Automation systems shall be designed in a manner which ensures that threshold warning of impending or imminent slowdown or shutdown of the propulsion system is given to the officer in charge of the navigational watch in time to assess navigational circumstances in an emergency. In particular, the systems shall control, monitor, report, alert and take safety action to slow down or stop propulsion while providing the officer in charge of the navigational watch an opportunity to manually intervene, except for those cases where manual intervention will result in total failure of the engine and/or propulsion equipment within a short time, for example in the case of overspeed. (SOLAS Ch. II-1/31.2.10).

4.9 At least two independent means shall be provided for communicating orders from the navigation bridge to the position in the machinery space or in the control room from which the speed and direction of thrust of the propellers are normally controlled; one of these shall be an engine-room telegraph which provides visual indication of the orders and responses both in the machinery spaces and on the navigation bridge. Appropriate means of communication shall be provided from the navigation bridge and the engine-room to any other position from which the speed or direction of thrust of the propellers may be controlled. (SOLAS Ch. II-1/37).

An engine telegraph with feedback facility is to be fitted. The engine telegraph may be mechanically linked to the operation of the remote control system. Remote control and telegraph shall, however, according to the system, be mutually independent and shall have separate supplies.

5. Supervision from a Control Room

5.1 Where the main propulsion and associated machinery, including sources of main electrical supply, are provided with various degrees of automatic or remote control and are under continuous manual supervision from a control room the arrangements and controls shall be so designed, equipped and installed that the machinery operation will be as safe and effective as if it were under direct supervision, for this purpose SOLAS Ch. II-1 Regulations 46 to 50 shall apply as appropriate. Particular consideration shall be given to protect such spaces against fire and flooding. (SOLAS Ch. II-1/31.3).

B. Diesel Engines

1. The number and duration of automatic start- attempts are to be limited.

Proof of the number of start attempts is also to be provided for maneuvering with the remote control system.

2. The controller and the actuator shall be suitable for controlling the engine under the operating conditions laid down in the Rules for Construction and also in line with the requirements specified by the engine manufacturer.

3. For details of the requirements relating to electronic governors and actuators, and also their power supplies, see Chapter 5 - Electrical Installations, Section 9, B.8.

4. At least those stop and reduce criteria listed in Section 8, Table 8.1 and 8.2 have to stop or reduce the main propulsion plant or have to request for reduction.

5. Where a reduction is not sufficient to protect the engine, an automatic shutdown facility shall be provided see Section 8, Table 8.1 and 8.2.

C. Main Steam Plants

1. The alarms listed in Section 8, Table 8.3 are to be provided for monitoring the main steam plant and the equipment needed for boiler operation.

The requirements according to Chapter 4 - Machinery, Section 12 are to be observed additionally.

2. The operational turbine plant is to be protected against damage by means of devices to permit automatic turning using steam. Facilities are to be provided on the bridge to stop turning.

It is necessary to ensure an adequate supply of lubricating oil to the turbine plant.

3. Automatic control devices are to be provided for the following operating parameters:

- Lubrication oil temperature of turbine and gearing,
- Gland sealing steam pressure,
- Water level in condenser,
- Water level in the de-aerator,
- Pressure in de-aerator,
- Water level in boiler.

4. At least those stop and reduce criteria listed in Section 8, Table 8.3 have to stop or reduce the main propulsion plant or have to request for reduction.

5. When changing over the plant from port operation to manoeuvring mode and from manoeuvring mode to sea service mode and vice versa, it is necessary to ensure that all the change-over processes necessary for each change in operating mode are carried out automatically.

D. Gas Turbine Systems

1. General Requirements

For the monitoring, protection and control concept, Section 8, Table 8.4 shall be observed.

2. Governors and Over Speed Protection

2.1 Main propulsion gas turbines shall be fitted with an over speed protection which ensures that the speed of the engine cannot exceed the maximum continuous rating of the engine by more than 115%.

2.2 If a main propulsion gas turbine is coupled to a reversing gear, an electrical power

2.3 transmission, a variable-pitch propeller or a clutch coupling, an independent speed governor shall be provided that is suitable for controlling the speed of the unloaded gas turbine without the over speed protection being triggered.

3. Safety Devices

3.1 Main propulsion gas turbines shall be fitted with a quick-action turbine stopping device which automatically interrupts or stops the fuel feed to the turbine in accordance with Section 8, Table 8.4.

3.2 The following auxiliary systems for auxiliary turbines shall be fitted with an automatic temperature control system, which is able to keep the normal operating values over the entire output range:

- Lubricating oil supply,
- Fuel supply, or alternatively fuel viscosity,
- Exhaust gas.

3.3 There shall be facilities or interlocks which purge accumulations of liquid fuel, or blow out gaseous

fuel, from all parts of the main propulsion gas turbine before the ignition sequences can begin or re-ignition after a misfire can take place.

3.4 An emergency manual quick-closing device for the fuel feed shall be provided at the control position.

3.5 In the event of misfire, the starting device of the gas turbine shall be capable of aborting the ignition sequence and of shutting off the fuel feed within a specified period of time.

3.6 Safety devices prescribed in addition by the manufacturer with the purpose of preventing dangerous situations in the event of a malfunction in the turbine plant shall be submitted for approval.

E. Electrical Propulsion Plants

See Chapter 5 - Electric Installations.

F. Multi-Shaft Systems, Systems with Several Propulsion Machines

1. Safety systems are to be divided so that in the event of failure of one part of the system, the function of the other system parts is still maintained or can be restored by adopting simple measures.

2. In the case of multi-shaft systems the capability shall be provided for controlling and shutting down the individual drive systems from the bridge.

3. Individual visual alarm displays for each drive system are to be provided on the bridge.

4. Separate supply facilities are to be provided for each control system where there is a multiple number of main engines.

5. The stand-by circuits specified for these systems may be omitted where a multiple drive system is installed which has separate systems and automatic individual shutdown (decoupling).

SECTION 6

AUXILIARY MACHINERY SYSTEMS

A. General

1. Means shall be provided for auxiliary machines which are started automatically or by remote control to prevent remote and automatic start-up.

For the scope of standby circuits and remote control facilities for essential auxiliary machinery, see Section 8, I.

2. The alarms and recording points listed in Section 8, are to be observed.

B. Auxiliary Diesel Engines

1. Automatic or remotely controlled start attempts are to be limited in duration and number.

With regard to the remotely controlled or automatic start of engines, the only systems permitted are those which allow the start in any position of the crankshaft.

2. For details of auxiliary engines with electric start-up, see Chapter 5 - Electric, Section 7, D.6.

3. An automatic shutdown is to be provided for the event of overspeed, detection of oil mist and failure of the lubrication oil supply of diesel engines.

C. Auxiliary Turbines

1. Remotely controlled or automatic start-up of auxiliary turbines and acceleration to rated speed are to be accomplished in such a way that the load applied is without risk to the turbines.

2. Safety system

See steam turbines, Section 5, C.

D. Auxiliary Steam Plants

The requirements according to Chapter 4 – Machinery, Section 12 are to be observed.

E. Thermal Oil Systems

The requirements according to Chapter 4 – Machinery, Section 13 are to be observed.

F. Purifier Systems

1. The temperature of the separating medium shall be automatically controlled and monitored.

2. Malfunctions in the purifying process must cause the flow to the purifier to be cut off automatically.

3. The inrush of water into clean oil shall be alarmed. The necessary monitoring device may be part of the separator system or a separate type approved sensor arranged in the clean oil pipe line.

4. Depending upon type and method of separation, the unintentional opening of the drum and the loss of the water seal shall trip an alarm.

5. The heating system of the preheater is to be designed that an interruption of the flow to the purifier does not result in overheating of the preheaters.

6. Fuel and lubrication oil purifiers are to be of self-cleaning type, unless no operation or maintenance is required to keep them in service during the period of which the machinery spaces are to remain unattended according to the class notation.

G. Air Compressor

In the event of failure of the pressurized lubrication system, independently driven compressors must shut

down automatically. A suitable automatic drain facility must be provided for the cooler and water traps (where appropriate also during operation).

H. Bilge and Drain Facilities

1. Bilge wells shall be located and monitored in such a way that the accumulation of liquid is detected at normal angles of trim and heel, and shall be large enough to accommodate easily the normal drainage during the unattended period.

2. Where devices are fitted to provide automatic drainage of engine room bilges or bilge wells, an alarm must be tripped to indicate when the bilge pump is running too often or too long.

3. At least two level sensors are to be fitted in each machinery space and the tripping of these sensors is to be indicated by an individual alarm.

4. Where, as a result of the MARPOL convention, a facility is specified for monitoring the residual oil content in the bilge water and, where appropriate, an automatic interruption in the drain process, an alarm is to trip when the limit value is exceeded and – where specified – the drainage process is to be stopped.

I. Valves on the Shell Plating

1. The location of the controls of any valve serving a sea inlet, a discharge below the waterline or a bilge injection system shall be so sited as to allow adequate time for operation in case of influx of water to the space, having regard to the time likely to be required in order to reach and operate such controls. If the level to which the space could become flooded with the ship in the fully loaded condition so requires, arrangements shall be made to operate the controls from a position above such level.

1.1 'Bilge injection system' is same as 'direct suction' referred in SOLAS Reg.II-1/35-1 3.7.1 and 3.7.2 and is understood to mean 'Emergency bilge suction', which is used to discharge overboard large quantities of sea water accumulated in engine room bilges using the main circulating pump or another suitable pump as permitted by 35-1 3.7.2.

1.2 The requirements for the controls of the "valves serving a sea inlet, a discharge below the waterline or a bilge injection system" are not applicable to valves serving an emergency bilge system provided:

1.2.1 The emergency bilge valve is normally maintained in a closed position,

1.2.2 A non-return device is installed in the emergency bilge piping, and

Note:
A normally closed non-return valve with positive means of closing is considered to satisfy both 1.2.1 and 1.2.2 above.

1.2.3 The emergency bilge suction piping is located inboard of a shell valve that is fitted with the control arrangements required by 1.

2. A calculation is to be carried out to show that the time taken from alarm activation plus the time to reach and fully close manually operated or powered valves is less than the time taken for the influx of water to reach the control without submergence of the platform on which the person is operating the valves. If necessary a remote control device is to be fitted above the level.

Note 1 :
The time it takes for the influx of water to reach the control of valves should be based on a breach in the largest diameter seawater line in the lowest location in the engine room when the ship is fully loaded.

Note 2 :
The time it takes to reach the sea valves should be determined based on the distance between the navigation bridge and the platform from where the valves associated with the aforementioned seawater line are manually operated (or the actuator for valves controlled by stored mechanical energy).

Note 3 :
In the event calculations are not available, 10 minutes shall be regarded as adequate time for operation unless other requirements are specified by the flag Administration.

Non return discharge valves need not to be considered.

SECTION 7

TESTS

A. General

1. The testing of systems, equipment and assemblies demanded according to Section 2 are subject to the following rules.

2. As part of the general quality assurance system, the manufacturer must ensure that the products which he manufactures meet the requirements as specified.

Records of the measures adopted and tests carried out as part of the quality assurance procedure shall be prepared.

3. For certain systems, equipment and components specified in the rules, tests are to be carried out in the presence of a **BCS** Surveyor.

The tests and test specimen specified below represent the minimum requirement.

BCS reserve the right to demand that tests also be carried
out on other items either on the manufacturer's premises or on board.

4. In the case of new systems or systems which are being used for the first time on ships classed by **BCS** , additional tests and trials are to be agreed , as required, between the manufacturer and **BCS**

5. Where computers are used for functions which are essential to ship, cargo, crew or passenger safety and which are subject to classification, records, test results and assessments are to be provided for the hardware and software in accordance with Chapter 5 – Electric, Section 10.

6. The purpose of the tests is to demonstrate compliance with the requirements as laid down in the Rules for Construction and the suitability of the test specimen for their intended use.

7. Tests comprise:

- Examination of technical documentation,
- Tests conducted at the manufacturer's works,
- Tests on board,
- Type approvals.

B. Examination of Technical Documents

1. The list of documents which are subject to approval is specified in Section 1, D.

2. Documents which have been examined and marked accordingly are to be submitted to the Surveyor on request.

C. Tests Conducted at the Manufacturer's Works

BCS reserve the right to demand tests for systems which have safety implications or where there are extensive automation systems or where individual systems are being integrated . This test might be a factory acceptance (FAT) with presence of **BCS**.

D. Tests on Board

1. General

Tests comprise:

- Tests during construction / installation,
- Tests during commissioning,
- Tests during sea trials,
- Repeated tests.

The test procedures are based on form PL-M-CL006 for engine driven systems.

Part I of Form PL-M-CL006 is used to apply for the relevant class notation. Concept approval for the whole system is given due to the information provided.

Part II of Form PL-M-CL006 is used for the operational testing of the whole system. Following successful completion of the tests, the relevant class notation is issued.

2. Tests During Construction / Installation

2.1 During the period of construction of the ship, installations are to be checked for compliance with the documents which have been approved by **BCS** and with the Rules for Construction.

2.2 Test certificates relating to tests which have already been carried out are to be submitted to the Surveyor on request.

3. Tests During Commissioning

The satisfactory condition and correct operation of all automation equipment are to be demonstrated.

Where not specified in the Rules for Construction, the tests to be conducted are to be agreed with the **BCS** Surveyor in accordance with the system requirements.

Form PL-M-CL006 is to be used as a basis.

4. Tests During Sea Trials

4.1 Scope

The purpose of the test is to prove that all systems are adjusted properly and that ship's machinery operation can be performed without manual intervention.

4.2 Preparation

4.2.1 A list has to be provided to the attending surveyor which shows all equipment that is switched off with sufficient explanation.

4.2.2 It has to be agreed on representative persons who are allowed to enter engine room and engine control room for checking and watch keeping during the test.

4.2.3 If applicable, the following is to be prepared:

4.2.3.1 All systems to be prepared for automatic control and adjusted to the correct settings.

4.2.3.2 Manual operated valves shall be completely closed or open.

4.2.3.3 All electric equipment is functioning and switched on.

4.2.3.4 Main propulsion control shall be on the bridge.

4.2.3.5 No alarms shall be manual inhibited.

4.2.3.6 The Duty alarm system shall be switched to "Unattended machinery"

4.3 Execution

4.3.1 The start and completion of the test shall be clearly communicated between control room and bridge. If appropriate, also announcement via the PA-system may be made.

4.3.2 The start and end of the test shall be marked on the alarm registration device.

4.3.3 Other tests which may be carried out during the endurance test shall be agreed before.

4.3.4 The minimum test time is four hours.

4.3.5 The test shall include at least two hours at 100% main engine load.

4.3.6 The test shall include manoeuvres from full ahead to dead slow astern.

4.4 De-Briefing

4.4.1 The trials report is to be completed in accordance with form PL-M-CL006.

4.4.2 Basically no alarms shall occur during the test.

4.4.3 If alarms come up which indicate malfunction of equipment or wrong system settings, the cause is to be rectified. This may result in repetition of the test.

5. Repeated Tests

Periodical surveys are to be carried out at preset intervals following award or renewal of the classification.

E. Type Approvals

1. The following installations, equipment and assemblies are subject to mandatory type testing.

2. Installations, equipment and assemblies which are subject to type testing:

- Computers and computer systems for open and closed loop controls and monitoring of equipment essential to ship operation.
- Remote control systems for the main propulsion plant,
- Fire detection systems and sensors,
- Sensors and actuators for specified automation equipment,
- Machinery alarm systems,
- Duty alarm systems,
- Protective devices
- Safety devices,
- Safety systems.

3. As an alternative to the type tests specified, particular tests may be carried out, where justified in individual cases, in the presence of a presence of a **BCS** Surveyor, with the prior consent of **BCS**.

SECTION 8

SENSORS, STAND-BY CIRCUITS AND REMOTE-CONTROL FACILITIES

A. General

1. The monitoring, protection, open-loop and closed-loop control concept for equipment and installations shall ensure safe operation under all operating conditions.

2. The alarm, reduction- and shutdown criteria listed below represent the minimum requirement.

3. Dependent upon the design of the machinery plant, it may be necessary to adapt the range and details given in the Tables.

4. If more than one sensor is required for a criterion according to the following tables, it shall be ensured that the evaluation of the data from sensors takes place independently. If designed suitably, redundancy concepts can replace the need for independent evaluation.

5. For the design of the alarm devices, the provisions set out in Section 4, A. and B. shall apply. Reductions of the operation parameters shall be in accordance with Section 4, D.

6. For the design of the stand-by circuits, the provisions set out in Section 3, D. and Section 4, H. shall apply.

7. For the design of safety systems and safety devices, the provisions set out in Section 4, E. shall apply.

8. In general, the alarms, reduction and shut downs, as shown in the Tables 8.1 to 8.9, shall be indicated in the machinery space as individual alarms. On the bridge the alarms shall be grouped as described in Section 4, A. If it is required to realize individual alarms on the bridge, a notation in the Tables 8.1 to 8.9 is made.

B. Sensors for Main Propulsion Diesel Engines (aligned with BCSS- R M 35)

1. Trunk piston engines

Table 8.1 Main propulsion diesel engines (Trunk piston engines)

F = Fault L = Low limit H = High limit R = Reduction RI = Remote Indication S = Shut down T = Trigger Stand-by activation	Sensor for alarms	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
Fuel oil system				
Fuel oil pressure after filter (engine inlet)	RI, L	L, T		
Fuel oil viscosity before injection pumps or fuel oil temperature before injection pumps **(1)**	L, H			
Leakage from high pressure pipes	F			
Level of fuel oil in daily service tank **(2)**	L			
Common rail fuel oil pressure	L			
Lubricating oil system				
Lub oil to main bearing and thrust bearing, pressure	L, RI	L, T	L, S	
Lub oil pressure at engine inlet **(3) (4)**	L	L, T	L, S	
Lub oil filter differential pressure	H, RI			
Lub oil inlet temperature	H, RI			
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) **(5)**	F		H,S	
Failure in cylinder lubrication	F, R			
Level in lubrication oil sump tanks **(3)**	L			
Fault at lubricating oil automatic filter	F			
Temperature thrust bearing	H, R			
Flow rate cylinder lubricator. Each apparatus	L, R			
Common rail servo oil pressure	L			
Turbocharger system				
Turbocharger lub oil inlet pressure **(6)**	L, RI			
Turbocharger lub oil outlet temperature each bearing **(6),(7)**	H			
Speed of turbocharger **(8)**	H, RI			
Sea water cooling system				
Sea water pressure	L, RI	L, T		
Cylinder fresh water cooling system				
Cylinder water inlet pressure or flow	L, R, RI	L, T	L, S **(9)**	
Cylinder water outlet temperature (general) **(10)**	H,R, RI			
Level of cylinder cooling water in expansion tanks	L			
Oil contamination in cylinder cooling water system **(11)**	F			
Pressure of LT (low temperature) freshwater cooling circuit	L			
Temperature of LT (low temperature) freshwater cooling circuit	H			
Temperature of cylinder cooling water at engine inlet	L			
Starting and control air systems				
Starting air pressure before main shut-off valve **(12), (13)**	L, RI			
Control air pressure	L, RI			

Table 8.1 Main propulsion diesel engines (Trunk piston engines) (continued)

F = Fault L = Low limit H = High limit R = Reduction RI = Remote Indication S = Shut down T = Trigger Stand-by activation	Sensor for alarms	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
Scavenge air system				
Scavenge air receiver temperature	H			
Exhaust gas system				
Exhaust gas temperature turbocharger inlet and outlet	H			
Exhaust gas temperature after each cylinder **(14)**	H, R, RI			
Exhaust gas temperature after each cylinder.Deviation from average **(14)**	H			
Engine speed	RI			
Engine overspeed (4)			H, S	
Control-safety-alarm system power supply failure	F			

(1) *For heavy fuel oil burning engines only.*

(2) *High-level alarm is also required if no suitable overflow arrangement is provided.*

(3) *Individual alarms are to be provided for separate circuits.*

(4) *Shut-down only for engines from 220 kW upwards*

(5) *When required by BCS- R 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 requirement for independence between alarm and shut-down system.*

(6) *Unless provided with a self-contained lubricating oil system integrated with the turbocharger.*

(7) *Where outlet temperature from each bearing cannot be monitored due to the engine/turbocharger design alternative arrangements may be agreed with **BCS** . Continuous monitoring of inlet pressure and inlet temperature in combination with specific intervals for bearing inspection in accordance with the turbocharger manufacturer 's instructions may be accepted as an alternative.*

(8) *Only required for turbochargers of Categories B and C (see BCS Machinery Rules, Chapter 4, Section 4,A.).*

(9) *If possible due to size, otherwise a shutdown for cooling temperature cylinder outlet to be provided when reaching high limit.*

(10) *Two separate sensors are required for alarm and reduction.*

(11) *Where cooling water is used for preheating or cooling fuel, lubricating oil.*

(12) *For engines with direct reversing capability and also all engines with remote start from the bridge, individual alarm.*

(13) *Where engine is started electronically the failure of the battery charger is to be alarmed.*

(14) *For engines > 500 kW/cyl.*

Note: *Remote indications are required only for ships which are operated with machinery space unattended but under a continuous supervision from a position where control and monitoring devices are centralized, without the traditional watch service being done by personnel in machinery space.*

2. Crosshead engines

Table 8.2 Main propulsion diesel engines (Crosshead engines)

F = Fault L = Low limit H = High limit R = Reduction RI = Remote Indication S = Shut down T = Trigger Stand-by activation	Sensor alarms	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
Fuel oil system				
Fuel oil pressure after filter (engine inlet)	RI, L	L, T		
Fuel oil viscosity before injection pumps or fuel oil temperature before injection pumps	L, H			
Leakage from high pressure pipes	F			
Level of fuel oil in daily service tank **(1)**	L			
Common rail fuel oil pressure	L			
Lubricating oil system				
Lub oil to main bearing and thrust bearing, pressure	RI, L, R	L, T	L, S	
Lub oil to crosshead bearing, pressure **(2)**	RI, L, R	L, T	L, S	
Lub oil to camshaft pressure **(2)**	L	L, T	L, S	
Lub oil to camshaft temperature **(2)**	H			
Lub oil inlet temperature	H			
Thrust bearing pads temp or bearing outlet temp	H, R		H, S	
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) **(3)**	F			
Flow rate cylinder lubricator. Each apparatus	L, R			
Level in lubricating oil tanks **(4)**	L			
Common rail servo oil pressure	L			
Turbocharger system				
Turbocharger lub oil inlet pressure **(9)**	L			
Turbocharger lub oil outlet temperature, each bearing **(10)**	H			
Speed of turbocharger **(11)**	H, RI			
Piston cooling system				
Piston coolant inlet pressure **(5)**	L, R	L, T		
Piston coolant outlet temp each cylinder	H, R			
Piston coolant outlet flow each cylinder **(8)**	L, R			
Level of piston coolant in expansion tank	L			
Sea water cooling system				
Sea water pressure	L	L, T		
Cylinder fresh cooling water system				
Cylinder water inlet pressure	L, R	L, T		
Cylinder water outlet temp (from each cylinder) or Cylinder water outlet temp (general) **(6)**	H, R			
Oily contamination of engine cooling water system **(7)**	F			
Level of cylinder cooling water in expansion tank	L			

Table 8.2 Main propulsion diesel engines (Crosshead engines) (continued)

F = Fault L = Low limit H = High limit R = Reduction RI = Remote Indication S = Shut down T = Trigger Stand-by activation	Sensor alarms	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
Starting and control air systems				
Starting air pressure before main shut-off valve	L, RI			
Control air pressure	L			
Safety air pressure	L			
Scavenge air system				
Scavenge air receiver pressure	RI			
Scavenge air box temperature (fire)	H, R			
Scavenge air receiver water level	H			
Exhaust gas system				
Exhaust gas temperature after each cylinder	H, R, RI			
Exhaust gas temperature after each cylinder, deviation from average	H			
Exhaust gas temperature before each T/C	H, RI			
Exhaust gas temperature after each T/C	H, RI			
Fuel valve coolant				
Pressure of fuel valve coolant	L	L, T		
Temperature of fuel valve coolant	H			
Level of fuel valve coolant in expansion tank	L			
Engine speed/direction of rotation	RI			
Wrong way	F			
Engine overspeed			H, S	
Control-safety-alarm system power supply failure	F			

(1) *High-level alarm is also required if no suitable overflow arrangement is provided.*
(2) *If separate lub oil systems are installed.*
(3) *When required by BCS- R M10.8 or by SOLAS Reg. II-1/47.2.*
(4) *Where separate lubricating oil systems are installed (e.g. camshaft, rocker arms, etc.), individual level alarms are required for the tanks.*
(5) *The slow down is not required if the coolant is oil taken from the main cooling system of the engine.*
(6) *Where one common cooling space without individual stop valves is employed for all cylinder jackets.*
(7) *Where main engine cooling water is used in fuel and lubricating oil heat exchangers.*
(8) *Where outlet flow cannot be monitored due to engine design, alternative arrangement may be accepted.*
(9) *Unless provided with a self-contained lubricating oil system integrated with the turbocharger.*
(10) *Where outlet temperature from each bearing cannot be monitored due to the engine/turbocharger design alternative arrangements may be accepted. Continuous monitoring of inlet pressure and inlet temperature in combination with specific intervals for bearing inspection in accordance with the turbocharger manufacturer's instructions may be accepted as an alternative.*
(11) *Only required for turbochargers of Categories B and C. (see BCSachinery Rules, Chapter 4, Section 4,A.).*

Note: *Remote indications are required only for ships which are operated with machinery space unattended but under a continuous supervision from a position where control and monitoring devices are centralized, without the traditional watch service being done by personnel in machinery space.*

C. Sensors for main steam plant

Table 8.3 Main steam plant

F = Fault L = Low limit H = High limit R = Reduction S = Shut down T = Trigger Stand-by activation	Sensor for alarms	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
Water level in boilers	LHR			
Water flow through boilers (in forced circulation boilers)	LR			
Pressure in feed pipe	LR			
Steam pressure at superheater outlet	LHR			
Steam temperature at superheater outlet	LHR			
Steam temperature at reheater outlet	LHR			
Steam temperature at internal cooler outlet	L			
Flue gas concentration	H			
Fire in the flue gas chambers	F			
Lubrication oil pressure at turbine and gearbox inlet	L		LS	
Differential pressure lubrication oil filter	H			
Lubrication oil temperature at each gearing and turbine bearing	HR			
Turbine stops longer than allowed	F			
Gland sealing steam pressure	HR			
Steam barrier pressure	LH			
Astern turbine temperature	HR			
Vibration velocity (turbine)	HR			
Condenser pressure	H		HS	
Condensate level in condenser	H		HS	
Pressure in condenser line	L			
Salinity of condensate	H			
Oil contamination of condensate	H			
Bilge water level at condensate pumps	H			
Pressure in de-aerator	LH			

Table 8.3 Main steam plant (continued)

F = Fault L = Low limit H = High limit R = Reduction S = Shut down T = Trigger Stand-by activation	Sensor for alarms	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
Level in de-aerator	LH			
Level in distillate tank	L			
Temperature of desuper heater	LH			
Failure of steam generator	F			
Level in lubricating oil sump tank	L			
Lubrication oil gravity tank level	L			
Turbogenerators				
Lubrication oil pressure	L		LS	
Gland sealing steam pressure	LH			
Pressure in auxiliary condenser	H			
Level in auxiliary condenser	H			
Salinity condensate	H			

D. Sensors for Propulsion Gas Turbines

Table 8.4 Propulsion gas turbines

F = Fault L = Low limit H = High limit R = Reduction S = Shut down T = Trigger Stand-by activation	Sensor for alarms	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
Level in lubrication oil sump tank	L			
Level in lubrication oil gravity tank	L			
Lubricating oil pressure before turbine **(1)**	L	LT	LS	
Lubricating oil filter differential pressure	H			
Lubricating oil temperature before turbine	H			
Coolant pressure	L	LT		
Fuel pressure	L			
Coolant temperature	H			
Bearing temperature	H			
Failure of flames/igniting flame	F		FS	
Vibrations **(1)**	H		HS	
Axial displacement of the rotor	H		HS	
Exhaust gas temperature **(1)**	H			
Fuel temperature	H			
Automatic starting failure	F			
Vacuum pressure at the compressor inlet	H		HS	
Low pressure before compressor **(1)**	L		LS	
Speed free turbine	LH		LHS	
Speed gas generator	H		HS	

(1) *Limits must be reachable, without achieving a critical condition leading to a shut-down.*

E. Sensors for Propulsion Plant and Steering Devices

Table 8.5 Propulsion plant (prime mover engine excluded)

F = Fault L = Low limit H = High limit R = Reduction S = Shut down T = Trigger Stand-by activation	Sensor for alarms	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
Main gear				
Lubricating oil pressure gear input	LR	LT **(1)**	LS	
Lubricating oil temperature gear input/after cooler **(2)**	HR			
Lubricating oil temperature gear output/before cooler **(3)**	HR			
Pressure drop lubricating oil at filter	H			
Temperature radial bearings **(4)**	H			
Temperature gear integrated thrust bearing **(5) (6)**	H R			
Level in lubrication oil sump tank **(11)**	L			
Mechanical/multi disc clutch (stand-alone or gear integrated)				
Control of unintended slip in engaged condition			LS **(7)**	
Operating pressure	LR	LT		
Shaft Bearings, Stern tube				
Temperature or lub. oil temperature radial bearings **(8)**	H			
Temperature or lub. oil temperature thrust bearings **(5), (8)**	HR			
Temperature aft. stern tube bearing **(9)**	H			
Oil level sterntube storage/gravity tank	L			
Stern tube bearing lubrication water flow **(12)**	L			
Direction of rotation **(10)**	F			
Controllable Pitch Propeller Plant				
Pressure of hydraulic oil	L	LT **(1)**		L
Level of hydraulic oil of control mechanism in tank	L			
Temperature hydraulic oil	H			
Pressure Drop in filter for hydraulic oil	H			
Failure / Malfunction of CP control	F			

(1) *Only when a stand-by pump is recommended.*

(2) *For all gears with plane bearings and for gears with roller bearings with a transmitted power >500 kW.*

(3) *Required only for applications, where no further temperatures are monitored within the gear.*

(4) *Not needed for applications with roller bearings.*

(5) *Only for the fwd. pads/direction.*

(6) *For roller bearing applications may be replaced by monitoring of lub. oil temperature.*

(7) *May be measured by direct methods, e.g. differential speed measurements, or indirectly, e.g. monitoring of minimal tolerable pressure. Shut down the driving engine can also be replaced by alternative protection methods, e.g. disengaging of the slippery clutch.*

(8) *Not needed for applications with roller bearings when the shaft diameter is less than 300 mm.*

(9) *For oil lubrication and shaft diameters less than 400 mm. the oil temperature in the next vicinity of the aft, bearing may be monitored. Not needed to be monitored for water lubricated bearings so far the shaft's diameter is less than 400 mm.*

(10) *For reversible engines only (direct coupled or for geared plants not equipped with reverse gear stage).*

(11) *Not needed for gears with totally transmitted input torque < 4000 Nm in combination with lubrication oil pressure monitoring.*

(12) *Only for seawater lubricated bearings with external water supply. Automatic on/off switching of external water supply depending on flow.*

Table 8.6 Steering Devices

F = Fault L = Low limit H = High limit R = Reduction S = Shut down T = Trigger Stand-by activation	Sensor for alarms	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
Steering gear (1) (2)				
Failure actual steering mode	F			F
Loss of voltage supply for power unit	F	FT (3)		F
Overload and failure of one phase of electric drive	F	FT (3),(4)		F
Low level hydraulic oil tank	L	FT (3),(4)		L
Loss of voltage supply control unit of steering gear	F	FT (3),(4)		F
Functional failure of hydraulic system (hydraulic lock))	F	FT (3),(4)		F

(1) *The sensors as listed in this table are to a great extent based on SOLAS regulations and are therefore required also for vessels without the Class Notation AUT.*

(2) *For each steering device common alarm in machinery space is acceptable.*

(3) *For oil, gas and chemical tankers of more than 10000 GT the steering capability must be regained within 45 sec after a failure within one of the two redundant systems (SOLAS).*

(4) *The defective subsystems is to be stopped and the affected parts shall be isolated.*

F. Sensors for Auxiliary Diesel Engines (aligned with BCS- R M 36)

Table 8.7 Auxiliary diesel engines

F = Fault L = Low limit H = High limit R = Reduction S = Shut down T = Trigger Stand-by activation	Sensor for alarms	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
Auxiliary diesel engines				
Fuel oil leakage from high pressure pipes	F			
Lubricating oil temperature	H			
Lubricating oil pressure	L		L, S	
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) **(3)**	F		H, S	
Pressure or flow of cooling water	L			
Temperature of cooling water or cooling air	H			
Level in cooling water expansion tank, if separate circuit	L			
Level in fuel oil daily service tank	L			
Pressure of starting air	L			
Overspeed activated			H, S	
Fuel oil viscosity before injection pumps or fuel oil temperature before injection pumps **(1)**	L H			
Exhaust gas temperature after each cylinder **(2)**	H			
Common rail fuel oil pressure	L			
Common rail servo oil pressure	L			
Speed of turbocharger **(4)**	H			

Notes:

(1) *For heavy fuel oil burning engines only.*

(2) *For engine power above 500 kW/cyl.*

(3) *When required by BCS- R 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 requirement for independence between alarm and shut-down system.*

(4) *Only required for turbochargers of Categories B and C. (see BCSachinery Rules, Chapter 4, Section 4,A.).*

G. Sensors for Fuel, Seperator, Generation and Utilization of Heat

Table 8.8 Fuel oil, seperator, generation and utilization of heat

F = Fault L = Low limit H = High limit R = Reduction S = Shut down T = Trigger Stand-by activation	Sensor for alarms	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
Fuel oil				
Heavy fuel oil viscosity **(4)**	LH			
Fuel level (gas blanket) in closed stand pipe **(2)**	L			
Fault in automatic fuel oil filter	F			
Level in fuel oil service tank	L **(3)**			
Differential pressure of fuel indicator filter	H			
Fuel oil temperature in daily service oil fuel tanks and settling tanks **(6)**	H			
Separator Systems				
Temperature of separating medium	LH			
Unintentional opening of drum	F			
Water in the discharge of the separation medium	F			
Loss of water seal	F			
Sludge tank level	H			
Thermal oil installation				
Thermal oil system				
Discharge temperature	L			
Level in expansion tank	LH			
Tripping of quick discharge/closing device	F			
Oil fired heaters				
Temperature at heater	H			
Circulation	L			
Temperature of flue gas	H			
Leakage	F			
Exhaust gas fired heaters				
Temperature at heater	H			
Circulation	L			
Exhaust gas temperature at heater outlet	H			
Fire in heater	F			
Leakage	F			

Table 8.8 Fuel oil, seperator, generation and utilization of heat (continued)

F = Fault L = Low limit H = High limit R = Reduction S = Shut down T = Trigger Stand-by activation	Sensor alarms	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
Auxiliary steam plant				
Condensate, feed water and steam system				
Steam pressure	L			
Level in condensate tank	L			
Salt content	H			
Oil penetration	F			
Oil fired boiler				
Level of water	LH			
Pressure of steam	H			
Circulation	L			
Exhaust gas boiler				
Level of water	LH			
Pressure of steam	H			
Fire in exhaust gas boiler (boiler with framed tubes)	F			
Oil fired system for steam and thermal oil plants				
Fuel supply system				
Fuel oil pressure **(1)**	L			
Fuel oil temperature /viscosity	LH			
Service tank level	L			
Oil burner				
Fuel oil pressure in pressure atomizer **(5)**	L			
Atomizing agent pressure	LH			
Rotary cup speed/primary air pressure	L			
Flame disturbance **(1)**	F			
Combustion air pressure	L			
Induced draught	L			
Evaporator plant				
Salt content of the produced distillate	H			

(1) *Reduce and registration for main steam plants.*

(2) *Not applicable in the case of automatic gas-venting.*

(3) *High level alarm is also required if no suitable overflow arrangement is provided.*

(4) *It may be agreed with **BCS** to alarm the temperature alternatively.*

(5) *If the fan for combustion air and the pump for fuel oil will be driven by one common motor the realisation of one of the Stated alarms is sufficient.*

(6) *Only if tanks are fitted with heating arrangements and the flashpoint of the oil fuel can be exceeded.*

H. Sensors for Fire Alarm Systems, Electrical Plants and Others

Table 8.9 Fire alarm systems, electrical plants and others

F = Fault L = Low limit H = High limit R = Reduction S = Shut down T = Trigger Stand-by activation	Sensor for alarms	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
Fire alarm system				
Fire alarm **(1)**	F			F
Fault	F			
FWBLAFFS (Local Fire Fighting System)				
Prealarm	F			
Released	F			F
Fault	F			
Electrical plant				
Failure of ship's main	F			
Disconnection of non-essential consumers	F			
Generator switch activated	F			
Low frequency	L			
Over voltage	H			
Failure 24 V main charger	F			
Common fault power management	F			
Others				
Failure of remote control	F			F
Failure of alarm system /duty alarm system	F			F
Failure of safety system	F			
Activation of the safety system	F			
Override of safety system is activated	F			
Set/actual values deviation of a remote control	F			
Automatic start of a stand-by unit **(4)**	F			
Fault of a stand- by control unit	F			
Level of engine room bilge, bilge suction pipe **(3)**	H			
Oil content of bilge water after separator	H			
Switching – on time and frequency of automatic bilge pumps	H			

Table 8.9 Fire alarm systems, electrical plants and others (continued)

F = Fault L = Low limit H = High limit R = Reduction S = Shut down T = Trigger Stand-by activation	Sensor alarms	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
Level of fuel overflow tank	H			
Level leakage oil tank	H			
Failure of CO_2 low pressure system	F			
Failure of compressor for starting air **(2)**	F			
System pressure of fire extinguishing system	L			
Activation of automatic fire extinguishing system	F			F
Failure of electrical speed governor	F			

(1) *Alarm to be optically and acoustically distinguished from other alarms.*

(2) *Only if main engine is directly reversible.*

(3) *At minimum two separate sensors for alarms at each engine room or department.*

(4) *If not started due to normal condition.*

I. Standby Circuit and Remote Control Facility for Essential Equipment

Table 8.10 Standby circuit and remote control of essential equipment

Plant/System		Stand-by circuit **(6)**	Starting after shut-down and return of the ship' s supply	Remote control for AUT-C
Diesel engine for propulsion	Lubricating oil pumps **(1)**	x	x	x
	Piston coolant pumps	x	x	x
	HT (high temperature) fresh cooling water pumps	x	x	x
	LT (low temperature) fresh cooling water pumps	x	x	x
	Sea water cooling pumps	x **(2)**	x	x
	Fuel valve coolant pumps	x	x	x
	Fuel feeding pumps	x	x	x
	Fuel pressure increasing pumps	x	x	x
Gas turbine	Lubricating oil pumps	x	x	x
	Coolant pumps	x	x	x
	Fuel feeding pumps	x	x	x
	Fuel pressure increasing pumps	x	x	x
Main turbine	Lubricating oil pumps	x	x	x
	Condensate pumps	x	x	x
	Condensate transfer pumps	x	x	x
	Air pump, if no steam-jet air ejector fitted	x	x	x
	Auxiliary cooling water pump	x **(2)**		x
Auxiliary Diesel engine	Fuel oil transfer pumps	x	x	x
	Cylinder water cooling pumps	x	x	x
Steam plant	Feedwater pumps	x	x **(5)**	x
	Circulating pumps	x	x **(5)**	x
Thermal oil system	Circulating pumps	x	x	x
Oil burning system	Fuel oil supply pumps	x		x
Turbo generator	Back-up lubricating pump	x	x	x
Pump for gear lubricating oil		x	x	x

Table 8.10 Standby circuit and remote control of essential equipment (continued)

Plant/System		Stand-by circuit **(6)**	Starting after shut-down and return of the ship' s supply	Remote control for AUT-C
Pump for power oil of controllable pitch propeller		x	x	x
Pump for hydraulic oil of steering gear		x **(3)**	x	x **(3)**
Compressor for starting air		x **(4)**		x **(4)**
Compressor for control air		x **(4)**		x **(4)**
Main fire extinguishing pump		x **(3)**		x **(3)**

(1) *Valid for separated circuit.*

(2) *For scoop operation automatic switch-on/switch-off of main coolant pump as a function of the rate of speed as substitution*

(3) *Starting by remote control from bridge*

(4) *Automatic switching on or off depending on pressure*

(5) *For auxiliary steam plant the starting after shut-down and return of the ship's supply is not required.*

(6) *Standby circuit not required for AUT-C Class Notation.*

J. Sensors for Electric Propulsion Plants

Table 8.11 Indicators for electric permanent excited propulsion motors (PE), as well as synchronous motors (SY) and asynchronous motors (AS)

Descriptions F = Fault L = Low limit H = High limit R = Reduction (R) = if applicable S = Shut-down (S) = if applicable T = Trigger standby activation C = Collective alarm		Sensor for alarms	Sensor for stand-by aggregate	Sensor for safety functions	Alarm at the bridge
Electric motor					
External lubrication failure	**PE SY AS**	F		F(R) (S)	C
Bearing temperature	**PE SY AS**	H		H	C
Stator winding temperature	**PE SY AS**	H		H R	C
Sliprings condition	**SY**	Inspection			-
External cooling water and/or air failure	**PE SY AS**	F		F	C
Cooling air temperature, engine inlet at closed loop cooling system	**PE SY AS**	H		H	C
Coolant leakage	**PE SY AS**	F		F	C
Speed	**PE SY AS**	H		H S	C
Voltage regulator breakdown	**SY**	F		F S	C
Earth fault monitoring at stator with transformer feeding	**PE SY AS**	L		L	C
Earth fault monitoring of exciting system with transformer feeding	**SY**	L		L	C
Transformer reactor					
Transformer winding temperature	**PE SY AS**	H		H R	C
Coolant leakage	**PE SY AS**	F		F	C
External cooling failure	**PE SY AS**	F		F	C
Converter					
Mains failure	**PE SY AS**	F		S	C
External cooling failure	**PE SY AS**	F		F R	C
Power section temperature	**PE SY AS**	H		H S	C
Cooling quality (only at direct cooling)	**PE SY AS**	L		L	C
Coolant leakage	**PE SY AS**	F		F	C
General warning	**PE SY AS**				C
Breakdown	**PE SY AS**	F		F S	C
Speed-/rotor position sensor detection failure	**PE SY AS**	F		F	C
Emergency stop (converter de-energized)	**PE SY AS**	F		F S	C

Table 8.11 Indicators for electric permanent excited propulsion motors (PE), as well as synchronous motors (SY) and asynchronous motors (AS) (continued)

Descriptions F = Fault L = Low limit H = High limit R = Reduction (R) = if applicable S = Shut-down (S) = if applicable T = Trigger standby activation C = Collective alarm		Sensor for alarms	Sensor for stand-by aggregate	Sensor for safety functions	Alarm at the bridge
Semiconductor fuse	**PE SY AS**	F		F S	C
Chopper temperature	**PE SY AS**	H		H R	C
DC-Link, voltage	**PE SY AS**	H		H S	C
DC-Link, current	**PE SY AS**	H		H S	C
Output current	**PE SY AS**	H		H S	C
Propulsion net/ship electrical system					
Harmonic filter breakdown	**PE SY AS**	F		F	C