



## Rules For Classification And Construction

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### Part 1 Seagoing Ship

Volume VII

# RULES FOR AUTOMATIONS

2018

Biro Klasifikasi Indonesia





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### Part 1 - Seagoing Ship

#### Volume VII

# RULES FOR AUTOMATIONS

2018

Biro Klasifikasi Indonesia

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Jl. Yos Sudarso No. 38-40, Tanjung Priok  
Jakarta 14320 - Indonesia  
[rules@bki.co.id](mailto:rules@bki.co.id)  
[www.bki.co.id](http://www.bki.co.id)

The following Rules come into force on 1<sup>st</sup> July 2018.

Amendments to the preceding Edition are marked by red colour and expanded text. However, if the changes involves a whole section or sub section, normally only the title will be in red colour.

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## Foreword

This 2018 Edition of the Rules for Automations (Pt.1, Vol.VII) supersedes the 2014 Edition of the Rules for Automations (Pt.1, Vol.VII). In this 2018 editions new amendments are introduced which are mainly derived from IACS publications, SOLAS and inputs from Research and Development Division.

The summary of current amendments for each section including the implementation date are indicated on the page of Rules Amendment Notice.

This Rules is available to be downloaded at [www.bki.co.id](http://www.bki.co.id). Once downloaded this Rules will be uncontrolled copy. Please check the website for the valid version.

Further quires or comments concerning this Rules are welcomed through communication to BKI Head Office.

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## Rules Amendment Notice

These pages contain amendments within the following section of the Rules for Automations (Pt.1, Vol.VII), 2018 Edition.

These amendments will come into force on 1<sup>st</sup> July 2018 unless specified otherwise in the table.

Paragraph	Title/Subject	Status/Remark
<b>Section 1 – General Requirements and Guidance</b>		
<b>1.B</b>	<b>Definitions</b>	
1.B.4	Safety system	To add additional requirement for definition of safety system in according to (IACS UR M30)
<b>1.C</b>	<b>Documents for Approval</b>	
1.C.2.1	Questionnaire form	To change the form number
<b>Section 4 – Automation Systems</b>		
<b>4.A</b>	<b>Machinery Alarm Systems</b>	
4.A.1	Location of alarm display	To elaborate the requirements for location of machinery alarm display that should be provided (IACS UR M35)
<b>4.C</b>	<b>Protective Devices for Machinery Plants</b>	
4.C.1.1	Protective devices are subject to mandatory type testing	To add additional requirement which further explain the type testing process
<b>4.D</b>	<b>Safety Devices for Machinery Plants</b>	
4.D.11	Safety devices are subject to mandatory type testing	To add additional requirement which further explain the type testing process
<b>4.E</b>	<b>Safety Systems for Machinery Plants</b>	
4.E.11	Safety systems are subject to mandatory type testing.	To add additional requirement which further explain the type testing process
<b>Section 7 – Test</b>		
<b>7.D</b>	<b>Tests on Board</b>	
7.D.1.1	Form used for onboard test	To change the form number
<b>7.E</b>	<b>Type Approval</b>	
7.E.1	Installations, equipment and assemblies subject to type testing	To add reference for the type testing procedure.
<b>Section 8 – Sensors, Stand-by Circuits and Remote Control Facilities</b>		
<b>8.B</b>	<b>Sensors for Main Propulsion Diesel Engines and Turbocharger</b>	
8.B.1	Table 8.1 Main propulsion diesel engines (medium and high-speed)	To adopt the requirements of IACS UR M35 Rev.7 <sup>1)</sup>
8.B.2	Table 8.2 Main propulsion diesel engines (slow-speed)	To adopt the requirements of IACS UR M35 Rev.7 <sup>1)</sup>
8.B.3	Table 8.3 Exhaust gas turbocharger/engine driven chargers	To adopt the requirements of IACS UR M73 Corr.1 <sup>2)</sup>
<b>8.E</b>	<b>Sensors for Propulsion Plant and Steering Devices</b>	

<sup>1)</sup> These amendments are to be implemented for engines:

i) when an application for certification of an engine is dated on or after 1 July 2017; or  
ii) which are installed in new ships for which the date of contract for construction is on or after 1 July 2017.

<sup>2)</sup> These amendments are to be implemented to turbochargers with the date of application for certification of the new turbocharger type on or after 1 July 2016.

Paragraph	Title/Subject	Status/Remark
8.E	Table 8.7 Steering devices	To add additional failure detection alarm (IACS UR E25) <sup>3)</sup>
<b>8.F</b>	<b>Sensors for Auxiliary Diesel Engines</b>	
	Table 8.8 Auxiliary diesel engines	To add definition of engine bearing in footnote of Table 8.8 (IACS UI SC76)

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<sup>3)</sup> These amendments are to be implemented on ships contracted for construction (as defined in IACS PR29) on or after 1 July 2017.



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## Section 1 General Requirements and Guidance

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### A. Scope and Application

- These Construction Rules apply additionally to automated machinery systems on seagoing ships, classified by Biro Klasifikasi Indonesia (BKI), which have one of the Class Notations in the Class Certificate relating to the machinery system as listed under E.
- Approval may be given for designs which differ from the Rules for Construction if they have been checked for suitability by BKI and accepted as being of equivalent design.
- BKI 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 devices for machinery plants

Protective device protects a machinery plant at a critical limit-value violations 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 devices 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. **The system is to intervene sequentially after the operation of alarm system by:**

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

## 5. Systems

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

## C. Documents for Approval

### 1. Document for submission

The following documents are to be submitted to BKI for examination **in form of soft copy or hard copy in triplicate**.

### 2. New buildings

**2.1** Questionnaire **OT-1-D** (form **F 21.2.14**) for diesel engine installations, for diesel electrical propulsion plants also form **F 21.2.20**.

**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 shut-down or reduction are to be submitted for the main propulsion plant and also for other equipment where necessary.

**2.5** BKI 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 new building 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. BKI Rules and Guidelines

1.1 The following additional BKI Rules for Construction apply:

- [Rules for Machinery Installations \(Pt.1, Vol. III\).](#)
- [Rules for Electrical Installations \(Pt.1, Vol. IV\).](#)

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 Construction Rules are to be observed.

### 2. National Regulations

If necessary, beside of the BKI Rules, 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 BKI's Rules for Construction for automated and/or remotely controlled systems are given the following additions to the Class Notation:

### 1. OT

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

Equipment has to comply with the conditions laid down in [Section 2.A.](#)

### 2. OT-nh

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

Equipment has to comply with the conditions laid down in [Section 2.B.](#)

### 3. OT-S

Class Notation for machinery systems on ships with a permanently attended 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 has to comply with the conditions laid down in [Section 2.C.](#)

## **F. Basic Technical Requirements and Guidance**

### **1. Maintenance**

**1.1** Access shall 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 is to 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 have to be protected against unintentional mixing up. Alternatively, they are to 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

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C.	Machinery with Class Notation OT - S.....	2-2

### A. Machinery with Class Notation OT

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. 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 [5.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 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, see [Section 8](#).
7. Means of communication system are 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 [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 have to 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 [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 are to be accessible and have to 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. See [Rules for Machinery Installations \(Pt.1, Vol. III\) Sec.12](#), for details of the design.

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 an instruction table:

"Keep valves open at all times!"

## B. Machinery with Class Notation OT-nh

1. For the range of equipment see [A.3](#) to [A.21](#).
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 unattended 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 unattended. A reserve capacity of 15 % is also to be provided.

## C. Machinery with Class Notation OT-S

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 maneuvered, without restriction, by one person. See also [Section 8](#).
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 [5.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.D](#) and [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 stand-by units is to be capable of being started and stopped from the control station. Further details are given in [Section 8.I](#).
9. It shall 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](#).



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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](#).

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## Section 3 Basic Requirements

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### A. Design and Performance

- The requirements laid down for each unit and system depends on their intended use and the process-technological conditions. The Construction Rules stipulate the minimum requirements for these.
- In all circumstances the operation of the ship using automated machinery installations shall be at least as safe as operation with the attended machinery installation.
- If special operating conditions call for a particular system design, BKI reserves the right to impose additional requirements depending on the operational and system-specific considerations.
- Systems should be intelligible and user-friendly and have to follow ergonomic principles.
- The potential risk in the event of breakdown of safety, protection and monitoring equipment, open and closed-loop controls is to be limited to a justifiable level of residual risk.
- 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 recognize faults and test capability
  - reproducibility of values.
- Systems have to 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.
- Redundant systems shall be individually protected against short-circuit and overload and selectively supplied with power.
- 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 unattended in line with their Class Notation.
- 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 have to be provided to permit manual operation.

12.1 The actual control mode shall be discernible at the concerned controls 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 [Rules for Machinery Installations \(Pt.1, Vol. III\)](#) shall be met accordingly.

16. To avoid unnecessary interruption of the operation the response of stand-by functions and alarm systems shall occur before responding of safety system.

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 is to 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 with [Rules for Electrical Installations \(Pt.1, Vol. IV\) Sec.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 has to 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 [Rules for Electrical Installations \(Pt.1, Vol. IV\) Sec.1.I.](#)

## 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, see. [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 recognizable 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 have to show the specified reaction over the full control range. Anticipated variations of the parameters are to be considered during the planning.
- 2.3 Defects in the 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 shall be signalled by an alarm.

## E. Integration of Systems for Essentials 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 data 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 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

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### A. Machinery Alarm System

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

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.

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

3. Optical signals shall be individually indicated at a central position. The meaning of the individual indications shall be clearly identifiable by text or symbols. If a fault is indicated, the optical signal shall remain visible until the fault has been eliminated. It shall be possible to distinguish between an optical signal which has been acknowledged and one that has not been acknowledged.

4. It shall be possible to acknowledge audible signals independent from the visual signal.

5. Acknowledgment 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 has been given.

6. The acknowledgment of an alarm shall not inhibit an alarm which has been generated by new causes.

7. Alarms have to 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 are to be installed.

8. 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.

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

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

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

11.1 "Stop" group: alarms signalling faults which require the propulsion system to be shut-down immediately. This alarm is summarization of the alarms, for which the measured has to effect a shut-down in accordance with [Section 8](#). This alarm has to be activated before the safety system shuts the engine down.

11.2 "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 measured 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.

11.3 "Common" group: alarms signalling faults which do not require actions as described in [11.1](#) or [11.2](#).

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

13. The alarm system is to 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.

14. 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 are to be clearly recognizable.

15. In individual cases, BKI may approve collective alarms from essential, stand-alone systems which are signalled to the machinery alarm system.

15.1 Each additional new single alarm has to re-trigger to collective alarm.

15.2 The individual alarms have to be recognizable at the concerned system.

15.3 Collective alarms are to be recorded as described under [14](#).

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

17. 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.

18. 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 is to 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 shall be released on the bridge and 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 shall 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.

**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 accommodation area of the technical officer or the crew members responsible for the machinery has to be installed. This might be a telephone system.

## **2 Wireless duty alarm systems**

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

**2.2** 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.

**2.3** At least two charged reserve units shall be available.

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

**2.5** Watch and alarm functionalities shall be realized as in standard hardwired systems.

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

## **C. Protective Device 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 [Rules for Electrical Installations \(Pt.1, Vol.IV\) Sec.4.1.7](#). 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 testing. [See Section 7.E.](#)
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.
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 systems 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 device shall initiate an automatic shut-down. See also [Section 8](#)
3. Safety device shall be supplied according to Rules for Electrical Installations ([Pt.1, Vol.IV](#)) [Sec. 4.I.7](#). For battery supply at least 15 minutes have to be safeguarded.
4. Safety devices shall be so designed that potential fault 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 device of the main propulsion plant may be equipped with overriding facilities. The over speed protection is excluded.
11. Safety device are subject to mandatory type testing. [See Section 7.E](#)

## E. Safety System for Machinery Plants

1. It is allowed to combine protective and safety device for one individual system only.
2. Requirements according to [C.](#) and [D.](#) are to be observed.
3. Safety systems are subject to mandatory type testing. [See Section 7.E](#)

## F. Overriding Facilities

1. Override facilities according to [C.10](#) and [C.12.4.](#) have to be provided.
2. The activation of the overriding facilities is to be indicated at the concerned control station.
3. The activation of the overriding facilities is to be recorded.
4. Overriding facilities are not permitted for overspeed protection or manual emergency stops.

## G. Means of Communication

A reliable means of vocal communication shall be provided between the main machinery control room or the propulsion machinery control position, the navigating bridge and the accommodation and mess areas of the engineer officers or the crew members responsible for the machinery.

The [Rules for Electrical Installations \(Pt.1, Vol.IV\) Sec. 9.C.5.1.](#) are to be observed for the lay out.

## H. Fire Detection Systems for Machinery Spaces

1. For general requirements relating to fire alarm systems, see [Rules for Electrical Installations \(Pt.1, Vol.IV\) Sec. 9](#) and [Section 14.D.4.](#)
2. Fire detection systems shall signal a fire at an early stage.
3. The fire alarm shall be optical and audible recognized 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 is to be distinguishable from other alarms.
4. Each detection loop shall not enclose 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<sub>2</sub>). 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 shall automatically become operative again after a preset time.

7. For requirements relating to fixed water-based local application fire-fighting systems (FWBLAFFS), see [Rules for Electrical Installations \(Pt.1, Vol.IV\) Sec. 9.D.4](#).

## I. Stand-by Circuits / Automatic Controls

### 1. General

1.1 Stand-by circuits as described in [Section 8.I](#) shall automatically start stand-by units, if these are required according to [Rules for Machinery Installations \(Pt.1, Vol. III\)](#)

- in the case of failure of units in operation
- to meet the demand of auxiliary machinery with staggered operation.

1.2 Automatic controls shall 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 maneuvers in the lower speed range where the output of the mechanically-driven auxiliary machines is not adequate under these conditions.

1.6 An alarm shall not be tripped in the case of machinery installations 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 [Rules for Electrical Installations \(Pt.1, Vol. IV\) Sec. 3.B.5](#).

2.2 Following a black-out and restoration of the power supply, essential auxiliary machinery has to start-up again automatically, possibly in staggered formation. See also [Section 8.I](#).

## J. Control Valve

The requirements according to [Rules for Electrical Installations \(Pt.1, Vol.IV\), Sec. 9.D.9](#) are to be observed.

## Section 5 Main Propulsion Plant

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### 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 have to be recognizable at all control stations.

**1.3** The remote control system shall carry out commands which are ordered, including emergency manoeuvres, 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 have to be erased and replaced by the new input.

**1.5** In the case of set speed stages, a facility is to 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 manoeuvres which would prevent operation of the shaft-driven generator system, that the supply of the equipment in accordance with [Section 4.1.2](#) is maintained without interruption.

**1.8** Following emergency manual shut-down or automatic shut-down of main propulsion plant, a re-start shall be only be possible via the stop position of the command entry.

**1.9** When the turning gear is engaged or automatic shut-down 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, BKI may approve other failure conditions, whereby it 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 approval.

**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 loss of control at the concerned control station is to be signalled audibly and visually.

## **2. Facilities on the Bridge**

**2.1** Changeover 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 is to be capable of being shut-down with an emergency manual shut-down facility from the bridge. This device shall be independent of the remote control system and its power supply.

**2.4** The emergency shut-down 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 BKI, 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 propeller.

**2.8** In the case of 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 shut-down criteria, as required in [Section 8](#), except for shut-down in case of over speed.

**2.11** Override opportunity shall be realized for slowdown criteria, as required in [Section 8](#). It shall be also realized for additional shut-down 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 [2.7](#) to [2.9](#) shall also be fitted in the machinery control room.

In addition the required equipment is to be installed in accordance with [Rules for Machinery Installations \(Pt.1, Vol.III\) Sec. 2.1](#).

#### 4. Facilities at the engine manoeuvring 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.

In addition the required equipment is to be installed in accordance with [Rules for Machinery Installations \(Pt.1, Vol.III\) Sec. 2.I.](#)

### B. Diesel Engines

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

Proof of the number of start attempts as specified in [Rules for Machinery Installations \(Pt.1, Vol.III\) Sec. 2.H.2.4](#) is also to be provided for manoeuvring 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, see [Rules for Machinery Installations \(Pt.1, Vol.III\) Sec. 2.F.](#)

3. For details of the requirements relating to electronic governors and actuators, and also their power supplies, see [Rules for Electrical Installations \(Pt.1, Vol.IV\) Sec. 9.B.9.](#)

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 shut-down 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 BKI in each individual case, taking into account the [Rules for Ships Carrying Liquefied Gases in Bulk \(Pt.1, Vol.IX\) Sec. 16.](#)

### C. Gas-Fuelled Engines

1. The requirements according to the [Rules for Machinery Installations \(Pt 1, Vol.III\) Sec. 2.O](#) are to be observed.

2. In general, the alarms and shut-downs, as shown in the [Rules for Machinery Installations \(Pt 1, Vol.III\) Sec. 2, Table 2.12](#) shall be indicated in the machinery alarm system as individual alarms.

### D. Main Steam Plants

1. The alarms listed in [Section 8, Table 8.4](#) are to be provided for monitoring the main steam plant and the equipment needed for boiler operation.

The requirements according to [Rules for Machinery Installations \(Pt.1, Vol.III\) Sec. 7.I](#) and [Section.9](#) 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 8.4](#) 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.

## E. Gas Turbine Plants

### 1. General requirements

For the monitoring, protection and control concept, [Section 8, Table 8.5](#) 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 to [Section 8, Table 8.5](#).

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 sequence 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.

## **F. Electrical Propulsion Plants**

See [Rules for Electrical Installations \(Pt.1, Vol.IV\), Sec. 13.](#)

## **G. 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 shut-down (decoupling).

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## Section 6 Auxiliary Machinery Systems

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### 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 stand-by 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 [Rules for Electrical Installations \(Pt.1, Vol.IV\) Sec. 7.D.6](#).

3. An automatic shut-down is to be provided for the event of over speed, 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 systems**

See main steam plants, [Section 5.D](#).

### D. Auxiliary Steam Plants

The requirements according to [Rules for Machinery Installations \(Pt.1, Vol.III\), Sec. 7. I.](#) and [Section 9](#) are to be observed.

## E. Thermal Oil Systems

The requirements according to [Rules for Machinery Installations \(Pt.1, Vol.III\)](#), [Sec. 7.II](#) and [Section 9](#) 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 have to 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 be alarmed.
5. The heating system of the pre-heater is to be designed that an interruption of the flow to the purifier does not result in overheating of the pre-heaters.
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 Compressors

In the event of failure of the pressurized lubrication system, independently driven compressors have to shut down automatically. A suitable automatic drain facility is to 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 shall 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. See also [Rules for Machinery Installations \(Pt.1, Vol.III\)](#), [Sec. 1.E.5](#).
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.

## Section 7 Tests

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### 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 has to ensure that the products which the 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 the BKI Surveyor.

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

BKI reserves 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 BKI, additional tests and trials are to be agreed, as required, between the manufacturer and BKI.

5. Where computer system is 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 [Rules Electrical Installations \(Pt.1, Vol. IV\) Sec.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.C](#).

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

BKI reserves the right to demand tests for systems which have safety implications, or in case of extensive automation systems or where individual systems are integrated. This test might be a factory acceptance test (FAT) with presence of BKI Surveyor.

## D. Tests on Board

### 1. General

Tests comprise:

- tests during construction/installation
- tests during commissioning
- tests during sea trial
- repeated tests.

The test procedures are based on forms **OT D** and **OT T** for engine driven systems and steam driven systems respectively.

#### 1.1 OT 1-D

Form OT 1-D (**F21.2.14**) "Details on Automatic and Remote Controls of Propelling Machinery In Motor-Vessels" is used to apply for the relevant Class Notation. For electrical main propulsion machinery form **F21.2.20** is used. Concept approval for the whole system is given due to the information provided.

#### 1.2 Survey "Unattended Machinery Spaces Initial"

The survey type "Unattended Machinery Spaces Initial" 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 BKI 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 BKI Surveyor in accordance with the system requirements.

The survey type "Unattended Machinery Spaces Initial" 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:

- All systems to be prepared for automatic control and adjusted to the correct settings.
- Manual operated valves shall be completely closed or open.
- All electric equipment is functioning and switched on.
- Main propulsion control shall be on the bridge.
- No alarms shall be manual inhibited.
- 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 public address (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 test 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 the survey type "Unattended Machinery Spaces Initial" is to be used as a basis.

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 pre-set intervals following award or renewal of the Classification.

## E. Type Approvals

1. The following installations, equipment's and assemblies are subject to mandatory type testing. **See Guidance for The Approval and Type Approval of Materials and Equipments for Marine Use (Pt.1, Vol.W) Sec.3.V.**

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

- 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 device
- 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 the Surveyor, with the prior consent of BKL.



## Section 8 Sensors, Stand-by Circuits and Remote Control Facilities

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### 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 shut-down 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. Reduction of the operation parameters shall be in accordance with [Section 4.C.12](#).
6. For the design of the stand-by circuits, the provisions set out in [Section 3.D](#). and [Section 4.I](#). 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, reductions and shut-downs, as shown in the [Tables 8.1](#) to [8.10](#), shall be indicated in the machinery alarm system 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 [8.10](#) is made.

## B. Sensors for Main Propulsion Diesel Engines and Turbocharger

### 1. Medium and high-speed engines (trunk piston engines)

Table 8.1 Main propulsion diesel engines (medium and high-speed)

No.	F = Fault L = Low limit H = High limit R = Reduction S = Shut-down T = Trigger Stand-by activation	Remote Indication <sup>11</sup>	Sensor for alarms activation	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
<b>1</b>	<b>Fuel oil system</b>					
1.1	Fuel oil pressure after filter (engine inlet)	X	L	LT		
1.2	Leakage fuel injection pipe		F			
1.3	Common rail fuel oil pressure		L			
1.4	Fuel oil viscosity before injection pumps or Fuel oil temperature before injection pumps <sup>1</sup>		H L			
<b>2</b>	<b>Lubricating oil system</b>					
2.1	Lubricating oil pressure to main bearing and thrust bearing <sup>2</sup>	X	L	LT	LS	
2.2	Lubricating oil filter differential pressure	X	H			
2.3	Temperature of lubricating oil at engine inlet	X	H R			
2.4	Concentration of oil mist in crankcase <sup>3</sup>		H S		H S	
2.5	Flow rate cylinder lubricator. Each apparatus		L R			
2.6	Failure in cylinder lubrication		F R			
2.7	Level in lubrication oil sump tanks <sup>2</sup>		L			
2.8	Fault at lubricating oil automatic filter		F			
2.9	Temperature thrust bearing		H R			
2.10	Common rail servo oil pressure		L			
<b>3</b>	<b>Sea water cooling system</b>					
3.1	Pressure of seawater for cooling	X	L	LT		
<b>4</b>	<b>Fresh water cooling system</b>					
4.1	Cylinder cooling water pressure or flow	X	L R	LT	LS <sup>9</sup>	
4.2	Temperature of cylinder cooling water at each cylinder outlet <sup>2,4</sup>	X	H R			
4.3	Level in coolant expansion tanks		L			
4.4	Oil contamination in cylinder cooling water system <sup>5</sup>		F			
4.5	Pressure of LT (low temperature) freshwater cooling circuit		L			
4.6	Temperature of LT (low temperature) freshwater cooling circuit		H			
4.7	Temperature of cylinder cooling water at engine inlet		L			
<b>5</b>	<b>Scavenge air system</b>					
5.1	Scavenge air temperature <sup>6</sup>		L H			
<b>6</b>	<b>Exhaust gas system</b>					
6.1	Exhaust gas temperature turbocharger inlet and outlet		H			
6.2	Exhaust gas temperature of each cylinder <sup>7</sup>	X	H R			
6.3	Deviation from exhaust gas mean temperature <sup>7</sup>		H			

Table 8.1 Main propulsion diesel engines (medium and high-speed) (continued)

No.	F = <u>F</u> ault L = <u>L</u> ow limit H = <u>H</u> igh limit R = <u>R</u> eduction S = <u>S</u> hut-down T = <u>T</u> rigger Stand-by activation	Remote Indication <sup>11</sup>	Sensor for alarms activation	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
7	Starting and control air systems					
7.1	Control air pressure	X	L			
7.2	Starting air pressure before main shut-off valve <sup>8,10</sup>	X	L			
8	Engine speed	X				
9	Overspeed trip				S	
10	Control-safety-alarm system power supply failure		F			
<sup>1</sup> For heavy fuel oil burning engines only. <sup>2</sup> Individual alarms are to be provided for separate circuits. <sup>3</sup> 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. <sup>4</sup> 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 <sup>5</sup> Where cooling water is used for preheating or cooling fuel, lubricating oil. <sup>6</sup> As alternative, "Water in charge air-duct" instead of low limit. <sup>7</sup> For engines > 500 kW/cyl. <sup>8</sup> For engines with direct reversing capability and also all engines with remote start from the bridge, individual alarm. <sup>9</sup> If possible due to size, otherwise a shut-down for cooling temperature cylinder outlet to be provided when reaching high limit. <sup>10</sup> Where engine started electronically the failure of battery charger is to be alarmed. <sup>11</sup> 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. Slow speed diesel engines (cross-head engines)

Table 8.2 Main propulsion diesel engines (slow-speed)

No.	F = Fault L = Low limit H = High limit R = Reduction S = Shut-down T = Trigger Stand-by activation	Remote Indication <sup>9</sup>	Sensor for alarms activation	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
<b>1</b>	<b>Fuel oil system</b>					
1.1	Fuel oil pressure <b>after filter (engine inlet)</b>	X	L	LT		
1.2	Leakage fuel injection pipe		F			
1.3	Common rail fuel oil pressure		L			
1.4	<b>Fuel oil viscosity before injection pumps or Fuel oil temperature before injection pumps</b>		H L			
<b>2</b>	<b>Lubricating oil system</b>					
2.1	Lubricating oil pressure <b>to main bearing and thrust bearing</b> <sup>1</sup>	X	LR	LT	LS	
2.2	<b>Lubricating oil pressure to crosshead bearing</b> <sup>2</sup>	X	LR	LT	LS	
2.3	Lubricating oil pressure to camshaft <sup>2</sup>		L	LT	LS	
2.4	<b>Lubricating oil temperature to camshaft</b> <sup>2</sup>		H			
2.5	Lubricating oil filter differential pressure	X	H			
2.6	Temperature of lubricating oil at engine inlet		H			
2.7	<b>Thrust bearing pads temperature or bearing outlet temperature</b>		H R		H S	
2.8	Main, crank, crosshead bearing, oil outlet temperature or oil mist concentration in crankcase <sup>3</sup>		H R			
2.9	<b>Flow rate cylinder lubricator. Each apparatus</b>		LR			
2.10	Failure in cylinder lubrication		FR			
2.11	Level in lubrication oil tanks <sup>4</sup>		L			
2.12	Fault at lubricating oil automatic filter		F			
2.13	Common rail servo oil pressure		L			
<b>3</b>	<b>Piston cooling system</b>					
3.1	Piston coolant <b>inlet</b> pressure <sup>5</sup>		LR	LT		
3.2	Piston coolant temperature at each piston outlet		H R			
3.3	Piston coolant flow each piston <sup>6</sup>		LR			
3.4	Level in piston coolant expansion tanks		L			
<b>4</b>	<b>Sea water cooling system</b>					
4.1	Pressure of seawater for cooling		L	LT		
<b>5</b>	<b>Cylinder fresh cooling water system</b>					
5.1	Cylinder cooling water <b>inlet</b> pressure		LR	LT	LS	
5.2	Temperature of cylinder cooling water (from each cylinder) or Cylinder water outlet temperature (general) <sup>7</sup>		H R			
5.3	Oil contamination in cylinder cooling water system <sup>8</sup>		F			
5.4	<b>Level in cylinder coolant expansion tanks</b>		L			
<b>6</b>	<b>Starting and control air systems</b>					
6.1	Control air pressure		L			
6.2	<b>Safety air pressure</b>		L			
6.3	Starting air pressure before main shut-off valve	X	L			

Table 8.2 Main propulsion diesel engines (slow-speed) (continued)

No.	F = Fault L = Low limit H = High limit R = Reduction S = Shut-down T = Trigger Stand-by activation	Remote Indication <sup>9</sup>	Sensor for alarms activation	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
7	<b>Scavenge air system</b>					
7.1	Scavenge air receiver pressure	X				
7.2	Scavenge air box temperature (fire)		H R			
7.3	Scavenge air receiver water level		H			
8	<b>Exhaust gas system</b>					
8.1	Exhaust gas temperature before each turbocharger	X	H			
8.2	Exhaust gas temperature after each turbocharger	X	H			
8.3	Exhaust gas temperature after each cylinder	X	H R			
8.4	Deviation from exhaust gas mean temperature after each cylinder		H			
9	<b>Fuel valve coolant</b>					
9.1	Pressure of fuel valve coolant		L	L T		
9.2	Temperature of fuel valve coolant		H			
9.3	Level of fuel valve coolant in expansion tank		L			
10	<b>Engine speed/direction of rotation</b>	X				
10.1	Wrong direction of rotation (wrong way)		F			
11	<b>Overspeed trip</b>				S	
12	<b>Control-safety-alarm system power supply failure</b>		F			
<sup>1</sup> Individual alarms are to be provided for separate circuits. <sup>2</sup> If separate lubricating oil systems are installed. <sup>3</sup> When required by UR M10.8 or by SOLAS Reg. II-1/47.2 <sup>4</sup> Where separate lubricating oil systems are installed (e.g. camshaft, rocker arms, etc.), individual level alarms are required for the tanks. <sup>5</sup> The slowdown is not required if the coolant is oil taken from the main cooling system of the engine. <sup>6</sup> Where outlet flow cannot be monitored due to engine design, alternative arrangement may be accepted. <sup>7</sup> Where one common cooling space without individual stop valves is employed for all cylinder jackets. <sup>8</sup> Where main engine cooling water is used in fuel and lubricating oil heat exchangers <sup>9</sup> 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.						

### 3. Sensors for Turbocharger

**Table 8.3 Exhaust gas turbocharger/engine driven chargers**

No.	F = <u>F</u> ault L = <u>L</u> ow limit H = <u>H</u> igh limit R = <u>R</u> eduction S = <u>S</u> hut-down T = <u>T</u> rigger Stand-by activation	Local or remote Indication <sup>6</sup>	Sensor for alarms activation	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
<b>1</b>	<b>Turbocharger (Category B)</b>					
1.1	Speed of turbocharger	X	H <sup>4</sup>			X <sup>4</sup>
1.2	Exhaust gas temperature at each turbocharger inlet (High temperature alarms for each cylinder at engine is acceptable <sup>2</sup> )		H <sup>1</sup>			X <sup>1</sup>
1.3	Lubricating oil pressure at turbocharger inlet (only for forced lubrication systems <sup>3</sup> )	X <sup>5</sup>	L			X
<b>2</b>	<b>Turbocharger (Category C)</b>					
2.1	Speed of turbocharger	X	H <sup>4</sup>			X <sup>4</sup>
2.2	Exhaust gas at each turbocharger inlet temperature (High temperature alarms for each cylinder at engine is acceptable <sup>2</sup> )		H			X
2.3	Lubricating oil temperature at turbocharger outlet (if not forced system, oil temperature near bearings)		H			X
2.4	Lubricating oil pressure at turbocharger inlet (only for forced lubrication systems <sup>3</sup> )	X <sup>5</sup>	L			X
<sup>1</sup> For Category B turbochargers, the exhaust gas temperature may be alternatively monitored at the turbocharger outlet, provided that the alarm level is set to a safe level for the turbine and that correlation between inlet and outlet temperatures is substantiated. <sup>2</sup> Alarm and indication of the exhaust gas temperature at turbocharger inlet may be waived if alarm and indication for individual exhaust gas temperature is provided for each cylinder and the alarm level is set to a value safe for the turbocharger. <sup>3</sup> Separate sensors are to be provided if the lubrication oil system of the turbocharger is not integrated with the lubrication oil system of the diesel engine or if it is separated by a throttle or pressure reduction valve from the diesel engine lubrication oil system. <sup>4</sup> On turbocharging systems where turbochargers are activated sequentially, speed monitoring is not required for the turbocharger(s) being activated last in the sequence, provided all turbochargers share the same intake air filter and they are not fitted with waste gates. <sup>5</sup> Only applicable for trunk-piston diesel engine (medium and high-speed) <sup>6</sup> 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 8.4 Main steam plant

No.	F = Fault L = Low limit H = High limit R = Reduction S = Shut-down T = Trigger Stand-by activation	Sensor for alarms activation	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
<b>1</b>	<b>Main steam plant</b>				
1.1	Water level in boilers	L H R			
1.2	Water flow through boilers (in forced circulation boilers)	L R			
1.3	Pressure in feed pipe	L R			
1.4	Steam pressure at superheater outlet	L H R			
1.5	Steam temperature at superheater outlet	L H R			
1.6	Steam temperature at reheater outlet	L H R			
1.7	Steam temperature at internal cooler outlet	L			
1.8	Flue gas concentration	H			
1.9	Fire in the flue gas chambers	F			
1.10	Lubrication oil pressure at turbine and gearbox inlet	L		LS	
1.11	Differential pressure lubrication oil filter	H			
1.12	Lubrication oil temperature at each gearing and turbine bearing	H R			
1.13	Turbine stops longer than allowed	F			
1.14	Gland sealing steam pressure	H R			
1.15	Steam barrier pressure	L H			
1.16	Astern turbine temperature	H R			
1.17	Vibration velocity (turbine)	H R			
1.18	Condenser pressure	H		HS	
1.19	Condensate level in condenser	H		HS	
1.20	Pressure in condenser line	L			
1.21	Salinity of condensate	H			
1.22	Oil contamination of condensate	H			
1.23	Bilge water level at condensate pumps	H			
1.24	Pressure in de-aerator	L H			
1.25	Level in de-aerator	L H			
1.26	Level in distillate tank	L			
1.27	Temperature of the super heater	L H			
1.28	Failure of steam generator	F			
1.29	Level in lubricating oil sump tank	L			
1.30	Lubrication oil gravity tank level	L			
<b>2</b>	<b>Turbogenerators</b>				
2.1	Lubrication oil pressure	L		LS	
2.2	Gland sealing steam pressure	L H			
2.3	Pressure in auxiliary condenser	H			
2.4	Level in auxiliary condenser	H			
2.5	Salinity condensate	H			

## D. Sensors for Propulsion Gas Turbines

Table 8.5 Propulsion gas turbines

No.	F = <u>F</u> ault L = <u>L</u> ow limit H = <u>H</u> igh limit R = <u>R</u> eduction S = <u>S</u> hut-down T = <u>T</u> rigger Stand-by activation	Sensor for alarms activation	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
1	Level in lubrication oil sump tank	L			
2	Level in lubrication oil gravity tank	L			
3	Lubricating oil pressure before turbine <sup>1</sup>	L	LT	LS	
4	Lubricating oil filter differential pressure	H			
5	Lubricating oil temperature before turbine	H			
6	Coolant pressure	L	LT		
7	Fuel pressure	L			
8	Coolant temperature	H			
9	Bearing temperature	H			
10	Failure of flames / igniting flame	F		FS	
11	Vibrations <sup>1</sup>	H		HS	
12	Axial displacement of the rotor	H		HS	
13	Exhaust gas temperature <sup>1</sup>	H			
14	Fuel temperature	H			
15	Automatic starting failure	F			
16	Vacuum pressure at the compressor inlet	H		HS	
17	Low pressure before compressor <sup>1</sup>	L		LS	
18	Speed free turbine	LH		LHS	
19	Speed gas generator	H		HS	
<sup>1</sup> Limits shall be reachable, without achieving a critical condition leading to a shut-down.					



## E. Sensors for Propulsion Plant and Steering Devices

Table 8.6 Propulsion plant (prime mover engine excluded)

No.	F = <u>F</u> ault L = <u>L</u> ow limit H = <u>H</u> igh limit R = <u>R</u> eduction S = <u>S</u> hut-down T = <u>T</u> rigger Stand-by activation	Sensor for alarms	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
<b>1</b>	<b>Main gear</b>				
1.1	Lubricating oil pressure gear input	L R	L T <sup>1</sup>	L S	
1.2	Lubricating oil temperature gear input / after cooler <sup>2</sup>	H R			
1.3	Lubricating oil temperature gear output / before cooler <sup>3</sup>	H R			
1.4	Pressure drop lubricating oil at filter	H			
1.5	Temperature radial bearings <sup>4</sup>	H			
1.6	Temperature gear integrated thrust bearing <sup>5,6</sup>	H R			
1.7	Level in lubrication oil sump tank <sup>11</sup>	L			
1.8	Mechanical / multi disc clutch (stand-alone or gear integrated)				
1.9	Operating pressure	L R	L T		
1.10	Control of unintended slip in engaged condition			L S <sup>7</sup>	
<b>2</b>	<b>Shaft bearings, stern tube</b>				
2.1	Temperature or lub. oil temperature radial bearings <sup>8</sup>	H			
2.2	Temperature or lub. oil temperature thrust bearing <sup>5,8</sup>	H R			
2.3	Temperature aft. Stern tube bearing <sup>9</sup>	H			
2.4	Oil level stern tube storage / gravity tank	L			
2.5	Stern tube bearing lubrication water flow <sup>12</sup>	L			
2.6	Direction of rotation <sup>10</sup>	F			
<b>3</b>	<b>Controllable pitch propeller plant</b>				
3.1	Pressure of hydraulic oil	L	L T <sup>1</sup>		L
3.2	Level of hydraulic oil of control mechanism in tank	L			
3.3	Temperature hydraulic oil	H			
3.4	Pressure drop in filter for hydraulic oil	H			
3.5	Failure / malfunction of CP control	F			
<sup>1</sup> Only when a stand-by pump is recommended <sup>2</sup> For all gears with plane bearings and for gears with roller bearings with a transmitted power > 500 kW. <sup>3</sup> Required only for applications, where no further temperatures are monitored within the gear. <sup>4</sup> Not needed for application with roller bearings <sup>5</sup> Only for the fwd. pads / direction <sup>6</sup> For roller bearing applications may be replaced by monitoring of lubricating oil temperature. <sup>7</sup> 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. <sup>8</sup> Not needed for applications with roller bearings when the shaft diameter is less than 300 mm. <sup>9</sup> 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. <sup>10</sup> For reversible engines only (Direct coupled or for geared plants not equipped with reverse gear stage). <sup>11</sup> Not needed for gears with totally transmitted input torque < 4000 Nm in combination with lubrication oil pressure monitoring <sup>12</sup> Only for seawater lubricated bearings with external water supply. Automatic on/off switching of external water supply depending on flow					

Table 8.7 Steering devices

No.	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
1	<b>Steering gear<sup>1, 2</sup></b>				
1.1	Failure actual steering mode	F			F
1.2	Loss of voltage supply for power unit	F	FT <sup>3</sup>		F
1.3	Overload and failure of one phase of electric drive	F	FT <sup>3, 4</sup>		F
1.4	Low level hydraulic oil tank	L	FT <sup>3, 4</sup>		L
1.5	Loss of voltage supply control unit of steering gear	F	FT <sup>3, 4</sup>		F
1.6	Functional failure of hydraulic system (hydraulic lock)	F	FT <sup>3, 4</sup>		F
1.7	Earth fault on AC and DC circuits	F			F
1.8	Loop failures in closed loop systems, both command and feedback loops (normally short circuit, broken connections and earth faults)	F			F
1.9	Data communication errors	F			F
1.10	Programmable system failures (Hardware and software)	F			F
1.11	Deviation between rudder order and feedback <sup>5</sup>	F			F
<sup>1</sup> 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 OT. <sup>2</sup> For each steering device common alarm in machinery space is acceptable. <sup>3</sup> For oil, gas and chemical tankers of more than 10000 GT the steering capability shall be regained within 45 sec. after a failure within one of the two redundant systems (SOLAS). <sup>4</sup> The defective subsystem is to be stopped and the affected parts shall be isolated. <sup>5</sup> Deviation alarm shall be initiated if the rudder's actual position does not reach the set point within acceptable time limits for the closed loop-control systems (e.g. follow-up control and autopilot). Deviation alarm may be caused by mechanical, hydraulic or electrical failures.					

## F. Sensors for Auxiliary Diesel Engines

Table 8.8 Auxiliary diesel engines

No.	F = <u>F</u> ault L = <u>L</u> ow limit H = <u>H</u> igh limit R = <u>R</u> eduction S = <u>S</u> hut-down T = <u>T</u> rigger Stand-by activation	Sensor for alarms	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
1	<b>Auxiliary diesel engines</b>				
1.1	Pressure of lubricating oil <sup>1</sup>	L		LS	
1.2	Temperature of lubrication oil	H			
1.3	Differential pressure of lubricating oil indicator filter	H			
1.4	Coolant pressure or flow	L			
1.5	Temperature of cooling water or cooling air	H			
1.6	Level of cooling water equalizing tank, if separate circuit	L			
1.7	Pressure of starting air <sup>5</sup>	L			
1.8	Pressure of fuel oil	L			
1.9	Heavy fuel oil viscosity or temperature	LH			
1.10	Leakage in fuel injection pipes	F			
1.11	Overspeed <sup>1</sup>			HS	
1.12	Level of fuel operating tank(s)	L			
1.13	Concentration of oil mist or temperature of engine bearings for engines with power above 2250 kW or with cylinder diameters above 300 mm. <sup>2, 4, 6</sup>	H		HS	
1.14	Exhaust gas temperature of each cylinder <sup>3</sup>	H			
1.15	Deviation from exhaust gas mean temperature <sup>3</sup>	H			
1.16	Common rail fuel oil pressure	L			
1.17	Common rail servo oil pressure	L			
<sup>1</sup> Shut-down only for engines from 220 kW upwards. <sup>2</sup> For high speed engines other methods of surveillance may be agreed with BKI <sup>3</sup> For engines > 500 kW/cyl. <sup>4</sup> One oil mist detector system for each engine having two independent output for initiating the alarm and shut-down would satisfy their requirement for the independence between alarm and shut-down system <sup>5</sup> Where engine is started electronically the failure of the battery charger is to be alarmed. <sup>6</sup> Engine bearing is understood to include all bearings i.e. journal and connecting rod bearings					

## G. Sensors for Fuel, Separator, Generation and Utilization of Heat

**Table 8.9** Fuel oil, separator, generation and utilization of heat

No.	F = <u>F</u> ault L = <u>L</u> ow limit H = <u>H</u> igh limit R = <u>R</u> eduction S = <u>S</u> hut-down T = <u>T</u> rigger Stand-by activation	Sensor for alarms	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
<b>1</b>	<b>Fuel oil</b>				
1.1	Heavy fuel oil viscosity <sup>4</sup>	L H			
1.2	Fuel level (gas blanket) <sup>2</sup> in closed stand pipe	L			
1.3	Fault in automatic fuel oil filter	F			
1.4	Level in fuel oil service tank	L <sup>3</sup>			
1.5	Differential pressure of fuel indicator filter	H			
1.6	Fuel oil temperature in daily service oil fuel tanks and settling tanks <sup>6</sup>	H			
<b>2</b>	<b>Separator system</b>				
2.1	Temperature of separating medium	L H			
2.2	Unintentional opening of drum	F			
2.3	Water in discharge of the separation medium	F			
2.4	Loss of water seal	F			
2.5	Sludge tank level	H			
<b>3</b>	<b>Thermal oil installation</b>				
<b>3.1</b>	<b>Thermal oil system</b>				
3.1.1	Discharge temperature	L			
3.1.2	Level in expansion tank	L H			
3.1.3	Tripping of quick discharge / closing device	F			
<b>3.2</b>	<b>Oil fired heaters</b>				
3.2.1	Temperature at heater	H			
3.2.2	Circulation	L			
3.2.3	Temperature of flue gas	H			
3.2.4	Leakage	F			
<b>3.3</b>	<b>Exhaust gas fired heaters</b>				
3.3.2	Temperature at header	H			
3.3.3	Circulation	L R			
3.3.4	Exhaust gas temperature at heater outlet	H			
3.3.5	Fire in heater	F			
3.3.6	Leakage	F			
<b>4</b>	<b>Auxiliary steam plant</b>				
<b>4.1</b>	<b>Condensate, feed water and steam system</b>				
4.1.1	Steam pressure	L			
4.1.2	Level in condensate tank	L			
4.1.3	Salt content	H			
4.1.4	Oil penetration	F			

**Table 8.9 Fuel oil, separator, generation and utilization of heat (Continued)**

No.	F = <u>F</u> ault L = <u>L</u> ow limit H = <u>H</u> igh limit R = <u>R</u> eduction S = <u>S</u> hut-down T = <u>T</u> rigger Stand-by activation	Sensor for alarms	Sensor for stand-by aggregate	Sensor for safety functions	Individual alarm at the bridge
<b>4.2</b>	<b>Oil fired boiler</b>				
4.2.1	Level of water	L H			
4.2.3	Pressure of steam	H			
4.2.4	Circulation	L			
<b>4.3</b>	<b>Exhaust gas boiler</b>				
4.3.1	Level of water	L H			
4.3.2	Pressure of steam	H			
4.3.3	Fire in exhaust gas boiler (boiler with frame tubes)	F			
<b>4.4</b>	<b>Oil fired system for steam and thermal oil plants</b>				
<b>4.4.1</b>	<b>Fuel supply system</b>				
.1	Fuel oil pressure <sup>1</sup>	L			
.2	Fuel oil temperature / viscosity	L H			
.3	Service tank level	L			
<b>4.4.2</b>	<b>Oil burner</b>				
.1	Fuel oil pressure in pressure atomizer <sup>5</sup>	L			
.2	Atomizing medium pressure	L H			
.3	Rotary cup speed / primary air pressure	L			
.4	Flame disturbance <sup>1</sup>	F			
.5	Combustion air pressure <sup>5</sup>	L			
.6	Induced draught	L			
<b>4.4.3</b>	<b>Evaporator plant</b>				
.1	Salt content of the produced distillate	H			
<sup>1</sup> Reduced and registration for main steam plants <sup>2</sup> Not applicable in the case of automatic gas-venting <sup>3</sup> High level alarm is also required if no suitable overflow arrangement is provided. <sup>4</sup> It may be agreed with BKI to alarm the temperature alternatively. <sup>5</sup> If the fan for combustion air and the pump for fuel oil will be driven by one common motor the realization of one of the stated alarm is sufficient <sup>6</sup> Only if tanks are fitted with heating arrangements and the flash point of the oil fuel can be exceeded					

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

**Table 8.10** Fire alarm systems, electrical plants and others

No.	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
<b>1</b>	<b>Fire alarm system</b>				
1.1	Fire alarm <sup>1</sup>	F			F
1.2	Fault	F			
<b>2</b>	<b>Fixed water-based local fire-fighting system (FWBLAFFS)</b>				
2.1	Pre-alarm	F			
2.2	Released	F			F
2.3	Fault	F			
<b>3</b>	<b>Electrical plant</b>				
3.1	Failure of ship's main	F			
3.2	Disconnection of non-essential consumers	F			
3.3	Generator switch activated	F			
3.4	Low frequency	L			
3.5	Over voltage	H			
3.6	Failure 24 V main charger	F			
3.7	Common fault power management	F			
<b>4</b>	<b>Others</b>				
4.1	Failure of remote control	F			F
4.2	Failure of alarm system / duty alarm system	F			F
4.3	Failure of safety system	F			
4.4	Activation of the safety system	F			
4.5	Override of safety system is activated	F			
4.6	Set / actual values deviation of a remote control	F			
4.7	Automatic start of a stand-by unit <sup>4</sup>	F			
4.8	Fault of a stand-by control unit	F			
4.9	Level of engine room bilge, bilge suction pipe <sup>3</sup>	H			
4.10	Oil content of bilge water after separator	H			
4.11	Switching-on time and frequency of automatic bilge pumps	H			
4.12	Level of fuel overflow tank	H			
4.13	Level leakage oil tank	H			
4.14	Failure of CO <sub>2</sub> -low pressure system	F			
4.15	Failure of compressor for starting air <sup>2</sup>	F			
4.16	System pressure of fire extinguishing system	L			
4.17	Activation of automatic fire extinguishing system	F			F
4.18	Failure of electrical speed governor	F			
<sup>1</sup> Alarm to be optically and acoustically distinguished from other alarms <sup>2</sup> Only if main engine is directly reversible <sup>3</sup> At minimum two separate sensors for alarms at each engine room or department <sup>4</sup> If not started due to normal condition					

## I. Stand-by Circuit and Remote Control of Essential Equipment

**Table 8.11** Stand-by Circuit and Remote Control of Essential Equipment

No.	Plant / System	Stand-by circuit <sup>6</sup>	Starting after shut-down and return of the ship's supply	Remote control for OT-S
<b>1</b>	<b>Diesel engine for propulsion</b>			
1.1	Lubricating oil pumps <sup>1</sup>	×	×	×
1.2	Piston coolant pumps	×	×	×
1.3	High temperature (HT) fresh cooling water pumps	×	×	×
1.4	Low temperature (LT) fresh cooling water pumps	×	×	×
1.5	Sea water cooling pumps	×	×	×
1.6	Fuel valve coolant pumps	×	×	×
1.7	Fuel feeding pumps	×	×	×
1.8	Fuel pressure increasing pumps	×	×	×
<b>2</b>	<b>Gas turbine</b>			
2.1	Lubricating oil pumps	×	×	×
2.2	Coolant pumps	×	×	×
2.3	Fuel feeding pumps	×	×	×
2.4	Fuel pressure increasing pumps	×	×	×
<b>3</b>	<b>Main turbine</b>			
3.1	Lubrication oil pumps	×	×	×
3.2	Condensate pumps	×	×	×
3.3	Condensate transfer pumps	×	×	×
3.4	Air pump, if no steam-jet air ejector fitted	×	×	×
3.5	Auxiliary cooling water pump	×		×
<b>4</b>	<b>Auxiliary diesel engine</b>			
4.1	Fuel feeding pumps	×	×	×
4.1	Cylinder water cooling pumps	×	×	×
<b>5</b>	<b>Steam plant</b>			
5.1	Feedwater pumps	×	×	×
5.2	Circulating pumps	×	×	×
<b>6</b>	<b>Thermal oil system</b>			
6.1	Circulating pumps	×	×	×
<b>7</b>	<b>Oil burning system</b>			
7.1	Fuel feeding pumps	×		×
<b>8</b>	<b>Turbo generator</b>			
8.1	Back-up lubricating pump	×	×	×
<b>9</b>	<b>Pump for gear lubricating oil</b>	×	×	×
<b>10</b>	<b>Pump for power oil controllable pitch propeller</b>	×	×	×
<b>11</b>	<b>Pump for hydraulic oil of steering gear</b>	×	×	×
<b>12</b>	<b>Compressor for starting air</b>	×		×
<b>13</b>	<b>Compressor for control air</b>	×		×
<b>14</b>	<b>Main fire extinguishing pump</b>	×		×
<sup>1</sup> Valid for separate circuit <sup>2</sup> For scoop operation automatic switch-on/switch-off of main coolant pump as a function of the rate of speed as substitution <sup>3</sup> Starting by remote control from bridge <sup>4</sup> Automatic switching on or off depending on pressure <sup>5</sup> For auxiliary steam plant the starting after shut-down and return of the ship's supply is not required <sup>6</sup> Stand-by circuit not required for OT-S Class Notation				

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