TÜRK LOYDU

Chapter 4-1 – Automation
2015

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 colour.

Unless otherwise specified, these Rules apply to ships for which the date of contract for construction as defined in IACS PR No.29 is on or after 1st of January 2015. New rules or amendments entering into force after the date of contract for construction are to be applied if required by those rules. See Rule Change Notices on TL website for details.

"General Terms and Conditions" of the respective latest edition will be applicable (see Rules for Classification and Surveys).

If there is a difference between the rules in English and in Turkish, the rule in English is to be considered as valid. This publication is available in print and electronic pdf version.

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Rules for Classification of Steel Ships – Automation

Section 5- Main Propulsion Plant

Section 6- Auxiliary Machinery Systems

Section 7- Tests

Section 8- Tables

SECTION 1

GENERAL RULES AND INSTRUCTIONS

A. General

1. Scope

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

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

1.3 **TL** 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.

2. References to other rules and regulations

2.1 The following additional **TL** Rules for Construction apply:

- Chapter 4 - Machinery Installations,

- Chapter 5 - Electrical Installations.

2.2 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.

2.3 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.

2.4 Further Rules and Regulations, named in the Construction Rules.

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

B. Class Notations

Machinery installations which comply with **TL’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.

C. Definitions

1. Alarms

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

2. Protective Devices

Protective devices detect actual values, activate alarms in the event of limit-value violation and prevent machinery and equipment being endangered. They automatically initiate curative measures or call for appropriate ones.

3. Safety Devices

Safety devices detect critical limit-value violations and prevent any immediate danger to persons, ship or machinery.

4. Safety systems

Combination of several safety-devices and/or protective devices into one functional unit.

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.

D. 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.

1. Newbuildings

1.1 Questionnaire PL-M-CL006 for motor systems.

1.2 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.

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

1.4 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.

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

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

2. 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.

E. Ship Documents

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

F. Maintenance

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.

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

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.

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.

G. Spare Parts

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

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, C. and Section 5, B. with regard to diesel engines and 5, C. with regard to steam turbine plants.

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, F.

8. Boilers and thermal oil systems are to be equipped as described in Section 5, C. 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. Fuel and lubrication oil purifiers are to be of self-cleaning type, unless no operation and 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.

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, H. and Section 8, C.

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, H.2.

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

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. A safety system in accordance with Section 4, C, Section 5, B., and C is to be provided for the propulsion plant, engine systems and steam turbine plant respectively.

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, G.

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, **TL** 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 designated 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 stand-alone 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, B.

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 IACS UR M29 “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 IACS UR M29 “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, **TL** 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 testing.

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.

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 The fixed stations shall be supplied at least for 15 minutes in case of a failure of the ship's mains.

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

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

C. Safety Systems

1. 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 **TL** 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 IACS URM30.2.8).

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 **TL**.

8. Safety systems are subject to mandatory type testing.

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

D. Reductions

1. When reaching dangerous limits, reductions shall manually or automatically adapt the operation temporary to the remaining technical capabilities.

The reduction may be a function of the machinery alarm system.

2. 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.

E. Safety Devices

1. The design of safety devices shall be as simple as possible and must be reliable and inevitable in operation. Proven safety devices which are not depending on a power source are to be preferred.

2. The suitability and function of safety devices must be demonstrated in the given application.

3. 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.

These faults and also the tripping of safety devices shall be signalled by an alarm.

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

5. The adjustment facilities for safety devices shall be so designed that the last setting can be detected.

6. Safety devices shall be designed preferably using conventional technology (hard wired). Alternative technical solutions shall be agreed with **TL**.

7. Where auxiliary energy is required for the function of safety devices, this has to be monitored and a failure has to be alarmed.

8. Safety devices are subject to mandatory type testing.

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 - Electrical Installation, Section 9 and Section 14, F.

G. Fire Detection Systems for Machinery Spaces

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

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 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).

For non addressable detectors, the number of detectors in each loop shall not exceed 10.

5. For requirements relating to fire detection systems with remotely and individually identified detectors, see Chapter 5 - Electrical Installations, Section 9, D.3.2.

6. 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.

7. 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.

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

9. For fire detection in unmanned machinery spaces, see Chapter 4 – Machinery, Section 18 C.4.5.

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 Machinery installations:

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

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 - Electrical Installation, 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 disturbed formation. See also Section 8, I.

SECTION 5

MAIN PROPULSION PLANT

A. Remote Controls

1. General

1.1 The remote control shall be capable to control, speed, direction of thrust and, as appropriate, torque or propeller pitch without restriction under all navigating and operating conditions.

1.2 Single lever control is to be preferred for remote control systems. Lever movement shall be in accordance to the desired course of the ship.

Commands entered into the remote control system from the bridge must be recognisable at all control stations.

1.3 The remote control system shall carry out commands which are ordered, including emergency maneuvers, in accordance with the propulsion plant manufacturer's specifications.

Where critical speed ranges are incorporated, their quick passing is to be guaranteed and a reference input within them have to be inhibited.

1.4 With each new command, stored commands must be erased and replaced by the new input.

1.5 In the case of set speed stages, a facility must be provided to change the speed in the individual stages.

1.6 An overload limitation facility is to be provided for the propulsion machinery.

1.7 On ships with shaft-driven generators, it shall be ensured in case of maneuvers which would prevent operation of the shaft-driven generator system, that the supply of the equipment in accordance with Section 4, H.2 is maintained without interruption.

1.8 Following emergency manual shutdown or automatic shutdown of the main propulsion plant, a restart shall only be possible via the stop position of the command entry.

1.9 When the turning gear is engaged or automatic shutdown has not been acknowledged, any start attempts are to be prevented.

1.10 The failure of the remote control system and of the control power shall not result in any sudden change in the propulsion power nor in the speed and direction of rotation of the propeller.

In individual cases, **TL** may approve other failure conditions, whereby is assumed that:

- There is no increase in ship's speed,
- There is no course change,
- No unintentional start- up processes are initiated.

1.11 The failure of the remote control system and of the control power is to be signalled by an alarm.

1.12 Remote control systems for main propulsion plants are subject to mandatory type testing.

1.13 It shall be ensured that control is only possible from one control station at any time. Transfer of command from one control station to another shall only be possible when the respective control levers are in the same position and when a signal to accept the transfer is given from the selected control station.

A display at each control station shall indicate which control station is in operation.

1.14 The take of control independent of the accept signal, stated in 1.13, shall only be possible in the machinery space.

The less of control at the concerned control station is to be signaled audibly and visually.

2. Facilities on the Bridge

2.1 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.

2.2 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.

2.3 The main propulsion system must be capable of being shutdown with an emergency manual shutdown facility from the bridge. This device shall be independent of the remote control system and it's power supply.

2.4 The emergency shutdown facility shall not be automatically cancelled and shall be protected against unintentional operation.

2.5 Where the safety system of the main propulsion plant shall be equipped with an overriding arrangement, this has to be installed on the bridge.

2.6 With the consent of **TL**, 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.

2.7 An indicator for the propeller shaft speed and the direction of rotation shall be provided for propulsion systems with fixed propellers.

2.8 In the case controllable pitch propeller systems, an indicator shall be provided to display the speed of the propeller shaft and the pitch of the propeller.

2.9 In the case of systems which have reversing gears, indicators shall be provided to display the speed and direction of rotation of the propeller shaft and also the speed of the propulsion machinery.

2.10 Override opportunity is permitted for shutdown criteria, as required in Section 8, except for shutdown in case of overspeed.

2.11 Override opportunity shall be realized for shutdown criteria, as required in Section 8. It shall be also realized for additional shutdown and slowdown criteria, not listed in Section 8.

3. Facilities in the Machinery Control Room

If remote control of the propulsion plant is provided from a machinery control room, the equipment listed under 2. shall also be fitted in the machinery control room.

4. Facilities at the Engine Maneuvering Platform

A manual operating facility for the engine which is independent of the remote control system is to be installed at the local machinery control station.

The indicators listed in 2.7 to 2.9 shall be fitted at the control station.

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.

Override is permitted except for the over speed protection and for shutdown in case of oil mist detection.

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.

6. Additional facilities for operating the engines with gas are to be established with **TL** in each individual case, taking into account the rules relating to seagoing ships, Chapter 10 - Liquefied Gas Tankers Section 16.

C. Main Steam Plants

1. The alarms listed in Section 8, Table 8.2 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 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 - Electrical Installations, 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 in the discharge of the medium to be separated shall trip an alarm.

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

4. 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.

5. 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 **TL** Surveyor.

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

TL 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 **TL**, additional tests and trials are to be agreed, as required, between the manufacturer and **TL**.

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 – Electrical Installation, 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 tests.

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

TL 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 **TL**.

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 **TL** 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 **TL** 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 Tests

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,
- 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 **TL** Surveyor, with the prior consent of **TL**.

SECTION 8

TABLES

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

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 alarms	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
Lubricating oil				
Lubricating oil pressure at engine inlet **(1) (2)**	L	LT	LS	
Lubricating oil filter differential pressure	H, RI			
Temperature of lubricating oil at engine inlet	HR, RI			
Concentration of oil mist or temperature of engine bearings for engines with power above 2250 kW or with cylinder diameters above 300 mm. **(4)**	H		HS	
Failure in cylinder lubrication	FR			
Flow rate of cylinder lubricator. Each apparatus	LR			
Level in lubrication oil sump tanks **(1)**	L			
Fault at lubricating oil automatic filter	F			
Temperature thrust bearing	HR			
Pressure of lubricating oil to main bearing and thrust bearing	L, RI	LT	LS	
Common rail servo oil pressure	L			
Coolant				
Cylinder cooling water pressure	L, RI	LT	LS **(10)**	
Temperature of cylinder cooling water at each cylinder outlet (general) **(5)**	HR, RI			
Level in coolant expansion tanks	L			
Oil contamination in cylinder cooling water system **(6)**	F			
Pressure of seawater for cooling	L,RI	LT		
Pressure of LT (low temperature) freshwater cooling circuit	L			
Temperature of LT (low temperature) freshwater cooling circuit	H			

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 alarms	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
Temperature of cylinder cooling water at engine inlet	L			
Cylinder water outlet temperature (general) **(16)**	HR, RI			
Level of cylinder cooling water in expansion tank	L			
Fuel oil				
Fuel oil viscosity before injection pumps or Fuel oil temperature before injection pumps **(13)**	H L			
Fuel oil pressure to injection pumps	L, RI	LT		
Leakage from fuel injection pipe	F			
Level of fuel oil in daily service tank **(14)**	L			
Common rail fuel oil pressure	L			
Turbocharger				
Lubricating oil inlet pressure turbocharger **(8)**	L, RI			
Lubricating oil temperature turbocharger at each bearing **(8), (12)**	H			
Charging air temperature **(7)**	LH			
Exhaust gas				
Exhaust gas temperature turbocharger inlet and outlet	H			
Exhaust gas temperature after each cylinder **(3)**	HR, RI			
Exhaust gas temperature after each cylinder . Deviation from average **(3)**	H			
Air				
Control air pressure	L, RI			
Starting air pressure before main shut-off valve **(9), (11)**	L, RI			
Overspeed trip (2)			HS	
Scavenge air receiver temperature	H			
Engine Speed	RI			
Control-Safety-Alarm System Power Supply Failure	F			

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

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

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

(4) *One oil mist detector system for each engine having two independent outputs for initiating the alarm and shut-down would satisfy the requirement for independence between alarm and shut-down system.*

(5) *Where all cylinders have a common cooling water chamber with no individual shut-offs, individual monitoring may be dispensed with. In this case, separate sensors for alarm and reduction are required.*

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

(7) *As an alternative, "Water in charge air-duct" instead of low limit.*

(8) *Not applicable for selfcontained lubricating oil circuits.*

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

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

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

(12) *Where outlet temperature from each bearing cannot be monitored due to the engine/turbocharger design alternative arrangements may be agreed with **TL**. 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.*

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

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

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
Lubricating oil				
Lubricating oil to crosshead bearing pressure	LR, RI	LT	LS	
Lubricating oil pressure at engine inlet **(1) (2)**	LR	LT	LS	
Lubricating oil to main bearing and thrust bearing, pressure	LR,RI	LT	LS	
Lubrication oil pressure camshaft **(1), (10)**	L	LT	LS	
Lubricating oil filter differential pressure	H			
Temperature of lubricating oil at engine inlet	HR			
Concentration of oil mist or temperature of engine bearings for engines with power above 2250 kW or with cylinder diameters above 300 mm. **(4)**	HR **(3)**			
Failure in cylinder lubrication	FR			
Level in lubrication oil sump tanks **(1)**	L			
Fault at lubricating oil automatic filter	F			
Temperature of lubricating oil to camshaft **(10)**	H			
Temperature thrust bearing or bearing outlet temperature	HR **(3)**			
Flow rate cylinder lubricator. Each appratus	LR			
Common rail servo oil pressure	L			
Coolant				
Cylinder cooling water inlet pressure	LR	LT		
Cylinder cooling water pressure	L	LT	LS	
Outlet temperature of cylinder cooling water (from each cylinder or cylinder water outlet temperature (general) **(5)**	HR			
Level of cylinder cooling water in expansion tank	L			
Oil contamination in cylinder cooling water system **(6)**	F			
Pressure of seawater for cooling	L	LT		
Pressure of LT (low temperature) freshwater cooling circuit	L			
Temperature of LT (low temperature) freshwater cooling circuit	H			

Piston coolant inlet pressure **(17)**	LR	LT		
Piston coolant temperature at each cylinder	HR			
Piston coolant outlet flow each cylinder **(12), (14)**	LR			
Level of piston coolant in expansion tank	L			
Fuel injection valve coolant pressure	L	LT		
Fuel injection valve coolant temperature	H			
Level of fuel valve coolant 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
Temperature of cylinder cooling water at engine inlet	L			
Fuel oil				
Fuel oil viscosity before injection pumps or Fuel oil temperature before injection pumps	H L			
Fuel oil pressure to injection pumps	L	LT		
Leakage fuel injection pipe	F			
Fuel oil pressure after filter (engine inlet)	L, RI	L		
Level of fuel oil in daily service tank **(16)**	L			
Common rail fuel oil pressure	L			
Turbocharger				
Lubricating oil inlet pressure turbocharger **(8)**	L			
Lubricating oil temperature turbocharger outlet , each bearing **(8) , (15)**	H			
Charging air temperature **(7)**	LH			
Speed of turbocharger	RI			
Exhaust gas				
Exhaust gas temperature turbocharger inlet and outlet	H, RI			
Exhaust gas temperature of each cylinder	HR, RI			
Exhaust gas temperature after each cylinder. Deviation from average	H			
Air				
Control air pressure **(11)**	L			

Starting air pressure before main shut-off valve **(9), (13)**	L,RI			
Safety air pressure	L			
Scavenge air system				
Scavenge air receiver pressure	RI			
Scavenge air box temperature (fire)	HR			
Scavenge air receiver water level	H			
Failure of electric scavenge air blower	F			
Fire alarm for scavenging air systems	FR			
Overspeed trip (2)			HS	
Engine speed/direction of rotation **Wrong Way**	F, RI			
Control-Safety-Alarm system power supply failure	F			

(1) *Individual alarms are to be provided for separate circuits.*
(2) *Shut-down only for engines from 220 kW upwards.*
(3) *Speed reduction to minimum manoeuvre speed.*
(4) *Other surveillance methods may be agreed with **TL**.*
(5) *Where all cylinders have a common cooling water chamber with no individual shut-offs, individual monitoring may be dispensed with.*
(6) *Where cooling water is used for preheating or cooling fuel, lubricating oil.*
(7) *As an alternative, "Water in charge air-duct" instead of low limit.*
(8) *Not applicable for selfcontained lubricating oil circuits.*
(9) *For engines with direct reversing capability and also all engines with remote start from the bridge, individual alarm.*
(10) *If separate lubricating oil systems are installed.*
(11) *If separate control air loop for emergency stop is installed, low limit alarm also required.*
(12) *Shut down, where necessary.*
(13) *Where engine is started electronically the failure of the battery charger is to be alarmed.*
(14) *Where outlet flow cannot be monitored due to engine design, alternative arrangements may be agreed with **TL**.*
(15) *Where outlet temperature from each bearing cannot be monitored due to the engine/turbocharger design alternative arrangements may be agreed with **TL**. Continuous monitoring of inlet pressure and inlet temperature in combination wit specific intervals for bearing inspection in accordance with the turbocharger manufacturer's instructions may be accepted as an alternative.*
(16) *High-level alarm is also required if no suitable overflow arrangement is provided.*
(17) *The slow down is not required if the coolant is oil taken from the main cooling system of the engine.*

***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 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 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 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			
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 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			
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 temperaturethrust bearings **(5), (8)**	HR			
Temperature aft. stern tube bearing **(9)**	H			
Oil level sterntube storage/gravity tank	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 general plants not equipped with reverse gear stage).*

Table 8.6 Steering Devices

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
Steering gear (1) (2)				
Loss of voltage supply for power unit	F	FT		F
Overload and failure of one phase of driving electromotor	F	FT		F
Low level hydraulic oil tank **(3)**	L	FT		L
Loss of voltage supply control unit of steering gear	F	FT		F
Functional failure of hydraulic system (hydraulic lock))	F			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). To fulfill this requirement and automatic, selective failure detection and isolation of the affected part of the power units must be implied as a rule. Depending on the design additional sensors for the adequate monitoring of the condition (such as low-low sensors) may become necessary.*

F. Sensors for Auxiliary Diesel Engines

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 alarms	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
Auxiliary diesel engines				
Pressure of lubricating oil **(1)**	L		LS	
Temperature of lubrication oil	H			
Differential pressure of lubricating oil indicator filter	H			
Coolant pressure or flow	L			
Temperature of cooling water or cooling air	H			
Level of cooling water equalizing tank, if separate circuit	L			
Pressure of starting air **(5)**	L			
Pressure of fuel oil	L			
Only for heavy fuel oil burning engines, fuel oil viscosity before injection pumps or fuel oil temp before injection pumps	LH			
Failure of fuel automatic filter	F			
Differantial pressure of fuel indicator filter	H			
Leakage in fuel injection pipes	F			
Overspeed **(1)**			HS	
Level of fuel operating tank (s)	L			
Concentration of oil mist or temperature of engine bearings for engines with power above 2250 kW or with cylinder diameters above 300 mm **(2) (4)**	H		HS	
Exhaust gas temperature of each cylinder **(3)**	H			
Deviation from exhaust gas mean temperature **(3)**	H			
Common rail fuel oil pressure	L			
Common rail servo oil pressure	L			

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

(2) *For high speed engines other methods of surveillance may be agreed with **TL**.*

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

(4) *One oil mist detector system for each engine having two independent outputs for initiating the alarm and shut-down would satisfy the requirement for independence between alarm and shut-down system.*

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

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 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			
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	LR			
Exhaust gas temperature at heater outlet	H			
Fire in heater	F			
Leakage	FR			

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	L			
Atomizing agent pressure	LH			
Atomizer pressure/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 **TL** to alarm the temperature alternatively..*

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 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			F
Released	F			F
Fault	F			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
No acknowledgement of an alarm	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

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

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

(3) *At minimum two separate 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
	Nozzle 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)**
Electrical ship's main		x	x	x
Static/rotating converter			x	

(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.*