RULES FOR
CLASSIFICATION OF

SHIPS

NEWBUILDINGS

SPECIAL EQUIPMENT AND SYSTEMS
ADDITIONAL CLASS

PART 6 CHAPTER 3

PERIODICALLY UNATTENDED MACHINERY SPACE

JANUARY 2004

CONTENTS PAGE

DET NORSKE VERITAS

Veritasveien 1, NO-1322 Høvik, Norway Tel.: +47 67 57 99 00 Fax: +47 67 57 99 11

CHANGES IN THE RULES

General

The present edition of the rules includes additions and amendments decided by the Board as of November 2003, and supersedes the January 2003 edition of the same chapter.

The rule changes come into force 1 July 2004.

This chapter is valid until superseded by a revised chapter. Supplements will not be issued except for an updated list of minor amendments and corrections presented in Pt.0 Ch.1 Sec.3. Pt.0 Ch.1 is normally revised in January and July each year.

Revised chapters will be forwarded to all subscribers to the rules. Buyers of reprints are advised to check the updated list of rule chapters printed in Pt.0 Ch.1 Sec.1 to ensure that the chapter is current.

Main changes

- **General**

This chapter has been revised and aligned with the current Pt.4 Ch.3 Rotating Machinery, Drivers and SOLAS Code of Alarms and Indicators.

- **Sec.1 General Requirements**

— The documentation requirements have been included in the text rather than in Table C1, which has been deleted.

- **Sec.2 System Arrangement**

— Sub-section elements C200 Alarm system on the bridge and C300 Alarm systems in the engineers' accommodation have been revised

- **Sec.3 Class Notation E0**

— As a consequence of the requirements in Pt.4, the previous Table A1 to Table A6 have been revised and replaced by new Table A1 to Table A8. Previous Table A7 and Table A8 has been renumered accordingly.
— A new sub-section D Control of Propulsion Machinery from the Navigation Bridge has been added (SOLAS Ch. II-1/49).
— Renumbered sub-section G Special Requirements for Ships less than 300 Gross Tonnage with Propulsive Output less than 1 000 kW per Engine has been revised and aligned with SOLAS.

Corrections and Clarifications

In addition to the above stated rule requirements, a number of corrections and clarifications have been made in the existing rule text.

Comments to the rules may be sent by e-mail to *rules@dnv.com*
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SECTION 1
GENERAL REQUIREMENTS

A. Classification

A 100 Application

101 The rules in this chapter apply to machinery spaces where arrangements are provided to ensure that the safety of the ship in all sailing conditions, including manoeuvring, and when alongside are equivalent to that of a ship having machinery spaces attended.

Cargo handling is not included.

A 200 Class notations

201 When all machinery and auxiliary systems in the engine room, necessary for the performance of the main functions, as specified in Pt.1 Ch.1 Sec.2, are fitted with instrumentation and automation equipment in compliance with the requirements of Pt.4 Ch.9 and the relevant sections of this chapter, class notations **E0** or **ECO** may be granted.

202 Class notation **E0** which is considered to meet the regulations of the International Convention for the Safety of Life at Sea (SOLAS) for unattended machinery spaces is granted when alarms, required for **E0** in this chapter, are relayed to the bridge and the engineers' accommodation, and a bridge control system for the main propulsion machinery, arranged as specified in Pt.4 Ch.1 Sec.4, and a watch responsibility transfer system are fitted.

203 Class notation **ECO** which is considered to meet the regulations of the International Convention for the Safety of Life at Sea (SOLAS) for continuous supervision from a control station is granted when alarms, required for **ECO** in this chapter, are initiated in an attended centralised control station, and a remote control system for the main propulsion machinery is installed at this station.

Guidance note:

It is not required for class notation **ECO** to have remote control, from the bridge, of main propulsion machinery or any safety functions installed in the engine room other than those required by **1A1**.

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204 The assignment of class notations **E0** and **ECO** is based on the assumptions that:

— engineering staff can attend the machinery space at short notice
— systematic maintenance and functional testing of instrumentation are performed and documented and necessary test equipment is kept on board
— maintenance and testing programs are approved and that a copy stamped by the Society for identification is kept onboard and presented at annual and complete periodical surveys, as specified in Pt.7 Ch.2 Sec.4.

Guidance note:

When considering to what extent availability of spare parts, design and level of redundancy or manual operation facilities should be arranged for, due regard should be taken to the manning level in order to ascertain continuity of operation upon failure of the instrumentation equipment.

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Guidance note:

Normally testing equipment for temperature and pressure simulation should be available onboard. The testing equipment should be sufficient for the tests specified in the maintenance and testing program.

A temperature bath up to 120°C and pressure simulator ranging 0 to 40 bar will be sufficient. For sensors with set point outside these values it is acceptable to test with set points within the above values if in addition they are checked with respect to linearity.

The test equipment should be calibrated regularly, at least annually. Calibration of ship's test equipment may be carried out on board by comparison with a portable "master calibrating kit" which has been brought on board, and in turn has a valid calibration status. The ship's personnel may carry out the calibration and the ship's personnel may sign the documentation of the calibration.

Alternatively, when the surveyor has good reason to believe the test equipment has been calibrated but no evidence thereof can be obtained onboard, a written statement from the Captain or Chief Engineer confirming that the test equipment has been calibrated should be obtained and kept together with the survey documentation in the office files.

Alternatively, consideration may be given to referring to a secondary source as a verification of the primary source. In this case a record of the numerical values of the different test equipment should be kept together with the survey documentation in the office files.

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B. Definitions

B 100 Definitions

101 *Main alarm system* is a system performing signal handling and initiation of an alarm, and communicates with the bridge alarm system, the engineers' alarm and the engineers' watch call system.

102 *Local (sub) alarm systems* is a system performing signal handling and initiates the local alarm, and communicates with the main alarm system.

Guidance note:

The local alarm system may only give visual signal when the audible signal is handled by the main alarm system.

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103 *The extension alarm system* is the main alarm system extension to the engineers' cabins, public spaces and the navigation bridge and shall be in operation when the engine room is unattended.

104 *Engineers' alarm* is an alarm system, which shall be provided to operate from the engine control room or the manoeuvring platform, as appropriate, and shall be clearly audible in the engineers' accommodation.

(SOLAS Reg. II-1/38)

Guidance note:

The engineers' alarm is normally an integral part of the extension alarm system, but may be a separate system.

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C. Documentation

C 100 Plans and particulars

101 In addition to the required documentation in Pt.4 Ch. 9 Sec.1, the following documentation shall be submitted for approval and or information (as applicable):

— extension alarm and watch responsibility system
— pipe and instrumentation drawings (P&ID's) for essential and important machinery systems
— alarm list with cross reference to P&ID's
— control and monitoring systems serving essential and important machinery systems
— fire detection and fire alarm system
— operation and maintenance manuals.

For class notation **ECO**, see Sec.4:

— control station layout
— pipe and instrumentation drawings (P&IDs) for essential and important machinery systems
— alarm list with cross reference to P&IDs
— fire detection and fire alarm system
— periodical test and maintenance manual.

For documentation types see Pt.4 Ch.9 Sec.1.

D. Periodical Test, Operation and Maintenance Manuals

D 100 General

101 Periodical test, operation and maintenance manuals shall be kept on board. For the required content of the manuals, see Pt.4 Ch.9 Sec.1.

Guidance note:
It may be convenient that the operation and maintenance material is arranged as a master manual covering the complete instrumentation and automation installation in the engine room, with reference to particular manuals for the sub-systems.

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102 The plan for periodical test shall show in detail how control, alarm and safety components and systems shall be tested and what shall be observed during the tests.

Columns showing test dates and verification of tests carried out shall be included. The plan shall include:

a) All instrumentation, automation and control systems affecting functions required to be controlled and monitored in this chapter.
b) Test intervals to reflect the consequences of failure involving a particular system. Functional testing of critical alarms should not exceed 3 month intervals. Normally the longest intervals are not to surpass 12 months.

Guidance note:
Critical alarms are defined as monitoring of low lubricating oil pressure, overspeed and crankcase explosive conditions for rotating machinery, if applicable, and water levels in boilers.

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103 On the bridge and at the control stand in the engine room, instructions shall be fitted, stating routines to be followed in connection with transfer of control to and or from the engine room, and precautions to be taken at alarm condition.

SECTION 2
SYSTEM ARRANGEMENT

A. General

A 100 Extent of automation

101 The extent of automation shall be sufficient to permit unattended engine room operation for 24 hours, or for the maximum continuous operation time when less than 24 hours. Normal service at sea and normal manoeuvres are presumed. Normal manoeuvres do not include emergency manoeuvres, where alarm and safety limits may be exceeded.

102 Starting of engine plant and transfer to various operating modes may be accepted as manual operations, if the need for such actions will not arise at short notice.

B. Automatic Control System

B 100 Special requirements

101 Where the bilge pumps are arranged for automatic starting, alarms shall be initiated if the influx of liquid is greater than the pump capacity and when the pump is operating more frequently than what would normally be expected.

102 For reversible engines, the starting air receivers shall be automatically charged.

C. Alarm System

C 100 General

101 A main alarm system shall be installed at the machinery control station in the engine room or in the engine control room, if provided.

102 Local (sub) alarm systems are permitted provided there is one common alarm to the main alarm system from each local alarm system. Local alarm systems may also, on consideration, be permitted to include a safety system, and in such case there shall be at least two separate alarms to the main alarm system from the local alarm system.

The common alarm to the main alarm system shall not be inhibited by acknowledged alarms in the local alarm system, but shall be activated by any new detected alarm by the local alarm system.

103 The alarm system including the extension alarm system shall be continuously powered. In case of loss of the normal power supply, an automatic change over to a continuously available power supply with a capacity for at least 30 minutes is required.

C 200 Alarm system on the bridge

201 During unattended machinery spaces, engine room alarms and indicators on the bridge shall be minimized. When the propulsion machinery is remote controlled from the navigation bridge, only engine room alarms and indicators which requires the attention of the navigation officers shall be activated on the navigation bridge.

202 Any alarm condition in the engine room during unattended machinery spaces operation shall initiate an alarm on the bridge with individual or groupwise indication. The visual alarm signal shall remain present until acknowledged in the engine room.

203 Alarm conditions within one group shall not prevent the initiation of alarms in other groups. New alarms within a group shall not be inhibited by acknowledged existing alarms.

204 The extension alarm system on the bridge and in the accommodation shall be so designed that failures such as loss of power supply or broken cable connection to the main alarm system in the engine room, initiate an alarm.

205 It shall not be possible to reduce the light intensity of alarm indicators on the bridge below the intensity necessary in normal daylight. Automatic adjustment of light intensity based on ambient light conditions is accepted".

206 Power failure to the extension alarm system shall initiate an audible alarm with visual indication.

C 300 Alarm systems in the engineers' accommodation

301 An extension alarm system shall be installed in the watch-keeping engine officer's cabins and all engineers' public spaces as for example day room, gymnasium and such like. Any alarm condition in the main alarm system shall initiate an alarm on the responsible watch-keeping engineers' extension alarm system and in the engineers' public spaces during unattended periods. Acknowledgement in the cabin shall be indicated on the bridge when the engine room is unattended.

302 The extension alarm system shall be activated by the watch responsibility transfer system.

303 When the engine room is unattended, the engineers alarm shall be activated if an alarm has not received attention locally, within a limited time.

(SOLAS Reg. II-1/51.1.3)

Guidance note:

Limited time should normally be understood to be between 1 to 3 minutes.

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C 400 Watch responsibility transfer system

401 A system for activating and deactivating the extension alarm system to the navigation bridge shall be provided.

402 The system shall initiate audible and optical (flashing light) warning at both control positions when watch transfer is requested, and the warning shall remain in operation until acknowledged.

403 The responsibility shall not be transferred before acknowledgement at the receiving end.

404 Indication shall be provided showing which control station has the watch responsibility.

405 Transfer of watch keeping responsibility to the navigating bridge shall not be possible before the extension alarm system has been set to a duty engineer's cabin. The watch keeping responsibility panel shall indicate which engineer is on duty.

406 When the engine room is unattended and the vessel is alongside the quay, it shall be possible to disconnect the extension alarm system to the navigation bridge, without disconnecting the extension alarm system to the accommodation.

D. Safety System

D 100 General

101 The safety system shall cover fault conditions which may develop too fast to be counteracted by manual intervention locally.

102 When two or more safety actions are initiated by one failure condition (e.g. start of standby pump and stop of engine at low lubricating oil pressure), these actions shall be activated at different levels.

The least drastic action shall be activated first.

103 Power failure in the safety system is neither to cause loss of propulsion nor steering functions.

104 Whenever the safety system is activated, alarm shall be initiated.

D 200 Automatic start of pumps

201 Faults in the mechanical or electrical system of the running pump are not to inhibit automatic start of the standby pump.

202 Automatic start of the standby pump shall be initiated by the process parameter which is being monitored, e.g. low pressure signal, and shall be arranged so that the standby pump does not stop automatically when first started («locking circuit»).

203 Manual start and stop of the pumps shall be possible without initiating an alarm for the automatic start of the standby pump.

204 Operating circuits for pump units shall be arranged according to Pt.4 Ch.8.

205 When a pump is standby, this shall be clearly indicated on the switch panel by indicating lamps.

D 300 Automatic stop of auxiliary engines and propulsion machinery

301 External circuitry for safety and alarm shall be arranged such that a failure to any one system or function cannot spread to another system or function. An alarm shall be initiated for voltage failure.

Guidance note:

The systems for safety and alarm should be separately fused. Similarly, automatic stop circuits for individual units should be separately fused.

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302 The safety system shall be arranged so that a single open circuit in wiring between sensors and control unit, or between control unit and actuators, including external stop circuit, does not cause unintentional stop.

Guidance note:

A single system based on normally open contacts can be accepted; alternatively, a system with normally closed contacts where discrimination between loop failure and stop signals is provided.

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303 The requirements of 302 can be waived if the manoeuvrability is maintained after shutdown of one unit, see Pt.4 Ch.9 Sec.3A.

304 In case of an automatic stop of one engine in a multi engien plant, measures shall be taken to avoid overload of the running engine.

305 All parameters which may cause automatic stop shall normally initiate an alarm prior to stop.

Guidance note:

Propulsion machinery is defined as all machinery which will cause loss of the propulsion function if stopped, with exception of main boilers.

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D 400 Automatic stop of oil fired auxiliary boilers

401 Connections between sensors and control unit shall be based upon normally closed contacts, so that an open circuit will lead to shutoff of the oil supply.

402 The parameter causing an automatic stop shall be identified on the control panel.

D 500 Internal communication

501 Internal communication shall be provided according to Pt.3 Ch.3 Sec.12.

E. Fire Safety and Fire Detection and Alarm System

E 100 General

101 A fixed fire detection and fire alarm system of an approved type shall be installed in periodically unattended machinery spaces in accordance with the relevant provisions of SOLAS, II-2, Part C, Reg.7 (Pt.3 Ch.3 Sec.10) shall be installed in periodically unattended machinery spaces.

(SOLAS reg. II-2, Part C, 7.4.1)

102 This fire detection system shall be so designed and the detectors so positioned as to detect rapidly the onset of fire in any part of those spaces and under any normal conditions of operation of the machinery and variations of ventilation as required by the possible range of ambient temperatures. Except in spaces of restricted height and where their use is specially appropriate, detection systems using only thermal detectors shall not be permitted. The detection system shall initiate audible and visual alarms distinct in both respects from the alarms of any other system not indicating fire, in sufficient places to ensure that the alarms are heard and observed on the navigating bridge and by a responsible engineer officer. When the navigating bridge is unmanned the alarm shall sound in a place where a responsible member of the crew is on duty.

(SOLAS reg. II-2, Part C, 4.2)

Guidance note:

Thermal detectors only may be used in workshops adjacent to machinery spaces when the nature of the work being carried out will cause erroneous alarms. This guidance note only applies if the compartments themselves do not contain fuel oil installations.

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103 Fire detectors shall be type approved.

Guidance note:

Where fire detectors are provided with timers (in workshops) for inhibiting the alarm, these should be arranged to automatically reset the alarm upon completion of timer and should not be possible to negate for period exceeding 15 minutes.

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104 Manually operated call points shall be located at the following positions:

— passageways and stairways, including emergency exits, having nearby entrance to engine and boiler rooms
— navigation bridge
— control station in engine room.

Guidance note:

Manual call points should be located as required by SOLAS Ch. II-2.

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105 Start of fire pumps shall be arranged according to the requirements in SOLAS Reg. II-2, Part C, 10.2.1.2.2.2.

SECTION 3
CLASS NOTATION E0

A. Extent of Monitoring

A 100 General

101 The control and monitoring systems shall cover machinery and auxiliary systems in the engine room, necessary for the performance of the main functions, as specified in Pt.1 Ch.1 Sec.2.

102 The parameters to be monitored will depend upon output and type of engine as well as arrangement of machinery plant. Normally, it will be required that the parameters listed in Tables A1 to A10 are monitored additionally to those specified in Pt.4. Other combinations than those listed may be accepted, when the chosen monitoring can detect fault conditions in an equivalent satisfactory manner.

A 200 Safety actions

201 The required safety shutdowns for propulsion systems in Pt.4 shall normally be automatically executed, but manual activation from the bridge of propulsion machinery safety actions except for over speed protection may be accepted if running of the machinery does not jeopardize the safety.

202 For automatic shutdowns that do not protect a propulsion engine from immediate break down an emergency device shall be arranged to override these safety actions.

The override facility shall be arranged such that unintentional operation is prevented and initiate a visual and audible indication when operated.

203 All conditions leading to a shutdown shall generally initiate a pre-warning.

204 For multi-engine propulsion plants, overriding of safety shutdowns is not required if manoeuvrability of the vessel is maintained.

B. Arrangement on the Bridge

B 100 General

101 Individual alarms are required for:

- automatic shutdown of main boiler
- automatic shutdown and/or slowdown of propulsion machinery
- request for manual shutdown and/or slowdown of propulsion machinery
- power failure bridge alarm system
- failure in the remote control systems with respect to propulsion machinery, including controllable pitch propeller if arranged
- failure in the remote control systems with respect to steering
- low starting air pressure for reversible propulsion engines.

102 The propulsion plant shall be restarted after a blackout, either manually from the navigating bridge or automatically. When manual starting from the navigating bridge is arranged, an indication shall be provided when the propulsion can be restarted, i.e., when all systems are in normal operating condition.

The starting arrangement shall be simple to operate. This requirement does not apply to steam propulsion plants, and for propulsion plants arranged such that single failures will not stop the propulsion.

103 Resetting of the propulsion machinery safety system shall be arranged when it is activated at black out. The reset action may either be automatic, or manually activated from the bridge, e.g. by bringing the manoeuvring lever to stop position. The reset shall only be possible when the all applicable parameters are in normal condition.

C. Arrangement in the Engine Room

C 100 General

101 Indicating instruments, alarm displays and manoeuvring devices shall be centralised in a convenient position, in or adjacent to the engine room.

Guidance note:

The layout of instruments in the control desk should comply with generally accepted ergonomic principles. Red lamps should be used only as alarm lamps.

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D. Control of Propulsion Machinery from the Navigation Bridge (SOLAS Reg. II-1/49)

D 100 General

101 In addition to the general requirements in Pt.4 Ch.1 Sec.4 the following shall be complied with.

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

103 Such remote control shall be performed by a single control device for each independent propeller, with automatic performance of all associated services, including where necessary, means of preventing overload of the propulsion machinery.

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

105 Propulsion machinery orders from the navigating bridge shall be indicated in the main machinery control room or at the propulsion machinery control position as appropriate.

106 Remote control of the propulsion machinery shall be possible only from one location at a time; at such locations interconnected control positions are permitted. At each location there shall be an indicator showing which location is in control of the propulsion machinery. The transfer of control between the navigating bridge and machinery space shall be possible only in the main machinery space or in the main machinery control room. The system shall include means to prevent the propelling thrust from altering significantly when transferring control from one location to another.

107 It shall be possible for all machinery essential for the safe operation of the ship to be controlled from a local position, even in the case of failure in any part of the automatic or remote control systems.

108 The design of the remote automatic control system shall be such that in case of its failure an alarm will be given, and the present speed and direction of thrust of the propeller is maintained until local control is in operation.

109 Indicators shall be fitted on the navigating bridge for:

a) propeller speed and direction of rotation in the case of fixed pitch propellers, or

b) propeller speed and pitch position in the case of controllable pitch propellers.

110 The number of consecutive automatic attempts which fail to produce a start shall be limited to safeguard sufficient starting air pressure. An alarm shall be provided indicating low starting air pressure set at a level which still permits starting operations of the propulsion machinery.

Guidance note:

Air should be understood as any stored energy.

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E. Electric Power Supply

E 100 General

101 Arrangements shall be provided to prevent overloading of the generating sets.

Guidance note:

A generating set consists of one electrical generator and its prime mover.

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102 The main source of electrical power shall comply with the following:

— automatic starting and connecting to the main switchboard of the stand-by generator, with automatic restarting of the essential auxiliaries on loss of power, shall be arranged
— connection to the main switchboard to be completed within 30 seconds after loss of power
— In addition, where the electrical power is normally supplied by more than one generator simultaneously in parallel operation, provision shall be made to ensure that, in case of loss of one of these generating sets, the remaining ones are kept in operation to permit propulsion and steering.

103 Standby generating sets are normally to have separate cooling water and lubricating oil pumps. Alternatively, automatic start of standby pumps shall be arranged when they also serve other generating sets.

104 When the manoeuvrability of the ship is independent of electric power, the requirements of 102 do not apply.

E 200 Secondary distribution systems

201 For essential consumers with power supply from secondary distribution systems, precautions against power failure shall be similar to those taken for units having power supply from the main system. E.g., the following means may be applied:

— adequate automatic emergency lighting for access to standby transformer for the lighting system and operating gear for manual connection
— automatic connection of standby transformer
— parallel connection of a sufficient number of transformers and arrangement for selective disconnection
— automatic connection of emergency source of power
— dividing the system in two or more circuits with automatic switchover.

In this context, essential consumers are units and equipment necessary for manoeuvring of the ship, including navigation lights and sufficient lighting (either as part of the normal lighting or as separate emergency lighting) in the engine room, on the bridge, in the chart room, in all passageways and stairways of the accommodation.

F. Fire Safety

F 100 General

101 Where the Society finds it necessary, oil fuel and lubricating oil pressure pipelines shall be screened or otherwise suitably protected to avoid as far as practicable oil spray or leakages on to hot surfaces or into machinery air intakes. Fuel oil injection pipes on all engines, irrespective of cylinder bore, shall be effectively shielded and secured. The number of joints in such piping systems shall be kept to a minimum and, where practicable, leakages from high pressure oil fuel pipes shall be collected and safe drainage to a collecting tank shall be provided (see Pt.4 Ch.3 Sec.1 Table E1 and Table E2).

G. Special Requirements for Ships less than 300 Gross Tonnage with Propulsive Output less than 1000 kW per Engine

G 100 General

Guidance note:

The requirements in A, B, C, E and F do not apply.

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G 200 Extent of monitoring

201 An alarm shall be initiated for the following conditions:

— fire in engine room
— bilge level, high
— power failure, alarm and remote control system
— for drivers, power transmissions and driven units according to Pt.4 Ch.3, Pt.4 Ch.4 and Pt.4 Ch.5.

Main and auxiliary engines: See Pt.4 Ch.3.

G 300 Arrangement on the bridge and engineers' accommodation

301 All alarms in the engine room shall initiate an alarm on the navigating bridge, and engineers' accommodation individual or collective.

G 400 Fire safety

401 Fuel oil injection pipes on all engines, irrespective of cylinder bore, shall be effectively shielded and clamped.

G 500 Fire alarm system

501 The ship shall have an electric fire alarm system. The electric fire alarm system shall be initiated in the event of fire in the engine room and or boiler room.

Guidance note:

The fire detectors may be arranged as a single loop provided it is normally closed.

The fire detectors loop(s) may be connected to the machinery alarm system provided separate indication on the navigating bridge is arranged.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

Table A1 Control and monitoring of propulsion engines

System	*Item*	*Valid for engine type [1]*	*Gr 1 Indication alarm load reduction*	*Gr 2 Automatic start of stand-by pump with alarm [2]*	*Gr 3 Shut down with alarm*	*Comments*
1.0 Fuel oil system	*Leakage from jacketed high pressure pipes*	*C, T*	*A*			*Level monitoring of leakage tank or equivalent.*
	Fuel oil pressure after filter (engine inlet)		*LA*	AS		
	High/low temperature or viscosity of heavy fuel		A			
2.0 Lubricating oil system	*Lubrication oil to all bearings, inlet pressure [3]*	*C, T*	*IR, IL, LA, LR*	*AS*	SH	
	Lubrication oil to all bearings, outlet temperature [3]		*IR, IL, HA*			
	Thrust bearing metal temperature	*C*	*IR, HA, LR*		SH	
	Cylinder lubricating flow	T	LA, LR			At least one measuring point for each lubricator unit.
3.0 Turbocharger system	*Turbocharger lubrication oil inlet pressure*	*C, T*	*IR, IL, LA*			*Applicable if separately forced lubrication or if turbocharger lubrication is part of engine main lubrication system but separated by pump, throttle or pressure reduction valve.*
	Turbocharger lubrication oil outlet temperature		*IR, HA*			*Applicable only when the T/C is served by group of cylinders > 2 500 kW.*
	Speed of turbocharger		*IR, HA*			*Applicable only when the T/C is served by group of cylinders > 1 000 kW.*
4.0 Piston cooling system	*Piston coolant inlet pressure (common)*	*C*	*IR or IL, LA, LR*	*AS*		*Load reduction and automatic start of stand-by pump is not required if the coolant is oil taken from the main lubrication oil system of the engine.*
	Piston coolant outlet flow each cylinder		A, *LR*			
5.0 Cylinder cooling medium	*Cylinder cooling inlet pressure or flow*	*C, T*	*IR or IL, LA, LR*	AS		*Monitoring of expansion tank level, with alarm at low level, is an acceptable alternative for engines with cylinder power equal to or less than 130 kW.*
	Cylinder cooling outlet temperature		*IR or IL, HA, LR*			*Temperature to be monitored for each cylinder if individual stop valves are fitted for the cylinder jackets, otherwise main outlet.* For trunk engines, two separate sensors are required for alarm and slow down.
6.0 Starting and control air systems	*Control air reservoir pressure (if arranged)*	*C, T*	*IR or IL, LA*			
	Starting air pressure		IR, IL, LA			Before starting valve.
6.1 Pneumatic operation of exhaust valve	*Exhaust gas valve air spring pressure*	*C*	*IR or IL, LA*			*Pressure readings are to be taken at the supply line locally at the engine.*
7.0 Charge air system	*Charge air pressure*	*C, T*	*IR*			
	Charge air temperature (fire)	*C*	HA, *LR*			
8.0 Exhaust gas system	*Exhaust gas temperature after each cylinder [4, 5]*	*C, T*	*IR, HA, LR*			
	Exhaust gas temperature after each cylinder. Deviation from average [4]		*IR, HA, LR*			*Chosen safety action (LR) depends on permissible misfiring condition.*
	Exhaust gas temperature before T/C [6, 7]		*IR, HA, LR*			*The safety action (LR) is only required when the T/C is served by group of cylinders > 2 500 kW.*

Table A1 Control and monitoring of propulsion engines
(Continued)

System	*Item*	*Valid for engine type* [1]	*Gr 1 Indication alarm load reduction*	*Gr 2 Automatic start of stand-by pump with alarm* [2]	*Gr 3 Shut down with alarm*	*Comments*
9.0 Hydraulic oil system	*Leakage from jacketed high pressure pipes for hydraulic operation of valves*	*C, T*	*A*			*Level monitoring of leakage tank or equivalent.*
10.0/11.0 Engine speed/direction of rotation	*Engine speed/direction of rotation*	*C, T*	*IL, IR,*			
	Over speed protection				SH	
	Excessive time within barred speed range [8]	*C*	*A*			
12.0 Chain tension	*Position feeler "sensor"*	*C*	*IL*			*Where applicable.*
13.0 Crankcase explosive condition	*Crankcase protection* [9]	*C, T*	*LR*		SH	*Applicable to engines of 2 250 kW and above, or with cylinder diameter > 300 mm.* Shut down is required for trunk engines.
14.0 Sea cooling water	Cooling water pressure	C, T	LA	AS		
15.0 Fuel valve cooling medium	Pressure	C, T	LA	AS		If installed.
	Temperature		HA			

Gr 1: Common sensor for indication, alarm, load reduction
Gr 2: Sensor for automatic start of standby pump
Gr 3: Sensor for shut down

IR = Remote indication (presentation of values)
IL = Local indication (presentation of values)
LA = Alarm for low value
HA = Alarm for high value
A = Alarm activated
AS = Automatic start of standby pump with alarm
LR = Alarm with request for load reduction, i.e. either manual or automatic slow down (r.p.m. reduction) or alternative means of load reduction (e.g. pitch reduction), whichever is relevant
SH = Shut down

1) C = Crosshead engine, T = Trunk engine.

2) To be provided when stand-by pump is required, see Pt.4 Ch.3 Sec.1 B1002 and Pt.4 Ch.1 Sec.3 B300.

3) Pressure and temperature to be monitored for all inlets to main bearings, crosshead bearings and camshaft bearings where pressure and temperature may differ due to presence of pumps, throttles or pressure reduction valves.

4) Individual exhaust temperature when cylinder power > 130 kW. See Pt.4 Ch.3 Sec.1 E103 for possible omissions of this requirement.

5) Alarm with request for load reduction to be given in case of excessive average exhaust gas temperature. This applies when there is no separate sensor before T/C, and the T/C is served by a group of cylinders > 1 000 kW. The alarm level must be set with due consideration to safe operation of T/C.

6) Applicable only when the T/C is served by a group of cylinders > 1 000 kW and if no individual exhaust gas temperature for each cylinder.

7) Temperature measurement after turbine is accepted for T/C served by a group of cylinders < 2 500 kW, provided that the alarm levels are set to safeguard the T/C. The alarm level shall be confirmed by the T/C manufacturer.

8) When driving in barred speed range in excess of approved maximum duration set by torsional vibration level in the shafting (where deemed necessary, limitations in duration will be given in connection approval of torsional vibration analysis). This safety device will only be required when so stated in connection with approval of torsional vibration analysis.

9) For trunk engines:

Either a) 'Oil mist concentration' or b) 'Temperature monitoring of main- and crank bearings combined with crank case pressure monitoring'. Other methods, like e.g. ´Crank case pressure monitoring´ combined with either 'Oil splash temperature deviation' or d) 'Metal particle detection' (shunt to filter) may be approved provided their capability with regard to risk of false alarms and speed of detection is proven.

For crosshead engines:

Oil mist concentration or temperature monitoring of main-, crank- and crosshead bearings together with other relevant positions, or other methods may be applied as additional measures of preventing crankcase explosions. These additional measures are optional.

Italic text in table = requirements are covered by Pt.4 Ch.3

Table A2 Control and monitoring of propulsion turbines					
System	*Item*	*Gr 1 Indication alarm load reduction*	*Gr 2 Automatic start of stand-by pump with alarm*	*Gr 3 Shut down with alarm*	*Comment*
1.0 Lubricating oil	*Inlet pressure (after filter)*	*IR, IL, LA*	*AS*	*SH*	
	Inlet temperature	*IR, HA*			
	Filter differential pressure	*IR, HA*			
	Level in system tank	*LA*			
2.0 Bearings	*Bearing temperature*	*IR, HA*			
3.0 Turbine speed	*Overspeed* 1)				
4.0 Condenser system	*Vacuum*	*IR, LA*		*SH*	
	Vacuum pump stopped		*AS*		
	Level	*IR, HA*	*AS*	*SH*	
	Level	*IR, LA* 2)			
	Salinity	*HA*			
5.0 Cooling water (main condenser)	*Inlet/outlet differential pressure*	*IR, HA*	*AS*		
6.0 Turning gear	*Failed*	*A*			Slow-turning arrangement.
7.0 Gland steam	*Pressure*	*IR, LA, HA*			
	Exhaust fan stopped	*A*			
8.0 Hydraulic system	*Pressure*	*IR, LA*	*AS*		
9.0 Vibration	*Level*	*HA*		*SH*	
10.0 Rotor	*Axial displacement*	*IR, HA*		*SH*	

Gr 1: Common sensor for indication, alarm, load reduction
Gr 2: Sensor for automatic start of standby pump
Gr 3: Sensor for shut down

IR = Remote indication (presentation of values)
IL = Local indication (presentation of values)
LA = Alarm for low value
HA = Alarm for high value
A = Alarm activated
AS = Automatic start of standby pump with alarm
SH = Shut down

1) See Pt.4 Ch.3 Sec.3 E200

2) If non-cavitating condensate pump.

Italic text in table = requirements are covered by Pt.4 Ch.3

Table A3 Control and monitoring of main steam and feed water installation			
	Gr 1 *Indication* *Alarm* *Load reduction*	*Gr 2* *Automatic start of stand-by pump with alarm* [1]	*Gr 3* *Shut down of boiler with alarm*
1.0 Water system			
Water level, high	HA		
Water level, high	HA		SH [7]
Water level, low	LA		
Water level, low			SH
Water circulation [2]			SH
2.0 Combustion air			
Supply fan stopped			SH
3.0 Rotating air heater			
Motor stopped	A		
4.0 Uptake gas			
Gas temperature [3]	HA		
5.0 Fuel oil system			
Fuel oil pressure	LA	AS	
Fuel oil temperature, or viscosity [4]	LA, HA		
6.0 Oil burner, atomising medium			
Atomising medium, pressure	LA		
7.0 Steam system			
Steam pressure,	LA, HA, LR		
Steam temperature [5]	HA		
8.0 Ignition/flame			
Failed ignition and/or flame failure			SH
9.0 Feed water system			
Atmospheric drain tank, level	LA, HA		
Deaerator, level	LA, HA		
Deaerator, pressure	LA, HA		
10.0 Feed water			
Temperature [8]	HA		
Pressure	LA	AS	
Feed water temperature	HA		
11.0 High pressure feed water			
Level	HA		
12.0 Fresh water generator			
Fresh water outlet, salinity	HA [6]		

Gr 1: Common sensor for indication, alarm, load reduction
Gr 2: Sensor for automatic start of standby pump
Gr 3: Sensor for shut down

LA = Alarm for low value
HA = Alarm for high value
A = Alarm activated
AS = Automatic start of standby pump with alarm
LR = Load reduction, turbin slow down
SH = Shut down

1) To be provided when standby pump is required, see Pt.4 Ch.1 Sec.3 B300
2) To be provided for forced circulation boilers
3) To be provided for fire detection
4) To be provided for heavy fuel oil
5) For superheated and de superheated steam outlet (external de super heaters)
6) Automatic stop of generator or by-passing of consumers
7) Turbine shut down
8) Outlet of ejector cooler/gland condenser

Table A4 Monitoring of shafting, propeller, gear, clutch and elastic couplings				
	Gr 1 Indication alarm load reduction	*Gr 2 Automatic start of stand-by pump with alarm* [1]	*Gr 3 Shut down with alarm*	*Comment*
1.0 Shafting				
Separate thrust bearings, temperature	*IL or IR, HA*			*Alarm to be provided for shaft power > 10 000 kW. Sensor to be placed in the bearing metal or for pads, in the oil outlet. Maximum permissible temperature to be marked on the indicators.*
Oil lubricated fluid film bearings, temperature (plain shaft and stern tube bearing)	*IL or IR, HA*			*Alarm to be provided for shaft power > 10 000 kW. Sensor to be located near the bearing surface at the area of highest load. Maximum permissible temperature to be marked on the indicators.*
Stern tube lubricating oil tank, level	*LA*			
Stern tube lubricating oil, pressure or flow	*LA*			*Applicable for forced lubrication.*
2.0 Servo oil for CP-propeller				
Pressure	*IL, IR, LA*	*AS*		*The indicators shall be able to show sudden peaks in servo pressure.*
Temperature	*IL, HA*			*For shaft power > 1 500 kW.*
Level	*IL, LA*			
Differential pressure over filter	*HA*			
3.0 Gear bearing and lubricating oil				
Oil lubricated fluid film bearings (axial and radial) temperature	*IR, HA*			*Applicable for gears with a total transmitted power of 5 MW or more.*
Thrust bearing, temperature	*IR, HA*, LR			*Applicable for gears with a total transmitted power of 5 MW or more. Sensor to be placed in the bearing metal or for pads in the oil outlet.*
Lubricating oil, pressure	*IL, IR, LA*	*AS*	SH	*At bearings and spray if applicable.* Shut down or clutch disengagement.
Lubricating oil, temperature	*IL, IR*			*At inlet to bearings and spray as well as in the oil sump.*
4.0 Integrated clutch activating media				
Hydraulic oil/pneumatic pressure	*IL, IR, LA, LR*	*AS*		
5.0 Twist of elastic couplings				
Angular twist amplitudes	*IR, HA*			*Applicable when failure of the elastic element leads to loss of torque transmission.* [2]
Mean twist angle	*IR, HA*			

Gr 1: Common sensor for indication, alarm, load reduction
Gr 2: Sensor for automatic start of standby pump
Gr 3: Sensor for shut down

IL = Local indication (presentation of values), i.e. in vicinity of the monitored component
IR = Remote indication (presentation of values), i.e. engine control room or other centralized control station
LA = Alarm for low value
HA = Alarm for high value
AS = Automatic start of standby pump with alarm
LR = Alarm with request for load reduction, i.e. either manual or automatic slow down (r.p.m. reduction) or alternative means of load reduction (e.g. pitch reduction), whichever is relevant
SH = Shut down

1) To be provided when standby pump is required, see Pt.4 Ch.1 Sec.3 B300

2) Exemption may be accepted for couplings that are of a design that enables the full torque to be transmitted in the event of failure of the elastic elements. Such emergency claw devices are not “getting home” devices, but only meant for temporary emergency in order to prevent loss of manoeuvrability in harbours, rivers, etc

Italic text in table = requirements are covered by Pt.4 Ch.4.

Table A5 Control and monitoring of auxiliary engines					
System	*Item*	*Gr 1 Indication Alarm Load reduction*	*Gr 2 Automatic start of stand-by pump with alarm 1)*	*Gr 3 Shut down with alarm*	*Comment*
1.0 Fuel oil system	*Leakage from jacketed high pressure pipes*	*A*			*Level monitoring of leakage tank or equivalent.*
	Fuel oil pressure	LA	AS		If dedicated heavy fuel oil treatment system.
	High/low temperature or viscosity of heavy fuel	A			
2.0 Lubricating oil system	*Lubrication oil to main bearings, pressure*	*IR or IL, LA, LR*	*AS*	SH	Automatic shut down for electric power generating engines. *Shut down is accepted as an alternative to load reduction (LR) also for other auxiliary engines.*
	Lubrication oil to main bearings, temperature	*IR or IL, HA*			
3.0 Turbocharger system	*Speed of turbocharger*	*IR or IL, HA*			*Applicable only when the T/C is served by group of cylinders > 1 000 kW.*
4.0 Cylinder cooling medium	*Cylinder cooling inlet pressure or flow*	*IR or IL, LA*			*Monitoring of expansion tank level, with alarm at low level, is an acceptable alternative for engines with cylinder power equal to or less than 130 kW.*
	Cylinder cooling outlet temperature	*IR or IL, HA, LR*		SH	Automatic shut down for electric power generating engines.
5.0 Starting air system	Start air pressure	LA			For electric power generating engines.
6.0 Exhaust gas system	*Exhaust gas temperature after each cylinder 2)*	*IR or IL, HA, LR 3)*		SH	Automatic shut down for electric power generating engines.
	Exhaust gas temperature after each cylinder. Deviation from average 2)	*IR or IL, HA, LR*			*Chosen safety action (LR) depends on permissible misfiring condition.* Automatic shut down for electric power generating engines.
	Exhaust gas temperature before T/C 4), 5)	*IR or IL, HA, LR*			*The safety action (LR) is only required when the T/C is served by group of cylinders > 2 500 kW.* Automatic shut down for electric power generating engines.
7.0 Hydraulic oil system	*Leakage from jacketed high pressure pipes for hydraulic operation of valves*	*A*			
8.0/9.0 Engine speed	*Engine speed*	*IR*			*For engines other than for electric power generation, local indication is an acceptable alternative.*
	Over speed protection			*SH*	
10.0 Crankcase explosive condition	*Crankcase protection 6)*	*LR*		*SH*	*Applicable to engines of 2 250 kW and above, or with cylinder diameter > 300 mm.* Automatic shut down for electric power generating engines. *Shut down is also accepted as alternative to load reduction (LR) also for other auxiliary engines.*

Table A5 Control and monitoring of auxiliary engines (Continued)

Gr 1: Common sensor for indication, alarm, load reduction
Gr 2: Sensor for automatic start of standby pump
Gr 3: Sensor for shut down

IR = Remote indication (presentation of values)
IL = Local indication (presentation of values)
LA = Alarm for low value
HA = Alarm for high value
A = Alarm activated
AS = Automatic start of standby pump with alarm
LR = Alarm with request for either manual or automatic load reduction. For auxiliary engines other than prime mover of generators, slow down may be accepted (depending on application) as alternative means of load reduction
SH = Shut down

1) To be provided when stand-by pump is required, see Pt.4 Ch.1 Sec.3 B300.

2) Individual exhaust temperature when cylinder power > 130 kW. See Pt.4 Ch.3 Sec.1 E103 for possible omission of this requirement.

3) Alarm with request for load reduction to be given in case of excessive average exhaust gas temperature. This applies when there is no separate sensor before T/C, and the T/C is served by a group of cylinders > 1000 kW. The alarm level must be set with due considerations to safe operation of T/C.

4) Applicable only when the T/C is served by a group of cylinders > 1000 kW and if no individual exhaust gas temperature for each cylinder. The alarm level must be set with due considerations to safe operation of T/C.

5) Temperature measurement after turbine is accepted for T/C served by a group of cylinders < 2500 kW, provided that the alarm levels are set to safeguard the T/C. The alarm level shall be confirmed by the T/C manufacturer.

6) Either a) 'Oil mist concentration' or b) 'Temperature monitoring of main- and crank bearings combined with crank case pressure monitoring'. Other methods, like e.g. ´Crank case pressure monitoring´ combined with either 'Oil splash temperature deviation' or 'Metal particle detection' (shunt to filter) may be approved provided their capability with regard to risk of false alarms and speed of detection is proven.

Italic text in table = requirements are covered by Pt.4 Ch.3

Table A6 Control and monitoring of auxiliary turbines

System	*Item*	*Gr 1 Indication Alarm Load reduction*	*Gr 2 Automatic start of stand-by pump with alarm*	*Gr 3 Shut down with alarm*	*Comment*
1.0 Lubricating oil	*Inlet pressure (after filter)*	*IR, IL, LA*		*SH*	
	Inlet temperature	*IR, HA*			
	Level in system tank	*LA*			
2.0 Turbine speed	*Overspeed* [1)]				
3.0 Condenser system	*Pressure*	*IR, HA,*		*SH*	
	Level	HA	AS		If vacuum condenser.
4.0 Steam inlet	*Pressure*	*IR, LA*			
5.0 Rotor	*Axial displacement*	*IR, HA*		*SH*	Multistage turbines.

Gr 1: Common sensor for indication, alarm, load reduction
Gr 2: Sensor for automatic start of standby pump
Gr 3: Sensor for shut down

IR = Remote indication (presentation of values)
IL = Local indication (presentation of values)
LA = Alarm for low value
HA = Alarm for high value
A = Alarm activated
AS = Automatic start of standby pump with alarm
LR = Load reduction
SH = Shut down

1) See Pt.4 Ch.3 Sec.3 E200.

Italic text in table = requirements are covered by Pt.4 Ch.3

Table A7 Monitored parameters for auxiliary boiler plant			
	Gr 1 *Indication* *Alarm* *Slow down*	*Gr 2* *Automatic start of stand-by pump with alarm* [1]	*Gr 3* *Shut down with alarm*
1.0 Water, not double pressure boilers			
Water level	*LA, HA*		
Water level, low			*SH*
2.0 Water, double pressure boilers			
Water level, primary system	*LA*		*SH*
Water level, secondary system	*LA, HA*		
3.0 Circulation			
Circulation stopped [1]			*SH*
4.0 Combustion air supply			
Fan stopped			*SH*
5.0 Heavy fuel oil system			
Temperature or viscosity [2]	*LA, HA*		
6.0 Steam			
Steam pressure	*HA*		*SH* [3]
Steam temperature [4]	*HA*		
7.0 Uptake			
Uptake temperature [5]			SH
8.0 Feed water system			
Feed water, salinity [6]	HA		
Feed water, oil contamination [7]	HA		
9.0 Condenser			
Condenser pressure	HA		
10.0 Ignition/flame			
Ignition/flame failure [8]			*SH*

Gr 1: Common sensor for indication, alarm, slow down
Gr 2: Sensor for automatic start of standby pump
Gr 3: Sensor for shut down

LA = Alarm for low value
HA = Alarm for high value
A = Alarm activated
AS = Automatic start of standby pump with alarm
SL = Slow down
SH = Shut down

1) Forced circulation boilers.

2) For heavy fuel oil.

3) When the automatic control system does not cover the entire load range from zero load.

4) For superheated steam > 350°C.

5) When heat exchangers are integral with the boiler. For fire detection.

6) Boiler pressure > 20 bar.

7) When steam is used in fuel and lubrication oil heat exchangers.

8) Separate monitoring and fuel shut off for each burner.

Italic text in table = requirements are covered by Pt.4 Ch.7 Sec.7 Table B1.

Table A8 Control and monitoring for electrical power plant			
	Gr 1 *Indication* *Alarm* *Load reduction*	*Gr 2* *Automatic start of stand-by pump with alarm*	*Gr 3* *Shut down* *With alarm*
1.0 Generator			
Lubricating oil, pressure [1)]	LA		
Voltage	LA, HA		
Frequency	LA		
Disconnection of nonessential consumers	A		

Gr 1: Common sensor for indication, alarm, load reduction
Gr 2: Sensor for automatic start of standby pump
Gr 3: Sensor for shut down

LA = Alarm for low value
HA = Alarm for high value
A = Alarm activated
AS = Automatic start of standby pump with alarm
LR = Load reduction
SH = Shut down

1) To be provided if separate system.

Table A9 Monitoring of miscellaneous objects		
Item	*Alarm*	*Comments*
Bilges and bilge wells Level, engine room, high	 x	2 independent alarm circuits. Minimum 2 detectors.
Purifiers Temperature, oil inlet, high Temperature, oil inlet, low Waterseal, loss	 x x x	 For heavy fuel oil.
Soot-blowers, sequence stopped	x	
Automatic control system, power failure Alarm and safety system, power failure Remote control system, power failure	x x x	Electric, pneumatic, hydraulic.
Fire alarm systems, failure	x	

Table A10 Monitoring of tanks		
Item	*Alarm*	*Comments*
Sludge and drain tanks, level, high	x	When automatic pumping up of tanks is arranged, alarm shall be released if the level exceeds safe level.
Service tanks, level, low	x	
Expansion tanks, level, low	x	
Circulating tanks, level, low	x	
Fuel oil drain collecting tank, level, high	x	

SECTION 4
CLASS NOTATION ECO

A. General Requirements

A 100 Application

101 This section applies to machinery operation with continuous supervision from a centralised control station. The control station shall provide control and monitoring devices necessary to make the machinery operation as safe and effective as it would be under direct supervision.

B. Control Station

B 100 Arrangement

101 The arrangement shall be such that all supervisions and manual operations which are necessary for safe operation of the machinery plant can be carried out at the control station. This will imply that stopping of machinery, starting of standby units etc. in case of machinery faults shall be possible from the control station if not automatically carried out.

102 The control station shall be located in the engine room or in its close proximity. The control station may be arranged on or adjacent to navigating bridge provided it does not interfere with the navigating bridge control positions, and an additional centralised control position is arranged in or adjacent to the engine room. This control position shall permit some machinery control and monitoring facilities as required in A101.

C. System Arrangement

C 100 General

101 The requirements of Sec.2 shall be complied with to the extent applicable.

C 200 Alarm system

201 A system of alarm displays shall be provided in the centralised control station for easy identification of machinery faults.

202 An extension alarm system to the navigation bridge and the engineers' accommodation is not required.

C 300 Safety system

301 The safety systems specified in Sec.2 D can be omitted with the exception of the safety functions required in Pt.4. Corrective actions at machinery faults are presumed to be carried out manually.

C 400 Remote control system

401 Propulsion machinery shall be arranged for remote control from the centralised control station. The requirements given in Sec.2 and Ch.1 Sec.5 shall be complied with to the extent applicable.

C 500 Fire alarm system

501 The fire alarm system shall satisfy the requirement of Sec.2 E.

D. Extent of Monitoring

D 100 General

101 Monitoring of machinery shall comply with the requirements in Sec.3 and Pt.4 Chs.3, 4 and 5.

SECTION 5
SURVEY

A. General

A 100 Trials

101 Upon completion of the installation, trials shall be carried out alongside quay and at sea in the presence of the surveyor.

102 The sea trials should be reserved solely for testing of the automatic and the remote control systems, and the fire alarm system. Other tests should be completed alongside quay.

103 The sea trials shall include a four hours continuous operation with unattended machinery spaces.

Agreement shall be made in advance in each case for personnel that will be present in the control room.

Guidance note:
Personnel for ordinary upkeep and control of the machinery are not to be present in the engine room. Special measurements can be carried out according to agreement, e.g. noise measurements.

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104 A detailed test programme, including expected test results, shall be prepared and submitted for approval well in advance of the trials. The programme shall be kept onboard, all filled in and signed by the surveyor upon completion of the trials.

105 Recording of important automatically controlled parameters may be required as part of the testing.

A 200 Monitoring system

201 Failure conditions shall be simulated as realistically as possible, preferably by letting the monitored parameters exceed the alarm and safety limits. Alternatively, when lack of space on an engine prevents the installation of test valves for pressure transmitters and or thermometer wells for analogue temperature elements, a system for ensuring that both electronic and sensor system part is in order without the use of pressure or temperature calibrators may be accepted. This system shall be quick and easy to use, and be developed and documented by the engine manufacturer. It may only be used in connection with sensors with an analogue value output. The system shall be approved by DNV before testing commences.

The alarm and safety limits shall be recorded in the test programme.

Guidance note:
Test methods:

1) Analogue sensors may be calibrated by in situ comparison to indicating instruments installed close to the sensors. When the deviation in reading is more than 5%, a more precise calibration is necessary.
2) Changing set point to the present system value during normal running may be an acceptable system test method for computer based systems only, provided sensor connection check has been performed separately.
3) It will not be acceptable to change a set point by e.g. potentiometer adjustment to simulate fault conditions.

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202 Any calibration of sensors prior to installation onboard shall be approved by the surveyor.

A 300 Automatic control systems

301 Automatic control systems shall be tested by varying the parameters having effect upon the controlled process. As far as practicable it shall be verified that all normal control ranges are covered.

Guidance note:
Observation of the automatic control system performance during the tests specified under B for the remote control system will normally be accepted as adequate testing.

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A 400 Electric power generating system

401 At bridge control and half speed ahead, simulate a fault condition causing automatic stop of electric power generator.

402 For plants with automatic start and connection of standby unit, check restart of all essential auxiliaries, and that the bridge control system is again operative without manual intervention in the engine room.

403 For plants with more than one generator running in parallel, it shall be checked that the stopped unit is automatically disconnected from the switchboard, and that the generator capacity of the remaining units is sufficient for propulsion and steering functions after tripping of non-essential consumers.

404 Verify that it is possible to start the propulsion machinery from the bridge unless automatically started after blackout. (see Sec.3 B103).

A 500 Fire alarm system

501 After installation the system shall be tested under varying conditions of engine operation and ventilation.

(SOLAS Reg. II-2/14.3).

Guidance note:
The test should be performed with all machinery and ventilation running in normal sea going conditions during the sea trial by means of smoke released in positions of high fire risk.

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A 600 Remote control system

601 Testing of the remote control system for the propulsion machinery shall be carried out at sea. Prior to testing, the propulsion machinery shall run for at least 1 hour.

602 All tests included in the test programme for the remote control system shall be carried out without manual assistance from the engine room, and all systems shall be in operation as normal for unattended machinery space.

B. Testing of Remote Control System. Guidance

B 100 Ships with fixed pitch propeller

101 The test programme should as a minimum include the following manoeuvres:

— from stop to dead slow ahead. Proceed stepwise to full ahead. Before each step increase, the r.p.m. of the previous setting shall have reached its steady state condition
— from approximately 2/3 of full speed ahead, go quickly to slow astern. Proceed stepwise to full astern
— stop
— after approximately 5 minutes stop, start ahead
— when the ship has reached approximately 2/3 of full speed ahead, go quickly to half astern
— when the ship is «dead in the water», go quickly to full ahead

— when the ship has reached approximately 2/3 of full speed ahead, go quickly to dead slow ahead
— when the r.p.m. is nearly stabilised, go quickly to full ahead
— when the ship has reached approximately half speed ahead, go to stop and back to dead slow ahead within 1 second.

102 With air compressors stopped, make 12 starts with the remote control system, alternatively between ahead and astern.

103 Testing of possible automatic restarts. Go to ahead and let the engine repeat the predetermined starting at tempts. Go to stop. Return to ahead and check that an additional starting attempt is effected.

104 Simulate failures causing automatic load reduction or stop of the engine. Cancel if possible this safety action and show that the engine is again controllable from the bridge.

105 During bridge control at half speed ahead, cut out power supply to the remote control system. No immediate critical situation shall arise. Switch over to standby manual control in the engine room, and show that this control system functions satisfactorily.

106 At approximately 2/3 of full speed ahead, test the emergency stop system.

B 200 Ships with controllable pitch propeller

201 The tests specified below apply to remote control systems with a single manoeuvring lever on the bridge.

For plants with dual lever control, one for r.p.m. and one for pitch, the tests to be carried out will be considered in each case.

— start the engine, from the bridge if possible, and go to dead slow ahead. Proceed stepwise to full ahead. Before each step increase, the r.p.m. of the previous setting shall have reached its steady state condition
— from approximately 2/3 of full speed ahead, go quickly to dead slow astern. Proceed stepwise to full astern
— go to neutral position
— after approximately 5 minutes in neutral position, go to ahead
— when the ship has reached approximately 2/3 of full speed ahead, go quickly to 2/3 of full astern
— when the ship is «dead in the water», go quickly to half ahead.

202 Simulate failures causing automatic load reduction or stop of the engine. Cancel if possible this safety action and show that the engine is again controllable from the bridge.

203 During bridge control at half speed ahead, cut out power supply to the remote control system. No immediate critical situation shall arise. Switch over to standby manual control in the engine room, and show that this control system functions satisfactorily.

204 At approximately 2/3 of full speed ahead, test the emergency stop system.

B 300 Steam turbine ships

301 The test programme should as a minimum include:

— from stop to dead slow ahead. Proceed stepwise to full ahead. Before each step increase, the r.p.m. of the previous setting shall have reached its steady state condition
— from full speed ahead, reduce stepwise to stop with the same intervals
— from stop, increase stepwise to full astern. Run until the ship has reached a fair speed astern
— from full astern, reduce stepwise to stop
— show that the automatic turning arrangement operates satisfactorily during the stop period. Go to full ahead
— after approximately 10 minutes full ahead, go quickly to stop
— after approximately 5 minutes stop, go quickly to 2/3 of full astern
— when the ship is «dead in the water», go quickly to full ahead
— when the ship has reached approximately 2/3 of full speed ahead, go quickly to 2/3 of full astern and run until the ship is «dead in the water»
— go to full ahead. When the ship has reached approximately 2/3 of full speed ahead, go to stop and back to dead slow ahead within 1 second. Transfer control to the engine room.

302 Repeat the first four manoeuvres using the manoeuvring system in the engine room. Transfer control to the bridge.

303 During bridge control at half speed ahead, cut out power supply to the remote control system. No immediate critical situation shall arise. Switch over to standby manual control in the engine room, and show that this control system functions satisfactorily.

304 Simulate failures causing automatic load reduction or stop of turbines. Cancel, if possible, this safety action and show that the turbines are again controllable from the bridge.

305 At approximately 2/3 of full speed ahead, test the emergency stop system.

C. Testing of Boiler Plant. Guidance

C 100 Automatic control system for auxiliary boilers

101 The system shall be tested by varying the boiler load as specified in 102. Recording of the following parameters may be required:

— steam pressure (primary and secondary system)
— water level in boiler
— automatic actions such as start and/or stop of burners, alarms, etc.

102 Boilers serving turbogenerators. One boiler in operation:

— increase load from minimum to full load during a period of minimum 15 minutes
— reduce load from full load to minimum during a period of minimum 15 minutes
— increase load suddenly to minimum 50% of full load by connecting one of the greater consumers
— when stationary conditions are reached, reduce load suddenly to minimum.

Parallel operation of two boilers:

— increase load suddenly to minimum 30% of full load, by connecting one of the greater consumers
— when stationary conditions are reached, reduce load suddenly to approximately 5% of full load and keep that load until stationary conditions are reached.

C 200 Automatic control system for main boilers

201 The system shall be tested by varying the boiler load as specified in 202. Recording of the following parameters may be required:

— steam flow (alternatively position of control valve)
— steam pressure
— temperature of superheated steam
— water level in boiler
— water level in condenser and deaerator
— fuel oil temperature or viscosity
— excess of combustion air in exhaust gas.

202 The boiler load shall be varied in accordance with the manoeuvring tests specified in B300. The boiler plant testing may be carried out simultaneously with testing of the remote control system for the main turbines.

C 300 Monitoring system

301 With all burners in operation, the fuel oil supply to one of the burners shall be shut off. Check that the flame detector of this burner is functioning. The remaining burners shall be tested in the same way.

302 With burners in operation, one of the flame detectors shall be shielded. Check that the automatic shutoff valve for fuel oil is operating. The remaining flame detectors shall be tested in the same way.

303 With boiler in operation, simulate a failure causing automatic stop of combustion air fan. Check that the fuel oil supply is shut off.

304 Reduce water level below safety limit and check that fuel oil supply is shut off.

305 Remaining alarms and safety actions shall be initiated by simulating failures as realistically as practicable.