PART II RULES FOR THE CONSTRUCTION AND CLASSIFICATION OF SHIPS IDENTIFIED BY THEIR MISSION

TITLE 102 AUTOMATION SYSTEMS

SECTION 5 ENGINES AND MECHANICS

CHAPTERS

CONTENTS

CHAPTER A
MONITORING, CONTROL AND AUTOMATION SYSTEMS FOR LOW AND MEDIUM SPEED ENGINES

A1. SCOPE

100. Nature of the systems

101. This Section applies to automation systems, installed on all ships, as follows:

a. All ships with additional automation class notation are to satisfy the requirements of Subchapters A3 and A4 below irrespective of the period in which machinery space remains unattended and the vessel's GT;

b. Ships with GT < 500, less than 2500 kW propulsion installed power and length ≥ 20 meters in compliance with Chapter B shall be assigned the additional automation class notation as defined in A1.238;

c. Ships with length < 20 meters complying with the requirements of Chapter B as far as possible and in compliance with item A1.103 below may be especially considered by RBNA for assignment of an additional automation class notations as defined in A1.238;

d. Ships destined to inland navigation complying with the requirements of this Section as far as possible and in compliance with of item to A1.103 below may be especially considered by RBNA for assignment of an additional automation class notations as defined in A1.238;

e. Ships with GT ≥ 500, and more than 2500 kW propulsion installed power and length ≥ 24 meters in compliance with Chapter A shall be assigned the additional automation class notation as defined in A1.238.

Ship's Length L	**Under 500 GT**	**500 GT or over**
L < 20 m	Will be specially considered	NA
L ≥20 m Installed power < 2500 kW (compact engines)	Subchapters A3 and A4 Chapter B	Subchapters A3 and A4 Chapter B
L ≥ 20 m Installed power ≥ 2500 kW	Chapter A	Chapter A
Inland navigation	Will be specially considered	Will be specially considered

Guidance:

The basic requirements for materials and control systems, safety and alarm are applicable at all degrees of automation, of AUT-A to AUT-F.

End of guidance

102. All requirements are additional to those of the Part II Title 11 Section 5.

103. The arrangement of the operational system is to ensure that under all conditions of operation and sailing, including manoeuvres, the safety is to be equivalent to that of a vessel with attended machinery space.

104. The present Rule edition 2014 does not cover steam propulsion systems, auxiliary steam turbines and gas turbines.

105. Guidance:

a. The Title 102 was divided into two sections, A and B, due to the fact that non-compact propulsion and auxiliary engines (chapter A) possess such characteristics that allow the installation of essential equipment external to the engine, whereas in compact engines (chapter B) it is not possible to install external essential equipment because the pumps, lubrication and cooling systems are built integral to the engine.

End of guidance

200. Terms

201. In addition of the terms defined in the Title 11 the following terms are used here:

202. **Alarm**: is an audible and visual signal whenever a parameter exceeds predetermined limits. The alarm function is to call the attention of the relevant personnel, by means of visual and audible signals; in case of any abnormal condition that requires attention.

203. **Automated control:** Type of control which is self-regulating in carrying out ordered instructions without action by the operator.

204. **Alarm indicator**: indicates audibly or visually any dangerous situation, unsafe situation, or failure of any system or equipment

205. **Alarm systems**: those which track and indicate any abnormal event or situation.

206. **Availability**: capability to be ready to perform a required function under given conditions at a given time interval, assuming that they are equipped with the necessary external resources.

207. **Basic computer systems**: those of one or more computers, associated software, peripherals and interfaces, and computer networks with their respective protocols.

208. **Basic software**: this includes "firmware" and "middleware", required to support implementation of the software.

209. **Machinery Control Room** (MCR) installed in machinery space or adjacent to it where all means of control and monitoring for an automated machinery space are available.

210. **Closed loop** is one in which the controlled process variable is kept within established limits.

211. **Collective alarm**: is an alarm that is activated throughout the ship.

212. **Compact engines** (integrated propulsion machinery): are those possessing their auxiliary machinery such as fuel oil pumps, lubrication, cooling, etc. driven by their own engine by the gearbox or driving shaft.

213. **Computerized system**: system that consists of one or more programmable electronic devices with their connections, peripherals and software necessary to automatically perform scheduled tasks.

214. **Control**: function aimed to regulate the behaviour of an equipment or system.

215. **Control station**: local or remote, is the central location where the necessary instrumentation required to maintain the control and monitoring of the specific machinery is fitted, and which is equivalent at least as if the machinery were under local supervision.

216. **Essential system** – Constitute the essential systems: the steering system, the propulsion and energy generation and emergency systems.

217. **Firmware** is the set of programmed operating instructions directly at the hardware of electronic equipment. It is permanently stored in hardware memory of integrated circuit.

218. **FMEA**: Failure mode and effect analysis is a quality tool used early in the product life cycle. It consists of a detailed analysis of the project with the goal of preventing the associated failure modes and to ensure the effective functioning of system.

219. **Fully redundant:** automated system that can comprehend two independent systems that operate simultaneously and perform the same function.

220. **Group alarm:** means a common alarm activated by any abnormal operational condition of the system or machinery under monitoring.

221. **Instrumentation**: is a sensor or element of monitoring.

222. **Integrated system**: the one that consists of two or more subsystems, connected on the network for the transmission of data from a file and operated from one or more workstations.

Guidance:
The data are sent to a processing center that collects and integrates the information and aimed to maintain the operational parameters. The data are presented in panels and displays especially designed.

End of guidance

223. **Local control**: Control by an operator of machinery through a device located on or adjacent to the controlled machinery.

224. **Middleware**: is a computer program that provides mediation between other software.

225. **Open-loop**: is a system that has no feedback, i.e., information about the controlled variable is not used to adjust any of the input variables.

226. **Permanent failures**: are those in which once the component failed, it never returns to work properly. Many techniques of tolerance to failure assume that the components fail permanently.

227. **Principle of protection against critical failures ("fail safe"**) means that the failure or malfunction of a component or system causes the output of the system will be automatically adjusted to a predetermined design condition where the consequences are less critical.

Guidance:

NOTE: The safe condition, in accordance to the application, will be pre-specified in terms of priority for the safety of the ship and can often be considered as the

condition less critical for the main and auxiliary components, such as the propulsion and manoeuvring.

Within the principle "fail-safe" is done the assessment not only of the equipment or system and associated machinery, but also with regard to the overall safety of the ship.

End of guidance

228. **Redundancy**: is the existence of more than one way to perform the same function

229. **Remote control:** means control of a device by an operator from a distance through mechanical electrical, electronic, pneumatic, hydraulic, electromagnetic or optical means or their combinations**.**

230. **Safety System**: that is used to limit the consequence of failure(s) and is automatically activated when an abnormal situation occurs. safety system means a system that operates automatically for safety of electrical equipment or machinery in accordance to three modes of operation in case of serious failures that put at risk the propulsion machinery, boilers, electrical generators and other essential equipment:

a. 1st mode: shutting off machinery, namely, emergency stop for main engines, boiler fuel shut off, and shut off electricity supply to consumers. Additionally, the machinery which was stopped or turned off can only work again if the system is reset manually

b. 2nd mode: the machinery operation is automatically adjusted to the prevailing conditions, for example, reducing the speed or rotation of equipment.

c. 3rd mode: normal operating conditions are restored by the automatic starting of the machinery.

231. **Semi – redundancy**: is a term used when two independent systems perform the same function, getting one in operation and another in standby, requiring a selector switch to change the system, automatically actuated.

232. **Single alarm**: is an alarm that is activated in just one control station, and that can be transferred to another station.

233**. Software**: program, procedures and associated documentation belonging to an operation of a computerized system and including the application program (user's), middleware and operational system program (firmware).

234. **"Stand alone" system**: means automation referring to a particular equipment or system isolated from the other ship systems.

235. **System**: collection of components organized to accomplish a specific function or function

236. **System monitoring**: control that tracks the operation of equipment, identifying any inaccuracies, by measurements of variables compared with specific values

237. **Transient failures**: are those of a limited duration, caused by a temporary malfunction or by any external interference. Such failures can be also intermittent, occurring repeatedly for short intervals of time.

238. **Automation additional class notation**

a. **Notation AUT-A** – Permanently Attended Machinery Space, with centralized control of equipment in MCR or in the machinery space.

b. **Notation AUT-B**: Unattended machinery space by minimum periods of 8 (eight) hours for all conditions of sailing and manoeuvring, with propulsion and auxiliary system control from the bridge.

c. **Notation AUT-C**: Unattended machinery space by minimum periods of 16 (sixteen) hours for all conditions of sailing and manoeuvring, with propulsion and auxiliary system control from the bridge.

d. **Notation AUT- E**: Unattended machinery space by minimum periods of 24 (twenty-four) hours for all conditions of sailing and manoeuvring, with propulsion and auxiliary system control from the bridge.

e. **Notation AUT-F**: Permanently Unattended machinery space for all conditions of sailing and manoeuvring, with control centralized in the bridge. Additionally, the vessel is to be equipped with an integrated computer system for control and monitoring of the propulsion and auxiliaries from the bridge.

f. **Notation CNC:** Centralized Navigation Control – The additional CNC class notation is assigned when in addition to the requirements for AUT- F notation (propulsion and auxiliary system integrated from the bridge) to the bridge arrangement is made so that the ship can be operated under normal conditions by only a navigational officer of watch. This notation includes specific requirements for the prevention of accidents caused by inadequacy of the operator.

Note 1: RBNA may analyse relaxation of the above requirements for vessels intended for inland navigation, determining at its discretion if the machinery space can stay unattended, and for what period of time. In this case will be appended to one of the above notations added notation "–INT".

Note 2: Correspondence between degrees of automation of the RBNA and the Table of Types of degree of Automation of the NORMAM 01, Annex 1-C:

TABLE T.A1.20.1 – Correspondence between degrees of Automation RBNA and NORMAM 01

Notation RBNA	Type of degree as per NORMAM 01
AUT-A	A
AUT-B	B
AUT-C	C
AUT-E	E
AUT-F	F
AUT-F + CNC	

Guidance:

Systems with AUT-A notation with permanently attended machinery space, with centralized control in MCR in the machinery space allow that certain essential systems may be triggered by the driver's action from the control point.

The systems with AUT-B and AUT-C notation differ from the AUT-A by the absence of MCR and for having the machinery space unattended by 8 hours (AUT-B) or by 16 hours (AUT-C). The control is done by the bridge. The period in which the machinery space remains unattended will depend on the need for the presence of a person every 8 hours or every 16 hours in the machinery space due to the need of local intervention in some system. Other factors that can influence:

- capacity of fuel oil daily tank

- transfer from the storage tank to the fuel oil daily tank

- factors affecting the safety of operation

The NORMAM 01 automation degree D is not considered by RBNA, since it only covers the sailing but not the manoeuvres. The requirements of this Title 102 cover both the sailing and manoeuvring conditions, but do not cover mooring and unmooring

Systems with AUT-E notation and that have the characteristic machinery space unattended for a period of 24 hours. What differentiates the AUT-E systems from AUT-B and AUT-C systems is that the propulsion system and equipment required for operation are to be free of local intervention along the period that the machinery space is unattended, in accordance to the additional class notation adopted: in the case of the AUT-B notation, the systems are to be free from need of local intervention for a period of at least 8 hours; in AUT-C, by 16 hours, and in the case of the AUT-E by 24 hours. As it turns out, what will differentiate the AUT-E from the AUT-and B and AUT-C is just the period in which the propulsion systems and equipment required for operation are free of local intervention, rather than requirements of rules and regulations, because how can one check in the subchapter A4, these requirements are the same for all three degrees of automation, this refers to the period in which the Machines remains unattended.

The systems with notation AUT-F require fulfillment of the requirements for AUT-E systems, the allocation of an integrated system of automation and control (see the A1.239 below),

While the AUT-systems can be:

-open-loop or closed loop;
-"stand alone" or integrated.

The AUT-F systems have to be necessarily:

-closed loop (see the A1.219 and A1.218 above)
-integrated.

The Table T.A1.201.2 below shows a summary of the main differences between the specific requirements for each additional notation of automation.

Note: The table T.A1.201.2 is informational only and does not replace the full application of the requirements of this Title 102.

TABLE. T.A1.201.2 – COMPARISON BETWEEN THE SPECIFIC REQUIREMENTS FOR THE AUTOMATION

	AUT-A	***AUT-B AUT-C***	***AUT-E***	***AUT-F***
Machinery space permanently unattended	*Yes*	*No*	*No*	*No*
Centralized Control in the MCR	*Yes*	*No*	*No*	*No*
Centralized Control in the bridge	*No*	*Yes*	*Yes*	*Yes*
Free of local direct intervention for a minimum periods of 8 or 16 hours	*No*	*Yes*	*Non Applicable*	*Non Applicable*
Free of local direct intervention for a minimum periods of 24 hours	*Non Applicable*	*Non Applicable*	*Yes*	*Yes*
Integrated automation and control system	*Non applicable*	*Non mandatory*	*Non mandatory*	*Mandatory*
IMO/ISO regulations on arrangement of bridge equipment	*Non Applicable*	*Non Applicable*	*Non Applicable*	*Only for additional notation CNC*
Requirements of subchapter A4 alarm, control and safety	*Applicable*	*Applicable*	*Applicable s*	*Applicable*
Requirements of subchapter A5.100 to specific requirements for automation systems (general-all degrees)	*Applicable*	*Applicable*	*Applicable*	*Applicable*
Requirements of subchapter A5.200- specific requirements for automation systems AUT- A	*Applicable*	*Non applicable*	*Non applicable*	*Non applicable*
Requirements of subchapter A5.300 to AUT- A automation systems for ships with L < 50 meters	*Applicable to ships with L < 50 meters*	*Non Applicable*	*Non Applicable*	*Non Applicable*
Requirements of subchapter A5.400 to specific Requirements for automation systems AUT-B and AUT - C	*Non Applicable*	*Applicable*	*Non Applicable*	*Non Applicable*
Requirements of subchapter A5.500 specific Requirements for automation systems AUT-E	*Non Applicable*	*Applicable *	*Applicable*	*Applicable s*
Requirements of subchapter A6 – specific Requirements for automation systems AUT-F	*Non Applicable*	*Non Applicable*	*Non Applicable*	*Applicable*
Requirements of subchapter A7 – Integrated computer systems for diesel engines	*Non mandatory*	*Non mandatory*	*Non mandatory*	*Mandatory*
Point Tables of the subchapter A8 (ships > 500 AB with non-compact engines) and subchapter B8 (ships with compact engine)	*Applicable*	*Applicable*	*Applicable*	*Applicable*

** In the case of AUT-B e AUT-C, applicable to the period during which the machinery space remains unattended. In the AUT-E systems, for 24 hours unattended machinery space.*

End of the Guidance

A2. DOCUMENTS, REGULATIONS AND STANDARDS.

100. Plans and information required

101. Plans and specifications shall be submitted for approval as follows:

a. Machinery arrangement showing the location of the control stations in relation to controlled units;

b. Arrangement and details of control consoles, including frontal views and arrangement, along with schematics for all monitoring and control systems, including their functions;

c. Type and size of all electrical cables and wiring associated with the control systems, including service voltages and currents along with protections of overload and short circuit;

d. Schematics of hydraulic and pneumatic control systems along with all the interconnections, diameters of pipes and materials including pressure and adjustment of safety valves;

e. Description of all alarms and triggering devices; functional diagrams or description of special valves, actuators, sensors and relays;;

f. Schematics and information of protection systems and fire-extinguishing systems, fire detection and alarm systems, high level systems for dales;

g. Failure analysis of control system (for AUT-F systems only);

h. Nomenclature of transducers and other devices used in automation circuits;

i. Operations Manual containing the necessary technical information and operational instructions for normal operation and emergency.

102. Systems and equipment for which the documentation described in A2.101 above shall be submitted to (but not limited to) the list below, where applicable:

a. Air compressors;

b. Bilge and ballast Systems);

c. Cargo pumping systems for tankers;

d. Cargo and ballast pumps in hazardous zones;

e. Variable pitch propeller system;

f. Energy generation facility;

g. Inert gas generators;

h. Propulsion machinery including essential auxiliaries;

i. Machinery or equipment for which control, alarm and safety systems are specified in this Rule, Part II, Title 102, Section 5, Chapter A;

j. Transfer and storage systems of fuel oil;

k. Boilers and auxiliary equipment;

l. Steering system;

m. Fluid heaters;

n. Side thrusters;

o. Valve position indication system;

p. Water jet thrusters; and

q. Instrumentation in cargo tanks and empty compartments (detection of water entrance).

200. Regulation and standards

201. For vessels covered by this chapter for navigation in open sea areas O1 and O2 in addition to the requirements of this Title 102 the following regulations are to be satisfied:

a. NORMAM 01 (Brazilian Maritime Authority regulations for vessels employed in navigation in open seas;

b. SOLAS International Convention for the Safety of Life at Sea;

c. Unified Requirements of IACS UR and unified interpretations of the IACS UI relevant;

d. IEEE e outras normas equivalentes.

e. IMO Code on Alarms and Indicators.

f. Standard IEC 60092-504 - Electrical installations in ships – Part 504: Special features – Control and instrumentation.

A3. MATERIALS FOR AUTOMATION SYSTEM

100. Qualification of components

- see Part III, Title 63, Chapter 8, Section A.

200. Environmental Conditions

- see Part II, Title 11, Section 7, Chapter E, subchapter E1.

A4. BASIC REQUIREMENTS FOR CONTROL, ALARM AND SAFETY SYSTEMS FOR SHIPS WITH PERIODICALLY UNATTENDED MACHINERY SPACE.

100. Application

101. The requirements of this subchapter A4 apply to any control, alarm and safety systems for ships for navigation in open seas with periodically unattended machinery space covered by this Part II, Title II, Chapter 5 Section 102. are in addition to the requirements of Part II, Title 11, Sections 3 and 5

102. The requirements of this subchapter A4 apply to any control, alarm and safety systems in which the machinery space be periodically unattended for any length of time or controlled from a permanently attended MCR (AUT-A until AUT-F), and are to be applied in conjunction with the specific requirements to the degree of automation, subchapters A5 and A6

Guidance:

The requirements of this Chapter A4 apply to all class notations relating to automation, from AUT-A

until AUT-F, without exception. They are in accordance with the relevant IMO regulations.

The requirements of remote control, alarm and safety systems for ships with attended machinery space can be found in part II, Title 11, Section 5, Chapter E and in part II, Title 11, Section 3, Chapter E.

End of guidance

200. General system requirements

201. The arrangements established are to be such as to ensure that the safety of the ship in all sailing conditions, including manoeuvreing, is equivalent to that of a ship having the attended machinery compartments.

202. Measures are to be taken to ensure that the equipment is functioning in a reliable manner and that satisfactory arrangements are made for regular inspections and routine tests to ensure continuous reliable operation.

203. Every ship shall be provided with evidence, proven with documents, to the satisfaction of the RBNA, of its fitness to operate periodically with unattended machinery compartments.

204. The automation is to cover the operation required for safe navigation while operating in the open sea, restricted navigation and manoeuvreing.

205. These requirements do not apply to operations required before departure, after dropping the anchor or after mooring.

206. Alarm, control and safety systems are to be designed in accordance to the Fail Safe principle, which is to be applied not only to the operation of the machinery, as well as the complete installation and personal safety.

207. Nameplates: each control panel, subpanel, indicating instrument, control lever, alarm signaling lamp, recording instrument, etc. are to be clearly and systematically identified through clear readable nameplates without ambiguity

208. The nameplates are to be permanently fixed and installed in a consistent manner in relation to the controls and instrumentation, and are to be made of durable materials, having clear and indelible characters

209. Lighting: instruments and controls are to be lit so as to enable clear reading and operation in ambient light conditions under which they are designed to operate without excessive glare or shadows. If the ambient lighting makes it difficult to detect an indicator lamp, a suitable guard is to be installed. If the equipment is installed in the bridge, means are to be provided to prevent interference with the navigation caused by any light source. The equipment installed in outdoor areas (i.e., in the bridge wings) are to be adequately lit for operation both daytime as at night.

300. Machinery control from the bridge for ships with a periodically unattended machinery space

301. When control of the propulsion machinery be located in bridge, the remote control is to include an automation that reduces considerably the amount of operations and is to be of simplified nature.

a. Automatic systems are to be designed in such a way that alarms of transgression of limits or imminent reduction of the propulsion system is given to the officer-in-charge of the navigation with enough time so that emergency measures are taken.

b. In particular, the systems are to manage, monitor and report, alarm and execute safety action taken to reduce or shutting off the power so that the navigational officer has the opportunity to intervene manually, except in cases where manual intervention result in total failure of the motor and/or propulsion equipment within a very short time, for example, in the case of overspeeding.

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

302. The operation of the automatic control device is to ensure the safe operation of machinery by information easily identifiable. Protections are to be provided in the event of a failure, having record of each command executed and alarm whenever there is any system failure or when a wrong command is selected.

303. Remote control vessels are to be equipped with direct controls from the propulsion machinery locations. The local direct control is to be independent of the remote control circuits, with selector switch allowing the operator to manoeuvre the ship in the manner that best suits.

304. Each equipment with local control, including partial control, is to be equipped with means of communication with the bridge, independent of machinery remote control system and that are able to operate even under conditions on-board power supply fault putting the ship in condition "ship-blackout".

305. The remote control of the propulsion machinery is to be possible only from one location at a time. Each location is to be equipped with an indicator showing which station is controlling the

propulsion machinery, with Repeater of all these indications in the Engine Room, in the machinery central control (if it exists) and the bridge. The control is to only be possible from one station and there shall be an indication of the active control station.

306. The transfer of control of propulsion system between the bridge and the Engine Room is to be carried out only from Engine Room or from bridge, after acceptance of the station that is taking control. The propulsion system is to have means to prevent significant change in transfer of control

307. An alarm is to be activated sounding in the bridge and in the MCR in the event of a failure in the power supply (voltage, hydraulic pressure, pneumatic, etc.) at the remote control of the propulsion. The failure is to be capable of being recorded, including in conditions of "ship-blackout".

308. In the event of a failure of the of remote control system the speed and course are to be kept until the local control be brought on-line, unless the assessment of the RBNA deems this impractical.

309. Each control station is to be equipped with indicators for:

a. Propeller rotation and direction of rotation in the case of fixed pitch propellers;

b. Rotation of the propeller and pitch in the case of controllable-pitch propellers.

310. The control of routine manoeuvres from the bridge for a shaft line shall as a rule be carried out by a single control device: a lever (joystick), a steering wheel or a button. And every mechanism that contributes directly to the propulsion, such as motor, clutch, automatic brake, or propeller pitch control, is to be equipped with individual, local control, or from a machinery central control in the machinery space.

311. The system is to be equipped with an emergency stop button at the bridge in event there is no reaction to a stop order. This device is to be independent of the bridge control system and is to be able to stop the system, whatever the cause of the problem.

312. After a manual or automatic emergency stop, the motor start shall only be given from the neutral position of the control.

313. When there are shaft generators it is to be assured that at certain manoeuvres will not cause disruption of power supply and that the system fits automatically to the generator groups in case of sequential propeller cavitation or in case of shaft generator failure without having the vessel undergone blackout or a sudden drop in energy.

314. It is to provide means to prevent the motor start with the turning wheel geared.

315. A remote system failure shall not result in an abrupt change of power, speed and direction of rotation of the propeller and if such failure happens it is to be signalled by alarm.

316. The loss of control at a station is to be indicated by visual and audible alarm.

317. In case of remote control from the bridge, the change of the control from the bridge to the local station is not required when the controls are mechanically or electrically connected, so that this transferring can be done at the location and are complying with the following requirements:

318. An Engine Room telegraph independent from the remote control system is to be installed.

319. A propulsion system stop in emergency is to be provided independent from the remote control system and power supply of the latter. In addition, this emergency stop cannot be cancelled and is to be protected against inadvertent operation.

320. When the safety system of propulsion machinery is provided with overlapping system, this is to be installed at the bridge

321. For systems with clutch, shaft line may be disconnected from the emergency stop at the bridge.

322. For fixed pitch propeller systems, indicators of rotating speed and direction of rotation are to be fitted on the bridge.

323. Controllable pitch systems are to be equipped with rotating indicator and propeller pitch.

324. Where there are systems fitted with reverse gear box, indicators of RPM and direction of rotation of the propeller shaft as well as the RPM of the propulsion machinery are to be fitted.

325. In the event of remote control from the MCR - Machinery Control Roomr: if done from the equipment listed above in item A4.318, A4.323 and A4.324 are also to be fitted in the MCR.

326. Local control in the vicinity of the motor: it is to be fitted a manual system of operation of the motor independent of the remote control system, with the indicators listed in A4.318, A4.323 and A4.324 also fitted in the location.

327. In the event of remote control from the bridge or from the MCR:

a. the propulsion system is to be controlled from the bridge in accordance to this subchapter A5.300 or otherwise from an MCR in such a

way that the machinery can be operated without restriction from a single station, which shall be identified. And that it is signalled which station actuates the control.

b. The MCR is to be fitted in a closed space, in which shall be centralized the propulsion and power generator systems.

c. All data from operation of the propulsion system and the operational status of auxiliary machinery essential to the propulsion system are to be available at the MCR.

328. Machine orders to the machinery propulsion issued from the bridge are to be duly indicated at the machinery control centre or at the engine local control panel.

329. The number of possible failures in consecutive attempts of automatic start-up is to be limited to safeguard sufficient starting air pressure. An alarm to indicate low starting air pressure is to be fitted regulated to start at a value still enough to allow starting operations of the main propulsion machinery.

400. Safety systems for ships with periodically unattended machinery space

401. Where the machinery is equipped with safety systems of open or closed loop, the requirements of the present Parte II, Title 102, Section 5, subchapter A4.400 is to be applied.

402. The safety systems are to operate automatically in case of failures that could put at risk the machinery, so that:

a. normal operating conditions are restored, for example, by the departure of standby machinery; or

b. the operation of the machinery to be temporarily adjusted to existing conditions, for example, reducing the power of the machinery; or

c. the machinery is protected from critical condition by closing the fuel supply or other energy sources, shutting off operation.

403. The safety system required by item 402.(c) above shall be designed as far as possible to operate independently from the control and alarm systems, so that a failure or malfunction of these systems will not hinder normal operation of the safety system

404. For the safety systems required by 402.(a) e (b), is not required the total independence of other control systems.

405. Safety systems for different parts of the machinery are to be designed in such a way that the failure of the safety system of one of the protected parts will not interfere with the operation of the safety system of any other part.

406. The safety system is to be designed in accordance with the concept of 'fail safe'. The characteristics of system operation ' fail safe ' shall be assessed on the basis not only of the safety of the system and associated machinery, but also based on the complete installation as a whole. Any failure of the safety system shall trigger a visual and audible alarm.

407. When a safety system is activated, a visual and audible alarm shall be triggered indicating the cause of the safety action.

408. The safety system is to be manually reset before the relevant machinery can be re-started.

409. When there is overlapping system (over-riding) that is to be protected against accidental operation and is to be indicated at every control station, as well as be recorded.

410. The safety system is to be designed with auto-switching for the standby power source in the event of a failure in the main power source. The system is to have devices that ensure the operation for at least 15 (fifteen) minutes in case of power failure. Power loss sis to be indicated by visual and audible alarm and is to be recorded.

411. When there are ways to adjust the system, the design is to be such that the final parameters are readily identified.

412. The open loop principle of monitoring is to be applied to the safety systems. Alternatively the principle of closed loop could be applied if required by National Regulations.

413. The table of points where the sensors are to be installed and alarm functions are in Part II, Title 102 Chapter A8.

414. The control system of diesel motors is to comply with the following requirements:

a. The number and duration of automatic starting attempts are to be limited.

b. The controller and actuator are to be adequate to control the motor operating conditions determined by these Rules and also with the motor manufacturer's requirements.

c. The minimum conditions of stopping and reducing stopping listed in the Table of Points in Part II, Title 102 Chapter A8 below are to stop or reduce propulsion engine or issue order to reduce.

d. An automatic stop device is to be installed in event of simple rotational reduction not be sufficient to protect the engine.

500. Alarm systems for ships with periodically unattended machinery space

501. There shall be an alarm system indicating any failure requiring attention and as follows:

a. capable of sounding an audible alarm at the engine control centre or at the Machinery Control Centre indicating visually, separately, each alarm information in a suitable presentation;

b. having communication with the recreation room of engineer officers and with each cabin of these officers, through selection, guaranteed at least a connection with one of those cabins. Similar provisions may be accepted by RBNA upon analysis;

c. triggering an audible and visual alarm at the bridge, in any situation that requires an action or attention from the officer on duty;

d. designed, as far as possible, within the fail safe principle;

e. triggering the alarm for the engineer officers. where the information, given by one of the alarms has not received due attention in the location, within a time limit; and

f. the alarm systems is to be fitted with effective means to test all visual and audio alarms and indication lamps without interrupting the normal operation of the system.

502. The alarm system shall be continuously powered and shall have a device that allows automatic switching to a backup power system, in case of loss of normal power supply. Shall have power supply in emergency by battery (back-up) for at least 15 (fifteen) minutes of operation.

503. Failure in the normal power supply of the alarm system shall be indicated by an alarm.

504. The alarm system shall be able to indicate at the same time more than one failure, and the entering into operation of an alarm shall not prevent the entering into operation of another.

505. The acceptance of any alarm condition at the position referred to in item A4.501 above is to be indicated in the locations where failure was shown. The alarm shall be activated until they are identified and the visual indications of each alarm shall be maintained until they have been remedied the causes of the accidents, occasion in which the system will be automatically reset in normal operating condition.

506. The machinery alarm system is to be provided with audio-visual signal to indicate unacceptable deviations from operating conditions.

507. The alarm retard time is to be kept within limits in order to avoid risk of damage to the monitored system.

508. The visual signals are to be individually listed and be clearly identifiable by text or symbols. It shall be possible to differentiate an alarm that was recognized from another that has not been.

509. It shall be possible to recognize audible signals independently of visual signals, i.e., when either a visual signal or an audible signal is activated, it shall be possible to identify the origin of the audible signal without recurring to the visual signal.

510. The recognition of a visual alarm is to be possible only when the individual failure that caused the triggering of the alarm has been identified.

511. Alarm recognition shall not inhibit an alarm that will be generated by new causes.

512. The alarms are to be discernible in all operational situations.

513. Transient failures that are self-correctable without intervention are to be memorized and indicated by signs that only disappear when the alarm has been recognized.

514. During operations at the port the alarms are to sound collectively in accommodation areas and canteens and in the Office of the Chief Engineer or crew member responsible for machinery. The presence of an Engineer Officer in the machinery space is required, unless the engine is unattended at all times

Guidance

Unattended machinery space at all times will only be possible for ships that have additional automation class notation for manoeuvres of mooring and unmooring, not covered by this Title 102.

End of guidance

Guidance on items A4.508 to A4.512

Text of IEC 60092-504:

9.1.3.3.5 Detectors and manually operated call points shall be grouped into sections. The activation of any detector or manually operated call point shall initiate a visual and audible fire signal at the control panel and indicating units. Indicating units shall denote the section in which a detector or manually

operated call point has operated. This signal shall be maintained until it is acknowledged on the control panel. Total resetting of activated section(s) shall only be possible when the detectors are within set points. If it is impossible to identify at a control panel which detector has been activated, each detector shall be equipped with a visual indicator. This signal shall be maintained until it is acknowledged. Indication of detectors shall be provided outside normally locked rooms, unless this indication is given at the control panel.

NOTE 1 Section: group of fire detectors and manually operated call points as reported in the indicating unit(s).

NOTE 2 Loop: electrical circuit linking detectors of various sections and connected to the control panel.

End of the guidance

515. Collective alarms in the bridge are to be grouped into three categories according to their urgency:

a. Stop alarms: failures that require action of type "stalling" ("shut down") the propulsion system

b. Shut-off alarms: failures which require “immediate stop” (“shut down”) actions of the propulsion system;

c. Common alarms: alarms that do not require the actions described in the items a) and b) above.

516. Alarm systems are to be designed according to the closed circuit system or open-circuit monitored.

517. The beginning and end of alarm and its recognition are to be distinguishable and recorded reporting what happened, with date and time.

518. Each additional new alarm or if there is no alarm recognition, shall trigger the collective alarm again.

519. The Individual alarms shall be recognizable in the system to which it belongs and the main control station to which the system belongs.

520. The collective alarms are to be recorded according to item A4.515, above.

521. The failure in the machinery alarm system is to be signalled at the bridge, in mess rooms and in the engineer officers’ cabins.

522. The watch cabin alarm system is responsible for informing the people responsible in the event of incorrect situations when the machinery space is not manned.

523. It shall be possible to choose the cabin and this shall be indicated at the bridge and at the location where the choice was made.

524. When an alarm has not been recognized within a predetermined period of time, another alarm shall sound at the bridge, accommodation areas, the mess room and in the cabins of the officers in order to be recognized in one of these areas. The alarm will be reset when it has been recognized in the machinery alarm system.

600. Boilers and heating oil systems for ships with periodically unattended machinery space

601. The alarms are to be fitted to monitor the main steam plant and related equipment

602. They shall be equipped with alarms to:

a. Water level in condenser;

b. Water level in deaerator;

c. Pressure in deaerator;

d. Water level in boiler

e. Pressure in boiler and pressurized systems.

603. The requirements of the Part II, Title 11, Subchapter E3 for boilers and fuel oil heaters are to be obeyed.

604. The temperature of the separation medium and pressure of the purifier oil output are to be monitored and controlled automatically

605. The purification process shall be shut off in the event of failures.

606. The entrance of water into the output of the medium to be separated shall trigger an alarm.

607. The heating system of the preheater shall be designed in such a way that an interruption in the flow of the purifier does not result in overheating

700. Bilge systems for ships with periodically unattended machinery space

701. The bilge sumps shall be located and monitored in such a way that the accumulation of liquids is detected at normal angles of trim and inclination and are to be of such dimensions that they can accommodate easily the normal drainage during the unattended period of machinery space.

702. When the bilge sumps are equipped with automatic drainage device, an alarm shall be triggered when the draining pump of the bilge sumps were running frequently, or for a very long period of time, or with low pressure off the bilge pump

703. At least two high level sensors are to be installed at each machinery space and the activation

of these sensors is to be indicated by individual alarms

704. When the MARPOL International Convention require a device to monitor the residual oil content in the water of the bilge sump and when necessary automatic interruption of the draining process, an alarm shall be triggered when the limit value is exceeded and, where specified, the drainage process is to be stopped.

800. Detection system and fire alarm for ships with periodically unattended machinery space [SOLAS II-2/C/Regulation 7]

801. A fixed fire detection and fire alarm system shall be installed in:

a. periodically unattended machinery spaces;

b. machinery spaces where:

a.1. the installation of automatic and remote control systems and equipment has been approved in lieu of continuous manning of the space; and

a.2. the main propulsion and associated machinery including sources of the main sources of electrical power are provided with various degrees of automatic or remote control and are under continuous manned supervision from a control room; and

c. enclosed spaces containing incinerators

802. The fixed fire detection and fire alarm system required in A4.801 above 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.

803. Except in spaces of restricted height and where their use is especially appropriate, detection systems using only thermal detectors shall not be permitted.

804. 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, accommodation and mess rooms of engineer officers or crew responsible for the machinery and also in the machinery space and must be distinguishable from any other alarms.

805. When the navigating bridge is unmanned the alarm shall sound in a place where a responsible member of the crew is on duty.

900. Continuity of electrical power supply for ships with periodically unattended machinery space

901. The continuity of electricity supply in ships with periodically unattended machinery space is to be in accordance with this subchapter A4, items 902-908 below.

902. When there is loss of power of the generator in operation in ships where the electricity is being usually provided by one of the generators, there shall be a stand-by generator with adequate facilities for automatic starting and connecting to the main switchboard and with sufficient capacity to permit propulsion and steering and to ensure the safety of the ship with automatic restarting of the essential auxiliaries including, where necessary, partial operations. The power supplied by the generator stand-by shall be available in no more than 45 seconds.

903. In ships where there is need for two or more generators in parallel, arrangements are to be provided (type load shedding, for example) so that in case of loss of one generator set, the other may remain in operation without overload to allow the propulsion and steering are maintained and ensure the safety of the ship.

904. When auxiliary machinery are driven mechanically by the propulsion system, shall be equipped with standby automatic start units when performing manoeuvres in the range of lower speeds, since in such instances the output of the mechanically driven machines is not adequate.

905. No alarm shall be triggered in the event of pump installations mechanically actuated when the independent pumps starts during normal operation.

906. The sensors for reserve circuits are to be independent from other systems.

907. The recommendations to reserve circuits for generators are in Part II, Title 11, Section 7.

908. Ventilators and exhausters at the machinery space shall have start and stop remote from the bridge (AUT-F/E/B/C) and MCR (AUT-A) are to have automatic restart after failure of one of the generators and starting up of stand-by generator

A5. SPECIFIC REQUIREMENTS FOR AUTOMATION SYSTEMS AS THE ADDITIONAL CLASS NOTATION

100. General requirements for automation systems

Guidance

The general requirements of the item A5.100 are applicable to all automation class notations from the AUT-A to AUT-F.

End of guidance

101. For the class notation with unattended machinery space for any length of time or control from an MCR, the controls, alarms and safety systems required by this Part II, Title 102, Section 5, Subchapter A5 shall be met for the systems listed below:

a. compressed air to start and control.

b. variable pitch propeller units and side thrusters

c. energy generation facilities.

d. inert gas generators.

e. Incinerators.

f. main propulsion machinery including essential auxiliaries

g. transfer and storage systems of fuel oil (oil purifiers and heaters)

h. steam generator installation (boilers and auxiliary equipment)

i. fluid heaters

The requirements of the SOLAS Chapter II-2, Part E shall be met.

102. When the control equipment, safety and monitoring have been installed in compartment with controlled environmental conditions, the temperature conditioning system (such as air conditioning) is to be provided with standby units. System failure shall trigger an alarm.

103. Electrical and electronic equipment that are part of control systems, safety and monitoring shall comply with the requirements of the Part II, Title 102 and are tested in accordance with chapter T of that same section

104. **Systems fitted with more than one propulsion engine and shaft line** – where systems with multiple propulsion are fitted, e.g., two propulsion engines with two shaft lines or two azimuthal propulsion lines, the stand-by circuits for such systems may be dispensed with in case the following conditions are fulfilled:

a. The safety systems are to be separated in so that a failure in one system does not affect the operation of the other system, or in such a way that the functioning of the other systems can be restored by simple measures;

b. Control and shut-off of the individual propulsion systems is possible from the bridge;

c. individual alarms for each individual propulsion systems are fitted on the bridge;

d. In case of more than one propulsion engine, separate power sources are to be fitted for the control system of each engine.

105. Process development activities, from initial design to the execution, and any subsequent modifications are to be planned and structured in a systematic manner, and are to be properly managed. The staff responsible is to be competent for the task. The activities, scope, responsibilities and competencies are to be documented

200. Requirements for systems AUT-A.

201. For AUT-A notation, it shall be provided a Machinery Control Room within, or adjacent to a periodically unattended machinery Space. The propulsion system is to be controlled from the bridge or in a Machinery Control Room installed within or adjacent to unattended Machine Space to allow that the ship be controlled without restrictions by a man. The remote control system is to comply with the applicable requirements of Part II, Title 102, Section 5, Subchapter A4.300. The materials are to be in accordance with Part II, Title 102, Section 5, subchapter A3.

202. All operational data of the propulsion system together with the system operation status of auxiliary machinery essential shall be shown in the Machinery Control Compartment.

203. Machinery safety system is to be installed in accordance with Part II, Section 102, Title 5, Subchapter to 4.400.

204. Machinery alarm system and alarm system of watch room are to be in accordance with the requirements of Part II, Title 102, Section 5, Subchapter 4.500.

205. Boiler and oil heating systems are to be in accordance with the requirements of Part II, Title 102, Section 5, Subchapter A4.600.

206. Auxiliary machinery essential to the propulsion system: essential auxiliary machinery and their reserve units shall be controlled starting and

stopping from the Machinery Control Compartment as the Table T.A5.206.1 below.

TABLE T.A5.206.1 – TABLE OF CONTROL OF THE ESSENTIAL AUXILIARIES

Essential Auxiliary Systems PT II, Tit. 102,Sec 5, A5.200					
Main Equipment	**Auxiliar Equipment**	**MCR AUT-A**		**Unattended machinery Space AUT-F, AUT- E, AUT-B/C**	
		Start	*Start after Failure*	*Automatic Switching*	*Departure after Failure*
Main Combustion Engine	Lubricating oil pumps.				
	Valve control shaft L. O. pumps	**x**	**x**	**x**	**x**
	Gear chain L. O. pumps	**x**		**x**	**x**
	Piston cooling pumps	**x**		**x**	**x**
	Cylinder cooling pumps	**x**		**x**	**x**
	Potable water circulation pumps	**x**		**x**	**x**
	Saltwater cooling pumps.	**x**	**x**	**x**	**x**
	Fuel oil booster pumps	**x**	**x**	**x**	**x**
	Fuel oil injecting valve cooling pumps	**x**	**x**	**x**	**x**
	Compressor and start air control	**x**		**x**	**x**
Reduction gearbox	Lubricating oil pumps.	**x**		**x**	**x**
Turbo-compressor	Stand-by lubricating oil pumps.	**x**	**x**	**x**	**x**
Main Boiler	Fuel oil service pumps	**x**		**x**	**x**
	Circulating pumps	**x**		**x**	**x**
	Feed water pumps	**x**		**x**	**x**
Azimuth Thruster	Hydraulic oil pumps	**x**	**x**	**x**	**x**
	Lubricating oil pumps	**x**		**x**	**x**
Auxiliary Combustion Engine	Lubricating oil pumps	**x**		**x**	**x**
	Cylinder cooling pumps	**x**		**x**	**x**
	Freshwater circulating pumps	**x**		**x**	**x**
	Saltwater cooling pumps	**x**		**x**	**x**
	Fuel oil booster pumps	**x**		**x**	**x**
	Compressors	**x**	**x**	**x**	**x**
Thermal Oil System	Circulating pumps	**x**	**x**	**x**	**x**
	Fuel oil pumps	**x**	**x**	**x**	**x**
Steering Gear	Hydraulic system pumps	**x**	**x**	**x**	**x**
Variable Pitch Propeller	Hydraulic pumps	**x**	**x**	**x**	**x**
Fire Fighting System	Main fire pump	**x**		**x**	**x**

207. It shall be possible the start and connecting of the generator sets from the Machinery Control Room.

208. It shall be installed a fire detection and alarm system in accordance with the Part II, Title 102, Section 5, Subchapter A8.

300. Requirements for systems AUT-A in ships with L < 50 meters

301. On ships with L < 50 meters or where there is no space available in the machinery space for installation of a Machinery Control Room, they can receive class notation AUT-A provided they comply with the requirements of Part II, Title 11, Section 5, A5.200, above.

302. In additional, they shall comply with the requirements of this Subchapter to A5.300 shown below.

303. Alarms: the alarm system shall indicate more than one failure at the same time and to be arranged in such way that the indication of a failure does not inhibit another alarm. Audible alarms shall be maintained until they are recognized

304. The high-pressure pipe injection line and return pipe of main and auxiliary engines shall be effectively screened and secured so as to prevent fuel or oil mist of fuel reaching the engine or ignition source around the same.

305. The height of the coaming for oil containment around the boiler shall be in accordance with the requirements of Part II, Title102, Sections 3 to 6 of these Rules. For other equipment, this coaming shall have a minimum height of 150 mm. There can be used tray coaming of 75 mm height around the fuel oil system components of Diesel engines (injection pumps, filters, etc.).

306. In case of fuel oil tank feeling be automatic or remote controlled there shall be provided means to prevent overflow.

307. In case of the service tanks or fuel oil settling be equipped with heating devices, a high temperature alarm, audible in the bridge, shall be provided in such a way that the fuel's flash point is not exceeded.

308. There shall be complied with the requirements of Part II, Title 102, Section5, Subchapter to A4.700 for high-level alarms in dales of the machinery space.

309. The following alarms and indicators shall be fitted in the navigation sector at the bridge:

a. low pressure alarm for main engine and LO reduction gearbox;

b. high temperature engine cooling medium;

c. Low start air pressure (if applicable);

d. propeller rotation;

e. indication of rotation or pitch: AV, AR, Pitch;

f. stopping the steering engine;

g. control power failure;

h. current and voltage of the generators;

i. low alarm level of fuel oil service tanks;

j. high temperature of heating fuel oil tanks;

k. high-level waste tank;

l. high-level alarm in the machinery space dale; and

m. fire alarm.

310. Means are to be provided for the automatic start and transfer to stand-by of vital auxiliary pumps associated with the propulsion system. Automatic start and transference to stand-by pumps shall trigger an alarm at the bridge control station. The bridge station shall have the means to start and stop remotely these vital auxiliary pumps for the following equipment:

a. The propulsion machinery.

b. Machinery for electric power generation

c. Variable pitch propeller controllers

d. Transfer system and/or fuel oil service: applicable to pumps associated with sedimentation tanks and service (daily)

311. For ships that have compact engines (integrated propulsion machinery), i.e. where the fuel pumps, cooling, etc. are integrated to the motors, see Part II, Title 102, Section 5, Chapter B.

Guidance

In the compact engines, pumps are integrated to the engine, and there is no way to install stand-by equipment.

Therefore, the requirements of item to A5.310 shall not apply, as there is no possibility of triggering the integrated engine pumps, reduction gearbox, etc. by an external station.

End of the guidance

400. Specific requirements for systems AUT-B and AUT-C

401. The equipment and systems ate to be in accordance with the requirements of the Part II, Title 102, Section 5, Subchapter A5.500, items 503 a 524. The materials are to comply with the ones cited at Part II, Title 102, subchapter A3.

402. Propulsion system and necessary equipment for operation free from local intervention for as long as the machinery space is unattended, according to the additional class notation adopted.

403. Service tank completed automatically with capacity enough to serve along the period the machinery space is unattended, according to the additional class notation adopted plus another 15 % reserve capacity, fitted with low level alarm and high level alarm, together with automatic filling pump shutdown and automatic pump start-up at a predetermined low level.

500. Specific requirements for systems AUT- E

501. Equipment and systems are to comply with the requirements of Part II, Title 102, Section 5, Subchapter A5.500, items 503 to 524, in addition to the requirements of Part II, Title 102, Subchapters A3 and A4. The propulsion system and necessary equipment are to be designed to operate with no local intervention for 24 hours.

502. Service tank completed automatically, with capacity for 24 hours plus a reserve capacity of 15%.

503. Remote control of the propulsion installation in accordance with the requirements of Part II, Title 102, Section 5, Subchapter A4.300.

504. Machinery safety system to be installed in accordance with Part II, Title 102, Section 5, Subchapter A4.400.

505. Machinery alarm system and alarm system of watch in accordance with the requirements of the Part II, Title 102, Section 5, Subchapter A4.500.

506. Boilers and oil heating systems in accordance with the requirements of the Part II, Title 102, Section 5, Subchapter A4.600.

507. Auxiliary diesel engines with remote control must meet the requirements:

a. the automatic start attempts or by remote control shall be limited in duration and number. The only systems allowed to start automatically or by remote control are those that allow the start at any position of the crankshaft;

b. automatic shut-down is to be provided in case of overspeed, detection of crankcase oil mist and failure in the lubrication of lube oil supply to the motors; and

c. auxiliary engines and equipment needed to operate with no local intervention for 24 hours.

508. Start air compressors are to be fitted with:

a. the automatic shut-down due to failure of pressurized system;

b. automatic shut-down due to lubricating oil pressure loss; and

c. proper automatic drain is to be provided for cooler and steam traps.

509. Start air control air bottles are to be completed automatically

510. Alarm recorder for engines with power greater than 1500 kW: provide alarm recorder of points when the limits of the parameters are exceeded as well as the time of the occurrence and the alarm release in chronological order. The beginning and the end of an alarm are to be clearly identifiable.

511. Remote fire pump start system: shall be installed in the bridge remote start system to one of the fire pumps and, where applicable, in the fire fighting main station. Associated valves shall bring instructional cards "keep the valves open at all times".

512. Pressures and temperatures needed for proper operation of the system: the pressures and temperatures required for the operation of the system in accordance with Table T.A8.101.1. are to be automatically controlled.

513. Auxiliary machinery essential to the propulsion system: For auxiliary machinery essential shall be provided with spare circuit according to the requirements of Part II, Title 102, Section 5, Subchapter A4.900.

514. Dales at the machinery space: are to be designed and fitted in accordance with the requirements of the Part II, Title 102, Section 5, Subchapter A4.700.

515. Systems of purifiers of FO e LO:

a. are to be of the type self-cleaning unless this operation is not needed during the period in which the machinery space remains unattended.

Guidance

If the FO and LO purifiers systems require cleaning with local intervention the degree of automation is to become AUT-16 or AUT-8, depending on the period in which it is necessary to clean.

End of the guidance

a. the sealing water temperature is to be automatically controlled and monitored;

b. poor operation in purification process shall cause automatic shut-down of purifiers.

c. the access of water into the sealing water output shall trigger an alarm; and

d. the preheating system is to be designed in such a way that the interruption of flow to the filtering system does not result in overheating

516. Power interruptions: shall be avoided or overcome in accordance with the requirements of the Part II, Title 102, Section 5, Subchapter A4.900

517. Shipside valves: valves of the side shell that are open during the operation of machinery shall be accessible and operated from safe height above the floors.

518. Fire alarm systems and fire alarm: shall be in accordance with the Part II, Title 102, Section 5, Subchapter A4.800.

519. It shall be installed remote control for one of the main fire pumps at the bridge and, where applicable, at the main fire control station

520. Fire fighting equipment: fire fighting equipment shall be in accordance with the Part II, Title 11, Section 3, Chapter E.

521. Communication system: reliable verbal communication system, i.e. designated phones, phones with batteries or sound activated are to be fitted between the MCR or control station, the bridge, the messing spaces and areas of engineer officers.

522. Controllable pitch propeller and side thrusters:

a. the system is to be equipped with an alarm that is triggered when the feeding of propulsion power unit fails. Preferably the direction driving force is to be retained long enough to allow the intervention of operators.

b. As a minimum requirement it shall be made arrangement to prevent an unexpected reversal of the thruster force, as, for example, the shaft line. The stop can be controlled automatically or by the operator

523. Clutches: an alarm shall sound in control stations in the event of a power failure (for systems operated electrically, pneumatically or hydraulically). The alarm shall occur in time to still be possible to operate the system manually.

524. Brakes: the automatic brake or with remote control shall be possible only if:

a. -the propulsion power is shut down;

b. -Ratchet is disconnected;

c. -the rotation of the shaft line is below the limit set by the manufacturer.

525. Main or auxiliary diesel engines that have integrated computer system shall comply with the requirements of Part II, Title 102, Section 5, Subchapter A7.

600. Specific requirements for systems AUT-F

601. The equipment and the systems are to be in accordance with the following requirements of the Part II, Title 102, Section 5:

a. Requirements for materials of the subchapter A3

b. Requirements for systems of monitoring of the subchapter A4

c. Requirements for notation AUT-E, of the subchapter A5 item .500;

d. Requirements of the present item A5.600;

e. Requirements for computerized systems of the Subchapter A6;

f. Requirements for systems integrated for diesel engines of the Subchapter A7.

602. The integrated computer control system shall control the failures within the tolerances and monitor the functions to one or more of the following services:

a. propulsion

b. system of generation and distribution of electric power (energy systems management)

c. Cargo and ballast

603. Special treatment will be given to other applications of the integrated computer system, except when it is already installed and available controls and monitoring as below:

a. -Integrated Control System for computing;

b. -Navigation System from the bridge (Integrated Navigation System or CNC); and

c. -Integrated System of fire fighting and prevention.

604. The report of analysis of failure modes and effects is to be presented (FMEA – failure mode and analysis).

605. The requirements of this subchapter A5.600 assumes that:

a. the conditions and emergency plans to be specified and the conditions in which is allowed a watch man of defined for this condition;

b. STCW regulations and national regulations relating to the watch are met;

c. personnel involved have qualified according to STCW or other relevant regulations.

Guidance

In addition to the requirements for 24 hours unattended machinery space controlled from the bridge, are to be met the requirements for integrated systems of control of the propulsion and auxiliaries from the bridge.

End of the guidance

A6. REQUIREMENTS FOR PROGRAMMABLE ELECTRONIC SYSTEMS

100. Application

101. The requirements of Part II, Title 102, Section 5, Subchapter A6 apply to the use of programmable electronic systems in control functions, alarm, monitoring and safety subjected to class requirements.

102. Aid to navigation equipment and cargo instruments are excluded.

Note: to cargo computers / instruments see the IACS REC No. 48.

200. Documents to be submitted

201. For the evaluation of programmable electronic systems of category II and III, the documents according to IEC 60092-504 paragraph 10.11 shall be submitted

202. When it is intended to use the design or is aimed to an alternative arrangement, it shall be presented to another engineering analysis.

203. For all tests required according to the category of the system shall be presented a test plan and the tests are to be documented.

204. More documentation may be required for the systems of category III. The documentation shall include a description of the test methods and results required.

205. For the equipment "*wireless data communication"*, the following requirements are to be submitted:

a. Details of installation and maintenance practices recommended by manufacturers;

b. Plan of the network with arrangement and antenna type and site identification.

c. Specification of the protocols of communication system "wireless" and functions of the management;

d. Details of radio frequency and power levels;

e. Evidence of type test in accordance with part III, Title 63, Section 8, Chapter A;

f. On-board testing program;

206. Documents for the evaluation of programmable electronic systems of category 1 shall be submitted if required.

207. The modifications are to be documented by the manufacturer. Significant modifications to the software and hardware for the system of categories II and III are to be submitted for approval.

208. Note: A significant change is one that influences the system functionality and/or safety.

300. Requirements for programmable electronic systems

301. All programmable electronic systems are to meet the requirements of the system to be controlled for all aimed operating conditions, taking into account the risk to personnel, the impact to the environment, damage to the ship as well as the equipment, ease of use of programmable electronic systems, and the operation of not-computerized systems and devices, etc. Programmable electronic systems are to provide functions to systems which are used in a safe, stable and repeatable under all operating conditions, including emergency operation. Response times are to be suitable for all functions, taking into account normal and abnormal operating conditions.

302. When it is proposed a different design or alternate arrangement of requirements, an engineering analysis is required, which shall be carried out according to national or international standards accepted by RBNA, as required by the regulations of SOLAS, Chapter II-1/F, rule 55.

303. Note: As the failure of a category III system can lead to an accident with catastrophic consequences the use of not-conventional technology for such applications will only be permitted in cases where evidence is presented showing that the performance of the system is reliable and acceptable to the satisfaction of the RBNA.

400. Categories of systems

401. The programmable electronic systems shall be classified into three categories, shown in table T.A6.401.1, according to the extent of possible damage caused by failure of the programmable electronic system. To be considered only the damages directly caused by the failure, but not the indirect consequences. Identical redundancies shall not be taken into account in the allocation of the category system.

402. The assignment of an appropriate category to a programmable electronic system is to be made according to the greatest extent possible due to a malfunction. For examples see table T.A6.402.1. The examples listed do not represent the totality of applications.

403. Note: when there is an efficient stand-by system or other effective means of avoiding risk in a system categorized as category III, can be considered a reduction of a category.

500. Links for data communication

501. The requirements presented in this item A6.400 will apply to systems classified as category II and III using shared data communication links to transfer data between different programmable systems or electronic equipment.

502. When the failure of a single component has resulted in the loss of means of communication it shall be provided for arrangement to restore automatically the data transmission.

503. The loss of a data transmission link shall not affect the ability to operate critical systems by alternative means.

504. They are to be equipped with means to protect the integrity of data and provide recovery of corrupted or invalid data in time

505. The data transmission link is to be verifiable by detecting flaws in the auto link and data communication failures in nodes connected to the link. The faults detected shall trigger an alarm.

TABLE TA6.401.1 - CATEGORIES OF SYSTEMS

Category	Effects	Function of the system
I	Systems in which failure will not lead to situations that endanger safety of human life, safety of the ship and / or threat to the environment.	-Monitoring function for informational and administrative tasks
II	Systems in which failure could eventually lead to situations of danger to safety of life, ship and / or threat to the environment.	-Monitoring and alarm Functions - Control functions that are necessary for maintaining the ship in normal operational and habitable conditions
III	Systems in which failure could lead to situations of immediate danger to safety of life, ship and / or threat to the environment	-Control functions to maintain the propulsion and ship's steering - Safety functions

TABLE T.A6.402.1 - EXAMPLES OF ASSIGNMENT OF CATEGORY TO SYSTEMS

Category	Examples
I	Maintenance and support systems Diagnostic and information systems
II	Monitoring and alarm equipment Level measuring equipment of the tanks Control systems for auxiliary machinery Remote control of the propulsion systems Fire detection systems Fire extinguishing systems Hull sewage systems Speed regulators
III	Machinery /equipment protection systems Burner control systems Electronic injection for diesel engines Propulsion and steering control systems Sync units for electric boards

506. Means are to be provided to self-assessments of system capabilities to start the transition to the state less dangerous for the complete installation in the event of a failure of communication of data.

507. The characteristics of the data communication link are to be such as to convey all the necessary information in useful time and the overload be prevented

600. Protection against modifications.

601. Programmable electronic systems of category II and III are to be protected against any modification of the program by the user.

602. For systems of category III parameter modifications by the manufacturer are to be approved by the Society.

603. Any modifications made after the performance of the tests witnessed by Society according to item 6 of the Table T. T 1.101.1 are to be documented and traceable

700. Additional requirements for wireless data links

701. These requirements are in addition to those mentioned above and apply to category II system using wireless data communication links to transfer data between distributed programmable electronic equipment or systems. For system category III, the use of wireless data communication links shall be according to A6.302.

702. Functions that are required to operate continuously to provide essential services dependent on wireless data communication links shall have an alternative form of control that can be put into action within a reasonable period of time.

703. Wireless data communication are to employ wireless protocols of recognized international wireless communication system incorporating the following:

a. Message integrity. Prevention, detection, diagnosis and correction of faults so that the message received be not corrupted or changed as compared to that was transmitted.

b. configuration and device authentication. Allow only the connection of devices that are included in the design of the system;

c. message encryption. Protection of confidentiality and criticality of the content or data;

d. Security Management. Network asset protection, prevention of unauthorized access to network assets.

704. The wireless system is to comply with the requirements of radio frequency and power level of the International Telecommunications Union – ITU - and the requirements of the flag state

705. Note: it shall be considered the operation of the system in case of being forbidden to date communication link by the port State and local regulations concerning the use of radio-frequency transmission due to restrictions of frequency and power level.

800. Systems integration.

801. Effective operation: the operation employing an integrated system shall be at least as effective as the operation with systems or equipment stand alone.

802. Integrated system failures: failures in one part of an integrated system shall not affect the functionality of other parts, except for the functions directly dependent on the faulty component.

803. Displays and multiple controls function: displays and multiple controls function must be redundant and interchangeable. The quantity of units control in stations are to be sufficient to ensure that all functions can be provided with any one of the units out of service, taking into account any functions that require continuous availability.

A7. INTEGRATED COMPUTING SYSTEMS FOR DIESEL ENGINES.

100. Implementation, general requirements, design requirements

101. This chapter applies to computerized control and monitoring systems for propulsion and auxiliary diesel engines.

102. These requirements are essential for the assignment of class notation AUT-F.

103. In addition to the documents required in section B, the following documents are to be submitted for information and analysis:

a. Block diagram of embedded computing system;

b. Description of information transmission protocol;

c. Description of the function of self-diagnosis;

d. Analysis of the failure mode and effects (FMEA) of the computer system used to track and monitor the machinery.

104. The computerized integrated system of control and monitoring of services essential for the propulsion and safety of the ship shall be tolerant to a specified level.

105. An Analysis of Failure Mode and Effects (FMEA) must be performed to demonstrate the functions of monitoring and control available in the event of a single failure of integrated computing system.

106. Measures are to be taken to prevent the interaction between the various automatic control circuits in case of a failure in one of them, such as galvanic separation automatic control circuit or ground fault monitoring with possibility of disconnecting the circuit where the failure occurred while keeping the other in operation.

107. The computing network is to allow communication between the subsystems up to an extent acceptable to that network. The interconnected subsystems on the network are as follows:

a. Automatic Control Systems of machinery according to A1 above.

b. Dynamic positioning systems, automatic, when applicable.

108. The computing machinery network is not to be used for not-essential functions. A separate network is to be equipped with means for not-core functions, as needed.

109. The computing machinery system shall be redundant or semi-redundant and can be equipped with a device which, in the event of a failure of a network, performs automatic change to another network. The redundant is monitored by two networks at the same time and does not change the key. In the case of semi-redundant, one of the networks remains in a state of "waiting" ("stand-by") and comes into action when it is required.

110. The integrated automation system is to be designed in such a way that the subsystem to keep operating in the event of loss of network transmission.

111. In the event of a failure of a service station the corresponding functions shall be transferred and exercised by any other station without stopping the operation of the system.

200. Construction requirements

201. Environmental requirements: specific environmental conditions shall be considered such as air temperature,

humidity, vibration and corrosion by chemical, biological or mechanical attacks.

202. Construction requirements for electricity and electronics

a. The connections must be installed with use of terminals that prevent vibrations.

b. Welded connections shall be avoided directly to printed circuit boards.

c. Fixing of circuit boards are to be free of mechanical stress.

d. Special consideration shall be given to printed wiring boards and their components with regard to vibration.

e. electrical components and fluid shall be separated and where there is the likelihood of leakage, there shall be means to drain or output the location.

300. Construction requirements for pneumatic systems

301. The compressed air is to be provided by two sources that have enough flow to maintain normal operation when one is out of service.

302. The pressure is to be automatically maintained at a level that permits satisfactory operation of the installation.

303. The monitoring and control system is to be equipped with one or more air tanks containing valves reserved for monitoring and control facilities.

304. If the compressed air to the monitoring and control circuit is supplied by reducing valves, these are to be duplicated along with their filters, unless there is an emergency power system.

305. The pneumatic systems of monitoring and control are to be provided with automatic cooling control, filtering, separation of water and oil from the compressed air before its introduction in the circuit.

400. Construction requirements for hydraulic systems

401. The circuits are to be equipped with at least two supply pumps for that pressure is maintained when one of them is out of service. The facilities shall be such that one of the pumps to suffer maintenance and repairs while the other remains in operation.

402. The capacity of the tanks is to be sufficient to ensure the maintenance of an adequate level during operations and during stop periods, as well as the settling of impurities and aeration of liquid.

403. The hydraulic fluid is to have constant characteristics and suitable for its function and particularly a satisfactory viscosity in the operating temperatures. The flash point and self combustion or destruction by heat is to be the highest possible.

404. The transducers employed in the networks are to be of the type that avoids delay in data transmission, especially where viscous fluids are used.

405. Vent pipes are to be laid down for the various circuits.

500. Machinery control

501. The operations required to pass from the condition manoeuvreing to condition sailing and vice versa, are to be automated.

502. When passing from the readiness condition to the sailing condition and from the sailing condition to the readiness condition, the gradual increase or decrease in power shall be automated if considered necessary by the manufacturer. When the system be fitted with this control, the device is to be capable of being quickly cancelled from the bridge, by MCR or location, for the case of emergency manoeuvres, in the engine itself or in the MCR.

503. The operations to be carried out from monitoring and control stations are to be set taking into consideration the type of facilities and their level of automation. Operating conditions shall also be considered during periods of problems when it is planned an intervention or direct observation.

504. When the controls are sufficiently centred on equipment allowing for rapid intervention, monitoring and control station can be replaced by a monitoring-only station with all the necessary information for a prompt intervention or direct observation.

505. When transmitting information for hydraulic circuits means shall be taken to prevent the leakage of fluid that may cause electrical effects in the operation of the equipment, and shall be separated from electrical equipment with the installation of trays where necessary.

506. The measuring instruments located on the bridge shall be bright or fluorescent. It shall be reduced to the maximum the number of “luminosity reducers" ("dimmers"). It must not be possible to hide or delete completely the light signal alarms.

507. Arrangements are to be provided with for start propulsion from the bridge after a crash or power loss. There shall be an indication on the bridge that the systems are all ready for the start. Special care is to be taken with regard to:

a. Reset shut-down devices;

b. Start of engines that can be uncoupled;

c. Automatic start of the auxiliary boiler.

d. Start in emergency of the propulsion engine exceeding all security devices.

508. When there is only one service watch controller and the he is supposed to be absent in the bridge, it shall be able to transfer the alarms to another location.

600. Installations with Diesel engines

601. The lubrication system of liners, when available, is to be equipped with alarm device that triggers in the event of a failure of one of the distribution panel. The monitoring shall be carried out in at least two power lines in each panel and at least one line per cylinder.

602. The drainage of the lower spaces under the pistons in engines with crosshead is to be performed continuously or automatically at regular intervals.

603. The frequency of the operation is to be manually adjusted to take account of the operating conditions and the condition of the motor (cylinder lubrication adjustment, condition of the rings, etc.). In this case, an alarm shall be triggered if the drainage has not been performed at the predetermined time.

604. An alarm is to be equipped to indicate the presence of water in the sinks ("manifolds") of the turbo feeder. In this case a motor auto lock is also to be installed unless be presented reasons justifying the not-locking installation.

605. During the condition of manoeuvre with heavy oil the correct motor operation is to be carried out automatically and provisions shall be laid down to ensure long-term stops. If specific operations are required, such as an exchange of the injector cooling, these are to be automated.

606. Unless it is not recommended by the manufacturer, the engines with remote starter are to be fitted with means of, from the bridge, turn on the motor with compressed air after any intentional shut-down greater than 10 minutes. With this aim it is be provided a warning light, identified and automatically activated. The operation shall be possible only when the following conditions have been met:

a. Shaft line brake released;

b. Ratchet disengaged;

c. Injection pump rack to the zero position;

d. Control system on bridge enabled.

607. Additionally the control station in operation shall be provided with the means to check that the compressed air start is being correctly executed.

608. The remote control of the start by compressed air from the bridge is to be able to be removed from the control station.

609. The bridge station shall be provided, for each engine, of:

a. A tachometer for the engines that can be uncoupled;

b. An indicator of the injector rack load or an overload alarm;

c. A sign “automatic start valve closed manually”.

610. The following additional alarms are to be installed:

a. Thermal overload of the engine (exhaust gas temperature);

b. Low-temperature cooling of the cylinder and/or piston. Additionally the inlet and outlet valves of each cylinder shall be locked in the "open" position;

c. Differential pressure through the fuel oil filters;

d. High temperature of reduction gearbox, reverse gearbox or clutch.

700. Propeller shafts, clutches, CPP, reducing gears.

701. The temperature of each shaft line bearing between the main engine (or reduction gearbox) and the telescopic tube are to be monitored. This monitoring may or may not be waived for bearings with roller bearings.

702. Alternatively, a group alarm shall be endowed, associated with an acceptable means of failure detection.

A8. AUTOMATION POINTS TABLE

100. Sensors for diesel engines for propulsion

101. Table for medium and high speed engines.

TABLE T.A8.101.1 – SENSORS FOR HIGH AND MEDIUM SPEED ENGINES

F = failure B = low A = high R = reduction P = stop D = triggering device at readiness	Points for alarms	Points for equipment at readiness	Points for functions of safety	Individual alarms on the bridge
Lubricating oil				
Lubricating oil pressure at engine input [1, 2.]	B	B, D	B, P	
Differential pressure in the lubricating oil filter	A			
Lubricating oil temperature at engine input	A		A,R	
Crankcase oil mist or high temperature of the engine bearings (engine with P > 2250 kW or cylinder diameter > 300 mm)	A		A,P	
Failure in the lubrication of the cylinders	F		F,R	
Level of LO in the crankcase sump [1]	B			
Failure in the LO automatic filter	F			
Temperature of the thrust bearing	A		A,R	
Cooling				
Pressure of cooling of liners	B	A, D	B, P [5]	
Temperature of cooling water of liners in the output of each cylinder [3]	A		A,R	
Water level in the expansion tank	B			
Oil contamination of water in the liners [4]	F			
Pressure of cooling saltwater	B	B, D		
Pressure of water in the circuit of freshwater cooling of low temperature	B			
Temperature of water in the circuit of freshwater cooling of low temperature	A			
Temperature of cooling water of liners in the output of the engine	B			
Fuel oil				
Pressure in the injection pumps of FO	B	B, D		
Injection pipe leak	F			
Exhaust gas				
Temperature of exhaust gas at the input and at output of the turbocharger	A			
Temperature of exhaust gas in each cylinder [6]	A		A,R	
Deviation from the mean temperature of exhaust gas [6]	B, A			
Turbocharger				
Pressure of LO of the turbocharger [7]	B			
Pressure of LO at the output of the turbocharger [7]	A			
Temperature f the intake air [8]	A, B			
Compressed air				
Pressure of control air pressure	B			
Pressure of starting air [9]	B			
Disarm by overspeed	A		A, P [2]	

Superscript:

1 Individual alarms are to be provided for separate circuits.
2 Stop device applicable only to engines with power greater than 220 kW.
3 When the cylinders have a common chamber of cooling water output the monitoring per cylinder can be waived. In this case it is to install separate alarm sensors and reduction.
4 Applicable only when cooling water is used to heat or cool fuel oil or lubricating oil.
5 If the dimensions of the engine do not permit its installation, provide alternatively of stop per high temperature of cooling water in the liners.
6 For engines with more than 500 kW per cylinder.
7 Do not apply to units containing self-contained lubricating circuits.
8 Alternatively water detector in intake duct instead of low temperature.
9 For reversible engines and engines starting from the bridge to be provided with individual alarm.

102. Table for low rotation engines

TABLE T.A8.102..1 – SENSORS FOR LOW ROTATION ENGINES

F = failure B = low A = high R = reduction P = stop D = triggering device at readiness	Points for alarms	Points for equipment at readiness	Points for functions of safety	Individual alarms on the bridge
Lubricating oil				
Lubricating oil pressure in the engine input [1, 2.]	B, R	B, D	B, P	
LO pressure on the camshaft [1]	B	B, D	B, P	
Differential pressure in lubricating oil filter	A			
Lubricating oil temperature at the input of engine	A		A, R	
Crankcase oil mist or high temperature at engine bearing (engine with P > 2250 kW or cylinder diameter > 300 mm)	A		A, R [3]	
Failure of cylinder lubrication	F		F, R	
LO level in the crankcase sump [1]	B			
Failure of the LO automatic filter	F			
LO temperature in the camshaft [10]				
Temperature of the thrust bearing	A		A, R	
Cooling				
Pressure of cooling of liners	B	A, D	B, P [5]	
Temperature of the cooling water of liners at the output of each cylinder [5]	A		A, R	
Water level in the expansion tank	B			
Oil contamination of water in the liners [6]	F			
Pressure of cooling saltwater	B	B, D		
Pressure of water in the circuit of freshwater cooling of low temperature	B			
Temperature of water in the circuit of freshwater cooling of low temperature	A			
Cooling water pressure of pistons	B, R	B, D		
Cooling water temperature on each piston	A, R			
Cooling water flow to each piston [12]	B, R			

Cooling water pressure of injection valves	B			
Cooling water temperature of injection valves	A			
Cooling water temperature of liners at engine output	B			
Fuel oil				
Pressure in the injection pumps of FO	B	B, D		
Injection pipe leak	F			
Exhaust gas				
Temperature of exhaust gas at the input and at output of the turbocharger	A			
Temperature of exhaust gas in each cylinder	A, R			
Deviation from the mean temperature of exhaust gas	B, A			
Turbocharger				
LO pressure of the turbocharger [8]	B			
LO pressure at the output of the turbocharger [8]	B			
Temperature of the input air [7]	A, B			
Compressed air				
Control air pressure [11]	B			
Starting air pressure [9]	B			
Disarm by overspeed	A		A, P [2]	
Failure of the electric fan of the scavenging air	F			
Temperature of the scavenging air (fire)	A		A, R	
Wrong direction of rotation	F			

Superscript:
1 Individual alarms are to be provided for separate circuits.
2 Stop device applicable only to engines with power greater than 220 kW.
3 Reduction to the minimum speed for manoeuvres.
4 Alternative methods to be submitted to the RBNA.
5 When the cylinders have a common chamber of cooling water output the monitoring per cylinder can be canceled.
6 Applicable only when cooling water is used to heat or cool fuel oil or lubricating oil.
7 Alternatively water detector in intake duct instead of low temperature.
8 Not applicable for units with self-lubrication.
9 For reversible engines and engines starting from the bridge to be provided with individual alarm.
10 If separate systems of lubricating oil to be installed.
11 When a separate loop of the control air is used with the purpose of emergency stop a low alarm is to be provided.
12· Stop, where necessary.

200. Sensors for the auxiliary Diesel engines

201. Table for the auxiliary Diesel engines

TABLE T.A8.201.1 – SENSORS FOR AUXILIARY DIESEL ENGINES

F = failure B = low A = high R = reduction P = stop D = triggering device at readiness	Points for alarms	Points for equipment at readiness	Points for functions of safety	Individual alarms on the bridge
Lubricating oil				
Lubricant oil pressure [1]	B		B, P	
Lubricating oil temperature	A			
Diferential pressure in the LO filter	A			
Cooling water flow	B			
Cooling air or water temperature	A			
Water level in tank equalizer if a separate circuit	B			
Starting air pressure	B			
Fuel oil pressure	B			
Temperature or viscosity of heavy oil	A, B			
Injection pipe leak	F			
Overspeed [1]			P	
Oil level of the service tanks	B			A, P
Crankcase oil mist or high temperature of the bearings of the engine (engine with P > 2250 kW or cylinder diameter > 300 mm) [2, 4.]	A		P	
Exhaust gas temperature of each cylinder [3]	A			
Deviation from the mean temperature of exhaust gases [3]	A			
System *common rail* of the fuel oil pressure	B			
System *common rail* oil pressure of the servo-mechanism	B			

Superscripts:
1 For engines rated higher than 220 kW only.
2 High-speed engines for other monitoring methods may be accepted by RBNA.
3 For engines rated higher than 500 kW per cylinder.
4 Required also for engines without notation AUT.

300. Sensors for the reduction gearbox, shaft lines and variable pitch propellers

301. Table for the reduction gearbox, shaft lines and variable pitch propellers.

TABLE T.A8.301.1 – SENSORS FOR REDUCTION GEARBOX, SHAFT LINES AND VARIBLE PITCH PROPELLER

F = failure B = low A = high R = reduction P = stop D = triggering device at readiness	Points for alarms	Points for equipment at readiness	Points for functions of safety	Individual alarms on the bridge
Reduction gearbox				
LO input pressure	B, R	A, D [1]	B, P	
LO temperature at the input to the gearbox/ after the cooler [2]	A, R			
LO pressure at the input of the gearbox/before the cooler [3]	A, R			
Pressure drop of LO in the filter	A			
Radial bearings temperature [4]	A			
Reduction gearbox integrated bearings temperature [5, 6.]	A, R			
Lubricating oil level in the sump	B			
Mechanical / multi disc clutch				
Operating pressure	B, R	B, D		
Control to slip in the engaged position			B, P [7]	
Shaft line bearings, telescopic tube				
Temperature of the bearings or LO in the radial bearings[8]	A			
Temperature of the bearings or LO in thrust bearings [5, 8]	A, R			
Bearing temperature aft telescopic tube [9]	A			
Oil level in the gravity tank	B			
Direction of rotation [10]	F			
Variable pitch systeml				
Hydraulic oil pressure	B	B, D [1]		B
Device control tank oil level	B			
Hydraulic oil temperature	A			
Pressure drop in the hydraulic oil filter	A			
Pitch control failure / malfunction	F			

Superscripts:

1 Only when a stand-by pump is recommended.

2 For all the gearboxes with plain bearings and for gearboxes with bearings with roller bearings with transmission power greater than 500 kW.

3 Required for applications where no other temperature is monitored inside the gearbox.

4 Do not apply for gearboxes with rolling bearings.

5 Forward only.

6 For gearboxes with roller bearings, can be replaced by lubricating oil temperature monitoring

7 It can be measured by direct methods, i.e. speed differential measures, monitoring the minimum acceptable pressure. The engine stop can be replaced by alternative methods, such as sliding clutch disengagement.

8 Do not apply for devices with bearing when the shaft diameter is less than 300 mm.

9 For oil lubrication and for shaft diameters smaller than 400 mm the oil temperature in the vicinity of the aft bearing can be monitored. Do not apply for bearing with water lubrication provided the shaft diameter is less than 400 mm.

10 Applicable for reversible engines only.

400. Sensors for steering systems

401. Table for steering systems

TABLE T.A8.401.1 – SENSORS FOR STEERING SYSTEMS

F = failure B = low A = high R = reduction P = stop D = triggering device at readiness	Points for alarms	Points for equipment at readiness	Points for functions of safety	Individual alarms on the bridge
Steering system [1, 2.]				
Loss of voltage supply to the power unit	F	F, D [3]		F
Overload and phase failure of the electric drive	F	F, D [3]		F
Low level of hydraulic oil tank	B	F, D [3]		B
Loss of control unit to the voltage supply of the steering system	F	F, D [3]		F
Hydraulic system failure (hydraulic locking)	F	F, D [3, 4]		F

Superscripts:

1 The sensors as listed in this table are primarily based on the International Convention SOLAS regulations and shall, therefore be required also to vessels without the class notation AUT.
2 For each steering device a common alarm in the machinery space is acceptable.
3 For oil tankers, chemical and liquefied petroleum gas carriers with more than 10000 TAB the capacity of steering is to be retrieved in 45 seconds after a failure of one of two redundant systems (SOLAS).
4 The failed subsystem is to be stopped and the affected parties shall be isolated

500. Other sensors

501. Table for auxiliary boilers

TABLE T.A8.501.1 –AUXILIARY BOILERS

F = failure B = low A = high R = reduction P = stop D = triggering device at readiness	Points for alarms	Points for equipment at readiness	Points for functions of safety	Individual alarms on the bridge
Auxiliary boilers				
Water level	L,H		L, H (1)	
Steam pressure	H			
Steam temperature			F	
Circulation pump flow	L		L (1)	
The presence of oil on the heating steam drains	F			
Fuel oil pressure	L			
Failure in the ignition	F			
Temperature and viscosity of fuel oil (2)	L, H			
Low pressure combustion air supply			F	

(1) Auotmatic fuel oil shut-down
(2) If HFO (Heavy fuel oil) be used

502. Table of fire systems and electrical Installations

TABLE T.A8.502.1 – FIRE SYSTEMS AND ELECTRICAL INSTALLATIONS

F = failure B = low A = high R = reduction P = stop D = triggering device at readiness	Points for alarms	Points for equipment at readiness	Points for functions of safety	Individual alarms on the bridge
Fire Systems				
Fire alarm	F			
Failures	F			
Electrical installations	F			
Failure in main power supply system	F			
Disconnect not-essential consumers	F			
Main generator key activation	F			
Low frequency	L			
Over-voltage	H			
Failure in the 24 V charger	F			
Common failure in the power management system	F			

502. Other

TABLE T.A8.503.1 – OTHER SENSORS

F = failure B = low A = high R = reduction P = stop D = triggering device at readiness	Points for alarms	Points for equipment at readiness	Points for functions of safety	Individual alarms on the bridge
Other				
Failure in the main engine remote control system	F			F
Failure in the machinery alarm system	F			F
Failure in the watch alarm system	F			F
Failure in the safety system	F			
Activation of the safety system	F			
Override the activated safety system	F			
Automatic starting of essential auxiliaries if they have not started in normal condition	F			
Failure of a sand-by control unit	F			
High level in the bilge of the machinery space	F			
Oil content in water in output of oil and water separator	F			
Starting time and frequency of automatic bilge pumps	F			
Tank level of overflow of fuel oil	F			
Failure of low pressure of system CO2	F			
Failure in the starting of air compressor	F			
Low pressure in the fire fighting system	F			
Activation of automatic spraying for fire fighting system (spray)	F			F

CHAPTER B
MONITORING SYSTEMS, AUTOMATION AND CONTROL FOR COMPACT ENGINES WITH PERIODICALLY UNATTENDED MACHINERY SPACE

B1. SCOPE

100. Nature of the systems

101. Considering that ships usually are:

a. Fitted with compact engines with power less than 2500 kW where the fuel systems, lubrication and cooling are integral to the engine, and therefore there are no external main or stand-by pumps;

b. The dimension of the machinery spaces does not allow the installation of a control station inside;

c. Are operated from the bridge;

102. Considering else that such ships can be equipped with monitoring and control systems that set up the bridge as a control station and, even more, that they allow their operation from the bridge being the machinery space unattended for periods of time perfectly established;

103. The RBNA Technical Committee decided to issue a chapter with specific rules for monitoring systems, control and automation for such ships being generated this Part II, Title 102, Section 5, Chapter B.

200. Application

201. This section applies to the automation class notation of ships for navigation in Open Seas fitted with compact power engines of less than 2500 kW and gross tonnage of less than 500 AB and length ≥ 20 metres.

a. Ships with length < 20-meter may be especially considered by RBNA provided it is established that comply with the requirements of item B1.206 below;

b. Ships intended to inland navigation may be granted additional class notation provided that after examination by RBNA is established that comply with the requirements of item B1.205 below;

202. RBNA may review upon request the approval of automation systems for engines with power less than 1500 kW that are not fully in accordance with the requirements of this Title 102.

Guidance

Compact engines with power less than 1500 kW are equipped with automation and control systems that vary according to the manufacturer, and it is not always possible to meet fully the requirements of subchapter B8. In this case, all the information about the existing automation and control functions shall be subjected to the RBNA for analysis, accompanied by the relevant documentation.

End of guidance

203. Present Chapter B contains modifications in relation to Chapter A in which the requirements for sensors and essential auxiliaries shall attend the construction characteristics of compact engines. However:

a. The requirements of Part II, Title 102, Section 5, subchapters A3 and A4, have not been modified.

204. All requirements are additional to those in part II Title 11 Section 3 and Section 5.

205. In the present Chapter B the arrangement of the system shall ensure that under all conditions of operation and navigation, including manoeuvres, the safety shall be equivalent to that of a vessel with a machinery space manned.

206. This 2014 Edition Rule does not cover steam propulsion, auxiliary steam turbines and gas turbines.

300. Terms
- see Chapter A

Guidance

TABELA T.B1.301.1 – Correspondence between degrees of automation RBNA and NORMAM 01

Notation RBNA	*Degree Type according to NORMAM 01*
AUT-A	*A*
AUT- B	*B*
AUT-C	*C*

AUT-E	*E*
AUT-F	*F*

Systems notation AUT-A with machinery space permanently manned with centralized control in MCR in the machinery space allow certain essential systems to be triggered by the engineer's action from the control station.

Systems notation AUT-B and AUT-C differ from the AUT- system by the absence of MCR and for having the machinery space unattended by 8 hours (AUT-B) or by 16 hours (AUT-C). The control is done from the bridge. The period in which the machinery space is unattended will depend on the need for the presence of a person every 8 hours or every 16 hours in the machinery space due to the need of local intervention in some system. Other factors that can influence:

- capacity of daily fuel oil tank

-transfer from the storage tank to the daily fuel oil tank

-factors affecting the safety of operation

The NORMAM 01 degree D of automation is not considered by RBNA, since it only covers navigation and manoeuvres. The requirements of this Title 102 cover both the navigation conditions and the manoeuvres, but do not cover mooring and unmooring

Systems notation AUT-E features the machinery space unattended for a period of 24 hours. What differentiates the AUT-B and AUT-C systems is that the propulsion system and equipment required for operation shall be free of local intervention for as long as the machinery space is unattended, according to the additional class notation adopted: in the case of the notation AUT-B, the systems remain free of the heed of local intervention for a period of at least 8 hours; in AUT-C, for 16 hours, and in the case of the AUT-E for 24 hours. As it turns out, what will differentiate the AUT-E of the AUT-B and AUT-C is just the period in which the propulsion systems and equipment required for operation are free of local intervention, rather than requirements of rules and regulations, because how one can check in the subchapter A4, these requirements are the same for all three degrees of automation, this refers to the period in which the Engine Rom remains unmanned.

Systems with AUT-F notation requires fully support the requirements for AUT-E systems and the provision of an integrated system of automation and control.

While the AUT-E systems can be:

of open-loop or closed loop
"stand alone" or integrated,

AUT-F systems must be:
closed loop
integrated

Table T. B1.301.2 below shows in summary form the main differences between the specific requirements for each additional notation of automation.

Note: the table T. B1.301.2 is informational only and does not replace the full application of the requirements of this Title 102.

TABLE. T. B1.301.2 – COMPARISON BETWEEN THE SPECIFIC REQUIREMENTS FOR THE AUTOMATION NOTATIONS

IMO/ISO regulations on arrangement of bridge equipment	*AUT-A*	*AUT-B AUT-C*	*AUT-E*	*AUT-F*
Permanently manned machinery space	*Yes*	*Yes*	*No*	*No*
Cetralized control on MCR	*Yes*	*No*	*No*	*No*
Cetralized control on bridge	*No*	*Yes*	*Yes*	*Yes*
Free of local direct intervention for a minimum period of 8 or 16 hours	*No*	*Yes*	*Do not apply*	*Do not apply*
Free of local direct intervention for a minimum period of 24 hours	*Do not apply*	*Do not apply*	*Yes*	*Yes*
Integrated automation and control system	*Do not apply*	*Not mandatory*	*Not mandatory*	*Mandatory*
IMO/ISO regulations on arrangement of the equipment on the bridge	*Do not apply*	*Do not apply*	*Do not apply*	*Additional CNC notation only*
Requirements of the subchapter A4 Alarm, control and safety	*Applicable*	*Applicable*	*Applicable*	*Applicable*
Requirements of the subchapter A5.100 Specific requirements for automation systems (general – all degrees)	*Applicable*	*Applicable*	*Applicable*	*Applicable*
Requirements of the subchapter A5.200- for automation systems AUT-A	*Applicable*	*Do not apply*	*Do not apply*	*Do not apply*
Requirements of the subchapter A5.300 for automation systems AUT-A for ships with L < 50 meters	*Applcable to ships with L < 50 meters*	*Do not apply*	*Do not apply*	*Do not apply*
Requirements of the subchapter A5.400 Specific requirements for automation systems AUT-B e AUT-C	*Do not apply*	*Applicable*	*Não Aplicáveis*	*Não aplicáveis*
Requirements of the subchapter A5.500 Specific requirements for automation systems AUT-E	*Do not apply*	*Applicable **	*Applicable*	*Applicable*
Requirements of the subchapter A6 – Specific requirements for automation systems AUT-F	*Do not apply*	*Do not apply*	*Do not apply*	*Applicable*
Requirements of the subchapter A7 – Integrated computer systems for diesel engines	*Not mandatory*	*Not mandatory*	*Not mandatory*	*Mandatory*
Tables of points of subchapter A8 (vessels > 500 AB with not-compact engines) and subchapter B8 (ships with compact engine)	*Applicable*	*Applicable*	*Applicable*	*Applicable*

* In the case of AUT-B and AUT-C, applicable to the period in which the machinery space remains unattended. AUT-E systems, for 24 hour unattended machinery space.

End of the guidance

B2. DOCUMENTS, REGULATIONS AND STANDARDS

100. Required Plans and Informations
– see Chapter A

B3. MATERIALS FOR AUTOMATION SYSTEM

100. Qualification of components
– see Part III, Title 63, Section 8, Chapter A.

200. Environmental conditions
– see Part II, Title 11, Section 7, Chapter E, subchapter E1.

B4. BASIC REQUIREMENTS FOR CONTROL, ALARM SYSTEMS AND SAFETY ON SHIPS WITH A PERIODICALLY UNATTENDED MACHINERY SPACE – See Chapter A

B5. SPECIFIC REQUIREMENTS FOR AUTOMATION SYSTEMS ACCORDING TO CLASS NOTATION

100. General requirements for automation systems - See chapter A

200. Requirements for systems AUT-A

201. For AUT-A notation, it must be installed a Machinery Control Room within, or adjacent to a periodically unattended machinery space. The propulsion system is to be controlled from the bridge or from a Machinery Control Room installed within or adjacent to unattended machinery space to allow the ship to be controlled without restrictions for a man. The remote control system is to comply with the applicable requirements of Part II, Title 102, Section 5, Subchapter A4.300. The materials are to be in accordance with Part II, Title 102, Section 5, subchapter A3.

202. All propulsion system operational data together with the status of operation of essential auxiliary machinery system shall be shown in the Machinery Control Room.

203. Machinery safety system to be installed as Part II, Title 102, Section 5, Subchapter A4.400.

204. Machinery alarm system and watch alarm system of room in accordance with the requirements of Part II, Title 102, Section 5, Subchapter A4.500.

205. Boilers and oil heating systems in accordance with the requirements of Part II, Title 102, Section 5, Subchapter A4.600.

206. Essential auxiliary machinery to the propulsion system: essential auxiliary machinery and their stand-by units shall have their departure and stopping controlled from the Compartment of Machinery Control as the Table T. B 5.206.1 below.

TABLE T.B5.206.1 – TABLE OF CONTROL OF THE ESSENTIAL AUXILIARY MACHINERY

Essential Auxiliary Systems PT II, Tit. 102,Sec 5, B5.200					
Main Equipment	**Auxiliar Equipment**	**MCR AUT-A**		**Unattended machinery Space AUT-F, AUT- E, AUT-B/C**	
		Start	*Start after Failure*	*Automatic Switching*	*Departure after Failure*
Main Boiler	Fuel oil service pumps	**x**		**x**	**x**
	Circulating pumps	**x**		**x**	**x**
	Feed water pumps	**x**		**x**	**x**
Azimuth Thruster	Hydraulic oil pumps	**x**	**x**	**x**	**x**
	Lubricating oil pumps	**x**		**x**	**x**
Steering Gear	Hydraulic system pumps	**x**	**x**	**x**	**x**
Variable Pitch Propeller	Hydraulic pumps	**x**	**x**	**x**	**x**
Fire Fighting System	Main fire pump	**x**		**x**	**x**

207. Starting and connecting the generator groups are to be possible by the Machinery Control Room.

208. Fire detection and alarm system shall be installed in accordance with the Part II, Title 102, Section 5, Subchapter A8.

300. Requirements for systems AUT-A in ships with L < 50 metes

301. For vessels with L < 50 meters or where there is no space available in the machinery space for installation of a Machinery Control Room the class notation AUT can be awarded provided they comply with the requirements of Part II, Title 11, Section 5, A5.200 above.

302. In addition, the requirements of this Subchapter A5.300 presented below are to be complied.

303. Alarms: the alarm system is to indicate more than one failure at the same time and be arranged so that the detection of one failure does not inhibit another alarm. Sound alarms are to be maintained until they are noticed.

304. The high-pressure pipe injection line and return pipe of main and auxiliary engines are to be effectively shielded and fitted in such a way as to prevent fuel or oil mist of fuel reaches ignition source on the engine or around the same.

305. The height of the coaming oil containment around the boiler shall be in accordance with the requirements of Part II, Title 11, Sections 3 to 6 of these Rules. For other equipment, that coaming is to have a minimum height of 150 mm. Around the fuel oil system components of Diesel engines (injection pumps, filters, etc.) a tray with coaming height of 75 mm may be used.

306. Where the oil fuel tanks are automatically filled or by remote control they are to be provided with means to prevent overflow

307. Where the service tanks or oil-fuel settling are equipped with heating devices, a high temperature alarm, audible in the bridge, is to be provided in such a way that the fuel's flash point is not exceeded

308. The requirements of Part II, Title 102, Section 5, Subchapter A4.700 for high-level alarms in dales of the machinery space is to be complied.

309. The following alarms and indicators are to be provided on the bridge, in the navigation sector:

a. Low pressure alarm for main engine and LO reduction gearbox;

b. High temperature engine cooling medium;

c. Low start air pressure (if applicable);

d. Propeller rotation;

e. Indication of rotation or pitch: AV, AR, Pitch;

f. Stopping the steering engine;

g. Control power failure;

h. Current and voltage of the generators;

i. Low alarm level of fuel oil service tanks;

j. High temperature of heating fuel oil tanks;

k. High-level waste tank;

l. High-level alarm in the machinery space dale; and

m. Fire alarm.

310. Means are to be provided for the automatic start and transfer to stand-by of vital auxiliary pumps associated with the propulsion system. Automatic start and transference to stand-by pumps shall trigger an alarm at the bridge control station. The bridge station shall have the means to start and stop remotely these vital auxiliary pumps for the following equipment:

a. The propulsion machinery.

b. Machinery for electric power generation

c. Variable pitch propeller controllers

d. Transfer system and/or fuel oil service: applicable to pumps associated with sedimentation tanks and service (daily)

311. For ships that have compact engines (integrated propulsion machinery), i.e. where the fuel pumps, cooling, etc. are integrated to the motors, see Part II, Title 102, Section 5, Chapter B.

Guidance

In the compact engines, pumps are integrated to the engine, and there is no way to install stand-by equipment.

Therefore, the requirements of item to A5.310 shall not apply, as there is no possibility of triggering the integrated engine pumps, reduction gearbox, etc. by an external station.

End of the guidance

400. Specific requirements for systems AUT-B and AUT-C

401. The equipment and systems ate to be in accordance with the requirements of the Part II, Title 102, Section 5, Subchapter A5.500, items 503 a 524.

402. Propulsion system and necessary equipment for operation free from local intervention for as long as the machinery space is unattended, according to the additional class notation adopted.

403. Service tank completed automatically with capacity enough to serve along the period the machinery space is unattended, according to the additional class notation adopted plus another 15 % reserve capacity.

500. Specific requirements for AUT-E systems

501. Propulsion system and equipment required to operate free from direct local intervention for as long as the machinery space is unattended according to additional class notation.

502. Automatically completed service tank, with a capacity for the period in which the machinery space is unattended according to the additional class notation plus a spare capacity of 15%.

Guidance

The periods in which the machinery space remains unattended are the following:

Notation AUT-B – 8 hours
Notation AUT-C – 16 hours
Notation AUT-E – 24 hours

Intermediate periods are not considered.

End of guidance

503. Remote control of the propulsion installation in accordance with the requirements of Part II, Title 102, Section 5, Subchapter A4.300.

504. Machinery safety system to be installed in accordance with Part II, Title 102, Section 5, Subchapter A4.400.

505. Machinery alarm system and alarm system of watch in accordance with the requirements of the Part II, Title 102, Section 5, Subchapter A4.500.

506. Boilers and oil heating systems in accordance with the requirements of the Part II, Title 102, Section 5, Subchapter A4.600.

507. Auxiliary diesel engines with remote control must meet the requirements:

a. the automatic start attempts or by remote control shall be limited in duration and number. The only systems allowed to start automatically or by remote control are those that allow the start at any position of the crankshaft;

b. automatic shut-down is to be provided in case of overspeed, detection of crankcase oil mist and failure in the lubrication of lube oil supply to the motors; and

c. auxiliary engines and equipment needed to operate with no local intervention for 24 hours.

508. Start air compressors are to be fitted with:

a. the automatic shut-down due to failure of pressurized system;

b. automatic shut-down due to lubricating oil pressure loss; and

c. proper automatic drain is to be provided for cooler and steam traps.

509. Start air control air bottles are to be completed automatically

510. Alarm recorder for engines with power greater than 1500 kW: provide alarm recorder of points when the limits of the parameters are exceeded as well as the time of the occurrence and the alarm release in chronological order. The beginning and the end of an alarm are to be clearly identifiable.

511. Remote fire pump start system: shall be installed in the bridge remote start system to one of the fire pumps and, where applicable, in the fire fighting main station. Associated valves shall bring instructional cards "keep the valves open at all times".

512. Pressures and temperatures needed for proper operation of the system: the pressures and temperatures required for the operation of the system in accordance with Table T.A8.101.1. are to be automatically controlled.

513. Auxiliary machinery essential to the propulsion system: For auxiliary machinery essential shall be provided with spare circuit according to the requirements of Part II, Title 102, Seção 5, Subchapter A4.900.

514. Dales at the machinery space: are to be designed and fitted in accordance with the requirements of the Part II, Title 102, Section 5, Subchapter A4.700.

515. Systems of purifiers of FO e LO:

a. are to be of the type self-cleaning unless this operation is not needed during the period in which the machinery space remains unattended.

b. the sealing water temperature is to be automatically controlled and monitored;

c. poor operation in purification process shall cause automatic shut-down of purifiers.

d. the access of water into the sealing water output shall trigger an alarm; and

e. the preheating system is to be designed in such a way that the interruption of flow to the filtering system does not result in overheating

516. Power interruptions: shall be avoided or overcome in accordance with the requirements of the Part II, Title 102, Section 5, Subchapter A4.900

517. Shipside valves: valves of the side shell that are open during the operation of machinery shall be accessible and operated from safe height above the floors.

518. Fire alarm systems and fire alarm: shall be in accordance with the Part II, Title 102, Section 5, Subchapter A4.800.

518. Fire alarm systems and fire alarm: shall be in accordance with the Part II, Title 102, Section 5, Subchapter A4.800.

519. It shall be installed remote control for one of the main fire pumps at the bridge and, where applicable, at the main fire control station

520. Fire fighting equipment: fire fighting equipment shall be in accordance with the Part II, Title 11, Section 3, Chapter E.

521. Communication system: reliable verbal communication system, i.e. designated phones, phones with batteries or sound activated are to be fitted between the MCR or control station, the bridge, the messing spaces and areas of engineer officers.

522. Controllable pitch propeller and side thrusters:

a. the system is to be equipped with an alarm that is triggered when the feeding of propulsion power unit fails. Preferably the direction driving force is to be retained long enough to allow the intervention of operators.

b. As a minimum requirement it shall be made arrangement to prevent an unexpected reversal of the thruster force, as, for example, the shaft line. The stop can be controlled automatically or by the operator

523. Clutches: an alarm shall sound in control stations in the event of a power failure (for systems operated electrically, pneumatically or hydraulically). The alarm

shall occur in time to still be possible to operate the system manually.

524. Brakes: the automatic brake or with remote control shall be possible only if:

a. the propulsion power is shut down;

b. Ratchet is disconnected;

c. the rotation of the shaft line is below the limit set by the manufacturer.

600. Specific requirements for AUT-F
– see Chapter A.

Guidance

The requirements for the unattended machinery space for 24 hours with control by the bridge are to be in addition to the requirements of integrated systems for propulsion and auxiliary control by the bridge.

End of the guidance

B6. REQUIREMENTS FOR ELECTRONIC PROGRAMMABLE SYSTEMS
-see Chapter A

B7. INTEGRATED COMPUTER SYSTEMS FOR DIESEL ENGINES-
-see Chapter A

B8. TABLE OF AUTOMATION POINTS

100. Sensors for propulsion diesel engines

101. Table for medium and high speed engines.

TABLE T.B8.101.1 – SENSORS FOR COMPACT ENGINES WITH INDIVICUAL POWER < 2500 KW

F = failure B = low A = high R = reduction P = stop D = triggering device in readiness	Points for alarms	Points for equipment in readiness	Points for functions of safety	Individual alarms on the bridge
Lubricating oil				
Lubricating oil pressure	B		B, P[1]	
Lubricating oil temperature	A			
Level of LO in the crankcase sump [1]	B			
Oil filter differential pressure	A			
Pressure on the crankshaft (when present)	A		A, P	
Cooling				
Cooling water temperature (of the liners) (see Pt II, Tit 11, Sec 5, E6.200)	A, B		A, P	
Cooling water pressure (of the liners)	B			
Water level in the expansion tank	B			
Cooling saltwater temperature	A			
Fuel oil				
Injection pipe leak	F			
Fuel Oil pressure	B			
Fuel Oil temperature	A			
Exhaust gas				
Temperature of exhaust gas	A			
Deviation in the temperature of exhaust gas			F	
Compressed air				
Control air pressure	B			
Starting air pressure [2]	B			

Intake manifold air temperature	A			
Disarm by overspeed			P	

1 Individual alarms are to be provided for separate circuits.

200. Sensors for the auxiliary Diesel engines

201. Table for the auxiliary Diesel engines

TABLE T.B8.201.1 – SENSORS FOR AUXILIARY DIESEL ENGINES

F = failure B = low A = high R = reduction P = stop D = triggering device in readiness	Points for alarms	Points for equipment in readiness	Points for functions of safety	Individual alarms on the bridge
Lubricating oil				
Lubricant oil pressure [1]	B		B, P	
Lubricating oil temperature (see Pt II, Tit 11, Sec 5, E6.300)	A			
Cooling air or water temperature	A,B			
Raw water cooling temperature (when applicable)	A			
Water level in tank equalizer if a separate circuit	B			
Starting air pressure	B			
Control air pressure	B			
Injection pipe leak	F			
Overspeed [1]			A, P	
Oil level of the service tanks	B		B	

1 For engines with power greater than 220 kW, only.

202. To be fitted on a panel installed on the engine, in an easily visible location, the following instruments are required at a minimum.

300. Sensors for the reduction gearbox, shaft lines and variable pitch propellers

301. Table for the reduction gearbox, shaft lines and variable pitch propellers. Do not apply to azimuthal and side thrust propellers.

TABLE T.B8.301.1 – SENSORS FOR REDUCTION GEARBOX, SHAFT LINES AND VARIABLE PITCH PROPELLER

F = failure B = low A = high R = reduction P = stop D = triggering device in readiness	Points for alarms	Points for equipment in readiness	Points for functions of safety	Individual alarms on the bridge
Reduction gearbox				
LO input pressure	B, R	A, D [1]	B, P	
LO temperature at the input to the gearbox/ after the cooler [2]	A, R			
LO pressure at the input of the gearbox/before the cooler [3]	A, R			
Pressure drop of LO in the filter	A			
Radial bearings temperature [4]	A			
Reduction gearbox integrated bearings temperature [5, 6.]	A, R			
Lubricating oil level in the sump	B			
Mechanical / multi disc clutch				
Operating pressure	B, R	B, D		
Control to slip in the engaged position			B, P [7]	
Shaft line bearings, telescopic tube				
Temperature of the bearings or LO in the radial bearings[8]	A			
Temperature of the bearings or LO in thrust bearings [5, 8]	A, R			
Bearing temperature aft telescopic tube [9]	A			
Oil level in the gravity tank	B			
Direction of rotation [10]	F			
Variable pitch system				
Hydraulic oil pressure	B	B, D [1]		B
Device control tank oil level	B			
Hydraulic oil temperature	A			
Pressure drop in the hydraulic oil filter	A			
Pitch control failure / malfunction	F			

Superscripts:
1 Only when a stand-by pump is recommended.
2 For all the gearboxes with plain bearings and for gearboxes with bearings with roller bearings with transmission power greater than 500 kW.
3 Required for applications where no other temperature is monitored inside the gearbox.
4 Do not apply for gearboxes with rolling bearings.
5 Forward only.
6 For gearboxes with roller bearings, can be replaced by lubricating oil temperature monitoring
7 It can be measured by direct methods, i.e. speed differential measures, monitoring the minimum acceptable pressure. The engine stop can be replaced by alternative methods, such as sliding clutch disengagement.
8 Do not apply for devices with bearing when the shaft diameter is less than 300 mm.
9 For oil lubrication and for shaft diameters smaller than 400 mm the oil temperature in the vicinity of the aft bearing can be monitored. Do not apply for bearing with water lubrication provided the shaft diameter is less than 400 mm.
10 Applicable for reversible engines only.

400. Sensors for steering systems

401. Table for steering systems. Do not apply to azimuthal and side thrust propellers.

TABLE T.B8.401.1 – SENSORS FOR STEERING SYSTEMS

F = failure B = low A = high R = reduction P = stop D = triggering device in readiness	Points for alarms	Points for equipment in readiness	Points for functions of safety	Individual alarms on the bridge
Steering system				
Loss of voltage supply to the power unit	F	F, D		F
Overload and phase failure of the electric drive	F	F, D		F
Low level of hydraulic oil tank	B	F, D		B
Loss of control unit to the voltage supply of the steering system	F	F, D		F
Hydraulic system failure (hydraulic locking)	F	F, D		F

500. Sensors for propulsion and azimuthal steering systems

501. Table for propulsion and thruster systems Government

TABLE T.B8.501.1 – SENSORS PROPULSION AND AZIMUTHAL STEERING SYSTEMS

F = failure B = low A = high R = reduction P = stop D = triggering device in readiness	Points for alarms	Points for equipment in readiness	Points for functions of safety	Individual alarms on the bridge
Azimuthal system				
Loss of voltage supply to the power unit	F			F
Overload and phase failure of the electric drive	F			F
Rudder angle indicator	F			
Low level of hydraulic oil tank	B			B
Low pressure hydraulics	B			B
High hydraulic oil temperature	A			A
Low lubricating oil pressure	B			B
Low flow of lubricating oil	B			B
Loss of control unit to the voltage supply to the steering system	F			F
Hydraulic system failure (hydraulic locking)	F			F
Transfer failure between panels	F			F
Clutch pressure				

600. Other sensors

601. Table for auxiliary boilers

TABLE T.B8.601.1 –AUXILIARY BOILERS

F = failure B = low A = high R = reduction P = stop D = triggering device in readiness	Points for alarms	Points for equipment in readiness	Points for functions of safety	Individual alarms on the bridge
Auxiliary boilers				
Water level	L,H		L, H (1)	
Steam pressure	H			
Steam temperature			F	
Circulation pump flow	L		L (1)	
The presence of oil on the heating steam drains	F			
Fuel oil pressure	L			
Failure in the ignition	F			
Temperature and viscosity of fuel oil (2)	L, H			
Low pressure combustion air supply			F	

(1) Automatic fuel oil shut-down
(2) If HFO (Heavy fuel oil) be used

602. Table of fire systems and electrical Installations

TABLE T.B8.602.1 – FIRE SYSTEMS AND ELECTRICAL INSTALLATIONS

F = failure B = low A = high R = reduction P = stop D = triggering device in readiness	Points for alarms	Points for equipment in readiness	Points for functions of safety	Individual alarms on the bridge
Fire Systems				
Fire alarm	F			
Failures	F			
Electrical installations	F			
Failure in main power supply system	F			
Disconnect not-essential consumers	F			
Main generator key activation	F			
Low frequency	L			
Over-voltage	H			
Failure in the 24 V charger	F			
Common failure in the power management system	F			

603. Other:

TABLE T.B8.503.1 – OTHER SENSORS

F = failure B = low A = high R = reduction P = stop D = triggering device in readiness	Points for alarms	Points for equipment in readiness	Points for functions of safety	Individual alarms on the bridge
Other				
Failure in the main engine remote control system	F			F
Failure in the machinery alarm system	F			F
Failure in the watch alarm system	F			F
Failure in the safety system	F			
Activation of the safety system	F			
Override the activated safety system	F			
Automatic starting of essential auxiliaries if they have not started in normal condition (see Pt II, Tit 102, Sec 5, A5.104)	F			
Failure of a stand-by control unit (see Pt II, Tit102, Sec 5, A5.104)	F			
High bilge level in the machinery space	F			
Oil content in water in output of oil and water separator (if applicable)	F			
Starting time and frequency of automatic bilge pumps (if applicable)	F			
Tank level of overflow of fuel oil	F			
Failure of low pressure of system CO2 (if applicable)	F			
Failure in the starting of air compressor (if applicable)	F			
Low pressure in the fire fighting system	F			
Activation of automatic spraying for fire fighting system (spray - (if applicable))	F			F

C. APPENDIX: GUIDE TO DETERMINING THE DEGREE OF AUTOMATION

C1 SCOPE

C2 DEGREES OF AUTOMATION

C3 GUIDELINES FOR THE DETERMINATION OF THE DEGREE OF AUTOMATION

C1. SCOPE

100. Introduction

101. This chapter aims to aid the understanding of the requirements of Part II, Title 102, Chapters A and B, in order to facilitate the determination of the degree of automation required.

C2. DEGREES OF AUTOMATION

100. Automation systems - definition –

101. In an automation system, the operating system arrangement shall ensure that under all conditions of operation and navigation, including manoeuvres, the safety must be equivalent to that of a ship with the machinery space manned.

200. Additional notations of class for automation

201. The figure F.C2.201.1 below provides a brief description of the main functions applicable

300. Note referring to OMBW (CNC class) – one man bridge watch

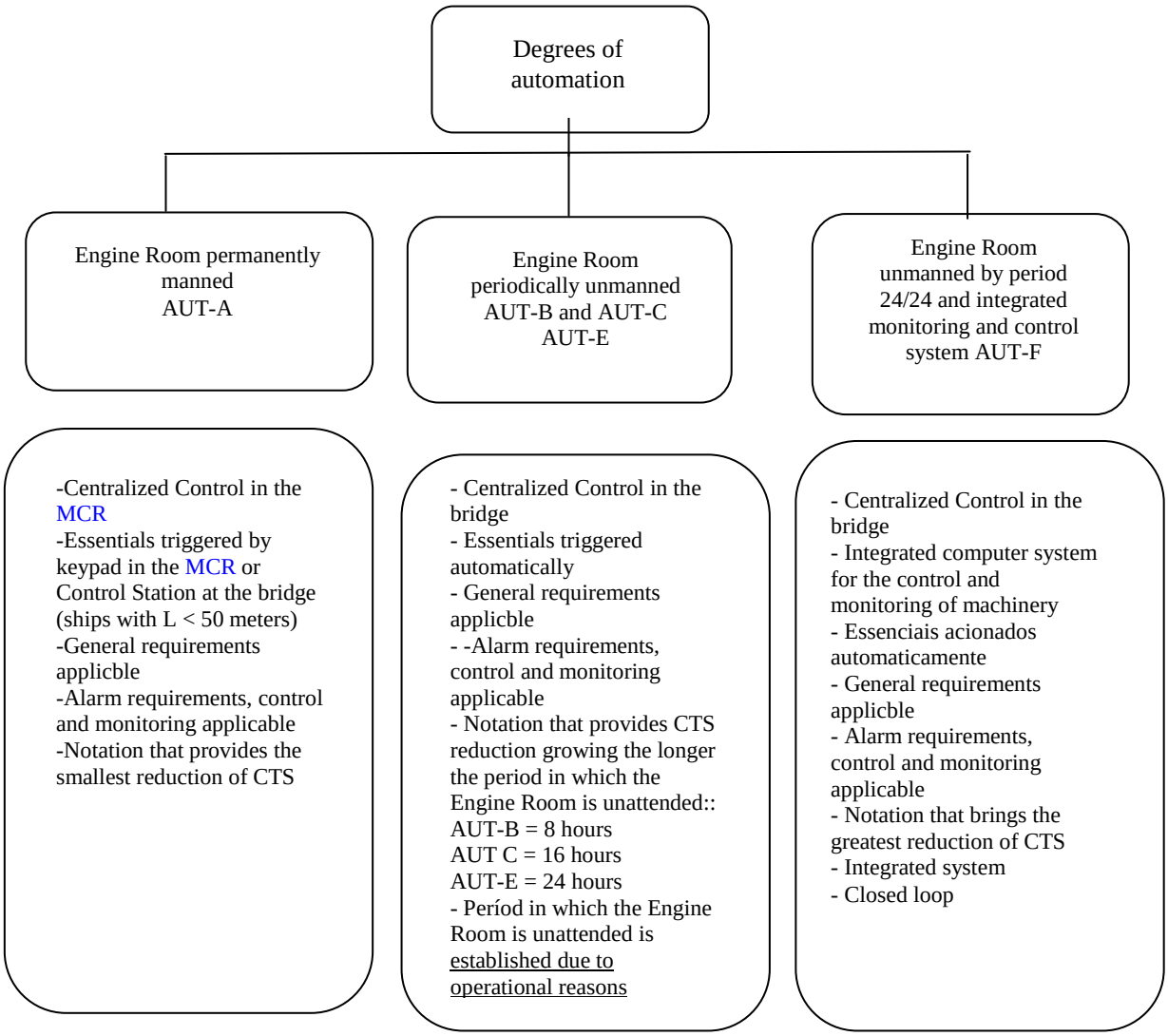
301. The CNC class systems are in accordance with the requirements of IMO / IACS and enable one man to control the navigation during the watch times without affecting the safety of the vessel.

302. NORMAM 1 regulations provide crew cuts for machinery automation (Annexes 1C and 1D). The CNC class system installation on a ship will permit a reduction of the required number of crew members (CTS) at the discretion of the responsible Maritime Authority (DPC).

303. The requirements for the additional notation of CNC class are in Part II, Title 11, Section 8, Chapter F.

304. Vessels with AB < 500 may receive additional CNC class notation provided they meet all the requirements stated in item C 2,303 above.

FIGURE F.C2.201.1 ADDITIONAL CLASS NOTATIONS FOR AUTOMATION



C3 GUIDELINES FOR THE DETERMINATION OF THE DEGREE OF AUTOMATION

100. Degrees of automation according to the characteristics of vessels

101. Ships with length < 20 meters: shall be subjected to the RBNA the set of plans and/or specifications of the proposed automation system to assess which possible exemptions in relation to Chapter B.

102. Length 20 meters < L < 50 meters:

a. Compact engines: applies the Chapter B.

b. Non-compact engines: applies the chapter A.

c. For ships on which is selected the degree of automation AUT-A and that have length greater than 20 meters and less than 50 meters, the machinery control station can be on the bridge provided that met the requirements:

a.1. Of the Part II, Title 102, Chapter B, item B5.200 and B5.300, for compact engines;

a.2. Of the Part II, Title 51, Chapter A, item A5.200 and A5.300.

103. Note 1: Therefore, it is possible to assign the degree of automation AUT-A to ships in which there is no available space for installation of the control station inside the machinery space, but rather on the bridge, and there is similarly a driver manning permanently this control station. In this case, the essential stand-by equipment can be started through the keypad triggered at the bridge provided such equipment comes into operation without the need to manoeuvre in the machinery space. Examples:

In the event of failure of a generator, the driver can start the stand-by generator by means of the keypad on the bridge, but the generator shall enter into the bar without the need of local intervention in the machinery space, that is, the coming in of a driver in the machinery space to perform the manoeuvre of setting up the generator on bus;
In the event of failure of an essential pump, for example, the fire pump, the driver can start the stand-by pump by keypad in the bridge, provided that at the starting the pump shall be brought into action automatically, without the need of a driver in the machinery space to perform the manoeuvre of valves to set up the pump on line.

104. For ships with degree of automation AUT-B, AUT-C and AUT-E, that is, with machinery space unattended for 8 hours, 16 hours or 24 hours:

a. Length < 20 meters: it shall be submitted to the RBNA set of plans and/or specifications of the proposed automation system to assess which possible exemptions in relation to Chapter B;

b. Length > 20 metros, applies:

a.1. Chapter A for non-compact engines;

a.2. Chapter B for compact engines.

c. For ships on which is selected the degree of automation AUT-B, AUT-C ou AUT-E, the starting of the essentials is to be automatic. The machinery control station is centralized in the bridge, and may exist other control stations.

For ships with degree of automation AUT-B, AUT-C and AUT-E, that is, with machinery space unattended for 8 hours, 16 hours or 24 hours

105. For ships with degree of automation AUT-F, that is, with machinery space unattended for 24/24 hours and integrated systems of monitoring, control and automation of propulsion and auxiliary systems:

a. Length < 20 meters: does not apply;

b. Length > 20 meters, applies:

a.1. Chapter A for non-compact engines;

a.2. Chapter B for powered copact engines.

c. All requirements for the degree of automation AUT-E apply and, in addition, the vessel is to be equipped with an integrated computer system for control and monitoring of the propulsion and auxiliary by the bridge.

Note: An integrated propulsion and auxiliary monitoring system by the bridge means that the various automation *systems of each propulsion and auxiliary equipment send information to a central that integrates and processes this information making decisions in order to maintain operation parameters pre-set such as setting up the stand-by equipment or taking other decisions (such as speed reduction) to maintain the safety of the ship, equipment and crew with the smallest possible impact on the operation of the vessel. The determination of the parameters is a result of a risk analysis (FMEA) in the early stages of the system project.*

200. Requirements for all automation systems degrees AUT-A, AUT-B, AUT-C, AUT-E and AUT-F

201. The arrangement of the automation system is to ensure that under all conditions of operation and navigation, including manoeuvres, the safety is to be equivalent to that of a ship with the machinery space manned.

202. For this purpose the functions of control, monitoring and manoeuvres performed by a driver shall be replaced by the automation system.

203. The first point to be examined is the definition of the system through a project and verification by the Classifier that the proposed project meets the requirements of the degree of automation to be assigned. Therefore, the submission and examination of the plans listed in Part II, Title 102, Section 5, Subchapter A2 is the first step in obtaining the degree of automation. This list of plans is common to all degrees of automation, being risk analysis (FMEA) applied only to ships with AUT-F degree.

204. The second point to be examined is referred to the materials for the automation system.

a. For any degree of automation, shall be subject to the requirements of Subchapter A3, that are presented in the Part III, Title 63, Section 8, Chapter A, and the requirements for the environmental conditions of the Part II, Title 11, Section 7, Chapter E, Subchapter E1.

b. All components of the automation system; panels, displays, control panels, etc. shall be approved in the supplier according to Part II, Title 102, Section 5, Chapter T.

c. Alll softwares shall be approved acording to Part II, Title 102, Section 5, Chapter T.

d. Component tests can only be conducted on the basis of approved plans.

e. Computerized systems shall meet the requirements of Part II, Title 102, Section 5, Subchapter A6

f. Integrated computing systems for diesel engines shall meet the requirements of Part II, Title 102, Section 5, Subchapter A7

205. The third point to be examined is that by virtue of the definition of the automation system and functions of the driver to be replaced by automation, monitoring, control and alarm systems are common to all degrees of automation. Even for the degree AUT-A featuring one man permanently manning the machinery space is valid the principle of locally non-intervention, that is, the driver will attend the Machinery Control Station and will manoeuvre all equipment from that station, without the need to go out of control station and enter in the machinery space for a local intervention. The necessary systems are described in Part II, Title 102, section 5, Subchapter A4, and are in summary:

a. General requirements, Subchapter A4.200;

b. Machinery Control from the bridge with unattended machinery space, Subchapter A4.300;

c. Safety systems for ships with unattended machinery space, Subchapter A4.300;

d. Alarm systems for vessels with permanently unattended machinery space, Subchapter A4.500;

e. Boilers and oil heated systems for ships with periodically unattended machinery space, Subchapter A4.600;

f. Systems of dale for ships with unattended machinery space, Subchapter A4.700;

g. Detection system and fire alarm for ships with periodically unattended machinery space, Subchapter A4.800;

h. Continuous supply of electric power for periodically unattended machinery space, Subchapter A4.900.

206 Notes*:*

a) the requirements of Subchapter B4 are the same as those of the Subchapter A4;

b) the requirements of Subchapter A.4 (and therefore B.4) come from the IMO resolutions and recommendations of the IACS to ships with AB ≥ 500;

c) vessels with L > 20 meters and AB < 500 are subject to the same requirements of Subchapter A.4 (B.4, therefore) by virtue of the definition of what is an automation system;

d) -therefore, all ships with length L > 20 meters are to meet the requirements of subchapters A.4 (B4) to obtain any of the additional class notations for automation;

e) *- ships with L < 20 meters may be subject to exemptions after examination by RBNA.*

207. The requirements of Part II, Title 102, Section 5, Subchapter A5, item 100 are also applicable to all vessels with L > 20 meters, for all degrees of automation, both for ships with AB ≥ 500 as for ships with AB < 500.

300. Specific requirements applicable to each one of the automation systems degrees degrees AUT-A, AUT-B, AUT-C, AUT-E and AUT-F

301. Table T.C3.301.1 shows the requirements for the automation systems for ships with non-compact engines, according to the chapter A.

302. Table T.C3.301.2 shows the requirements for automation systems for ships with compact engines, according to the chapter B.

Note: the table below has been reproduced from the Chapter A. It shows in summary form the application of the subchapters to each degree of automation

TABLE. T.C3.301.1 – COMPARISON BETWEEN THE SPECIFIC REQUIREMENTS FOR THE NOTATIONS OF AUTOMATION FOR SHIPS WITH NON-COMPACT ENGINES

	AUT-A	***AUT-B AUT-C***	***AUT-E***	***AUT-F***
Machinery space permanently unattended	*Yes*	*No*	*No*	*No*
Centralized control in the MCR	*Yes*	*No*	*No*	*No*
Centralized Control in the bridge	*No*	*Yes*	*Yes*	*Yes*
Free of local direct intervention for a minimum period of 8 or 16 hours	*No*	*Yes*	*Non Applicable*	*Non Applicable*
Free of local direct intervention for a minimum period of 24 hours	*Non Applicable*	*Non Applicable*	*Yes*	*Yes*
Integrated automation and control system	*Non applicable*	*Non mandatory*	*Non mandatory*	*Mandatory*
Requirements of subchapter A4 Alarm, control and safety	*Applicable*	*Applicable*	*Applicable*	*Applicable*
Requirements of subchapter A5.100 Specific requirements for automation systems (general-all degrees)	*Applicable*	*Applicable*	*Applicable*	*Applicable*
Requirements of subchapter A5.200-Specific requirements for automation systems AUT- A	*Applicable*	*Non applicable*	*Non applicable*	*Non applicable*
Requirements of subchapter A5.300 for automation systems AUT-A for ships with L < 50 meters	*Applicable to ships with L < 50 meters*	*Non Applicable*	*Non Applicable*	*Non Applicable*
Requirements of subchapter A5.400 to specific requirements for automation systems AUT-B and AUT - C	*Non Applicable*	*Applicable*	*Non Applicable*	*Non Applicable*
Requirements of subchapter A5.500 specific requirements for automation systems AUT-E	*Non Applicable*	*Applicable **	*Applicable*	*Applicable*
Requirements of subchapter A6 – specific requirements for automation systems AUT-F	*Non Applicable*	*Non Applicable*	*Non Applicable*	*Applicable*
Requirements of subchapter A7 – Integrated computer systems for diesel engines	*Non mandatory*	*Non mandatory*	*Non mandatory*	*Mandatory*
Tables of points of the subchapter A8 ships > 500 AB with non-compact engines	*Applicable*	*Applicable*	*Applicable*	*Applicable*

** In the case of AUT-B and AUT-C systems, applicable for the period during which the machinery space remains unattended. In the AUT-E systems, for 24 hours unattended machinery space.*

IMPORTANT NOTE: This table is informational only and does not replace the full application of the requirements of this Title 102.

Note: The table below has been reproduced from the Chapter B. It shows in summary form the complete application of the subchapters to each degree of automation

TABLE. T. C3.301.2 – COMPARISON BETWEEN THE SPECIFIC REQUIREMENTS FOR THE AUTOMATION NOTATIONS FOR SHIPS WITH COMPACT ENGINES

	AUT-A	*AUT-B AUT-C*	*AUT-E*	*AUT-F*
Machinery space permanently manned	*Yes*	*No*	*No*	*No*
Centralized control in the MCR	*Yes*	*No*	*No*	*No*
Centralized Control in the bridge	*No*	*Yes*	*Yes*	*Yes*
Free of local direct intervention for a minimum period of 8 or 16 hours	*No*	*Yes*	*Non Applicable*	*Non Applicable*
Free of local direct intervention for a minimum period of 24 hours	*Non Applicable*	*Non Applicable*	*Yes*	*Yes*
Integrated automation and control system	*Non applicable*	*Non mandatory*	*Non mandatory*	*Mandatory*
Requirements of the subchapter B4 Alarm, control and safety	*Applicable*	*Applicable*	*Applicable*	*Applicable*
Requirements of the subchapter B5.100 Specific requirements for automation systems (general – all degrees)	*Applicable*	*Applicable*	*Applicable*	*Applicable*
Requirements of the subchapter B5.200- for automation systems AUT-A	*Applicable*	*Do not apply*	*Do not apply*	*Do not apply*
Requirements of the subchapter B5.300 for automation systems AUT-A for ships with L < 50 meters	*Applicable to ships with L < 50 meters*	*Do not apply*	*Do not apply*	*Do not apply*
Requirements of the subchapter B5.400 Specific requirements for automation systems AUT-B e AUT-C	*Do not apply*	*Applicable*	*Do not apply*	*Do not apply*
Requirements of the subchapter B5.500 Specific requirements for automation systems AUT-E	*Do not apply*	*Applicable **	*Applicable*	*Applicable*
Requirements of the subchapter B6 – Specific requirements for automation systems AUT-F	*Do not apply*	*Do not apply*	*Do not apply*	*Applicable*
Requirements of the subchapter B7 – Integrated computer systems for diesel engines	*Not mandatory*	*Not mandatory*	*Not mandatory*	*Mandatory*
Tables of points of subchapter B8 (vessels > 500 AB with not-compact engines) and subchapter B8 (ships with compact engine)	*Applicable*	*Applicable*	*Applicable*	*Applicable*

* In the case of AUT-B and AUT-C, applicable to the period in which the machinery space remains unattended. AUT-E systems, for 24 hour unattended machinery space.

IMPORTANT NOTE: This table is informational only and does not replace the full application of the requirements of this Title 102.

303. Observations regarding the degree of automation AUT-B, AUT-C e AUT-E:

a. For ships with automation AUT-B the requirements apply to a period of 8 hours in which the machinery space remains unattended, and there is some operational factor that determines a person to entry at every 8 hours to a local intervention necessary for the operation;

b. For ships with automation AUT-C the requirements apply to a period of 16 hours in which the machinery space remains unattended, and there is some operational factor that determines a person to entry at every 16 hours to a local intervention necessary for the operation;

c. For ships with AUT- E the requirements apply to a period of 24 hours in which the machinery space remainss unattended

CHAPTER D
SPECIFIC REQUIREMENTS FOR THE CENTRALIZED NAVIGATION CONTROL CNC IACS UR N1

CHAPTER CONTENTS

D1. APPLICATION

100. Preamble

101. It is technologically possible to operate the bridge with an officer of the navigational watch alone, acting as the sole lookout. However, the design, performance and maintenance of the equipment can have considerable effects on the safety of one man bridge operation.

102. The aim of these rules is to provide technical requirements for the functionality of the bridge design and layout, the range of equipment to be installed, its performance and reliability.

103. The composition and qualification of the personnel on watch remain the responsibility of the shipping companies and national authorities.

200. Application

201. The following requirements apply to the classification of sea-going ships for the assignment of an optional class notation for one man bridge operation and are intended to cover all the normal sailing conditions as authorized by the relevant National Authority.

202. These requirements may be applied to new and existing ships.

300. Operational Assumptions

301. The requirements are framed on the following assumptions:

a. Plans for emergencies are specified and the conditions under which a one man watch is permitted are clearly defined in an operations manual, which is acceptable to the National Maritime Authority (in Brazil, DPC) with which the ship is registered.

b. The manning of the bridge watch is in accordance with the National Regulations in the country of registration and for the waters in which the ship is operating.

c. The requirements of the International Convention on Standards of Training Certification and Watch-keeping for seafarers (STCW) and other applicable statutory regulations are complied with.

D2. REGULATIONS, GUIDELINES, STANDARDS

100. Applicable IMO Regulations

101. IMO – The requirements are based on the understanding that the applicable regulations and guidelines issued by the International Maritime Organization are complied with and, in particular:

Regulation 12, chapter V of the 1974 "International Convention for the Safety of Life at Sea" (SOLAS) and applicable amendments;

a. the international Regulations for Preventing Collisions at Sea and all other relevant Regulations relating to Radiotelegraphy, Radiotelephony and Safety of Navigation required by Chapters IV and V of SOLAS 1974, as amended;

b. the Provisional Guidelines for the Conduct of Trials in which the Officer of the Navigational Watch acts as the sole Lookout in Periods of Darkness (MSC Circular 566 of 2 July 1991);

c. IMO Assembly Resolution A708 on Navigation Bridge Visibility and Functions;

d. the Performance Standards for navigational equipment applicable to:

e. magnetic compasses (Resolution A382),

f. gyro-compasses (Resolution A424),

g. radar equipment (Resolutions A222, A278, A477),

h. ARPA (Resolution A422),

i. speed and distance measuring equipment (Resolution A478)

j. echo sounding equipment (Resolution A224),

k. radio direction finder (Resolution A223),

l. electronic navigational aids – general requirements (Resolution A574),

m. VHF Radio installation (Resolution A609),

n. automatic pilots (Resolution A342),

o. rate-of-turn indicators (Resolution A526).

102. IEC, ISO Standards – The requirements and guidelines of the following international standards are applicable:

a. ISO 8468 "Ships bridge layout and associated equipment – Requirements and guidelines";

b. IEC 872: ARPA – Operational and performance requirements – Methods of testing and
c. required test results;

d. IEC 936: Shipborne radar – Operational and performance requirements – Methods of testing
e. and required test results;

f. IEC 1023: Marine speed and distance measuring equipment (SDME) – Operational and performance requirements – Methods of testing and required test results;

g. IEC Document 18 (Central Office) 534: Special features

103. Control and instrumentation.

a. National Authorities – Additional requirements may be imposed by the National Authority with whom the ship is registered and/or by the administration within whose territorial jurisdiction it is intended to operate.

b. IACS – The requirements of UR E10 'Unified environmental test specification for testing procedure for electrical control and instrumentation equipment, marine computers and peripherals covered by classification' are applicable.

D3. DEFINITIONS

100. Terms used in the requirements of the present Chapter

101 Acquisition: the selection of those target ships requiring a tracking procedure and the initiation of their tracking.

102. Alarm: a visual and audible signal indicating an abnormal situation.

103. ARPA: automatic radar plotting aid.

104. Back-up navigator: any individual, generally an officer, who has been designated by the ship master to be on call if assistance is needed on the navigation bridge.

105. Bridge: that area from which the navigation and control of the ship is exercised, including the wheelhouse and bridge wings.

106. Bridge wings: those parts of the bridge on both sides of the ship's wheelhouse which, in general, extend to the ship's side.

107. CPA: closest point of approach, i.e. the shortest target ship-own ship calculated distance that will occur in case of no change in course and speed data.

108. Display: means by which a device presents visual information to the navigator, including conventional instrumentation.

109. Ergonomics: application of the human factor in the analysis and design of equipment, work and working environment.

110. Field of vision: angular size of a scene that can be observed from a position on the ship's bridge.

111. Lookout: activity carried out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision.

112. Navigation: all tasks relevant for deciding, executing and maintaining course and speed in relation to waters and traffic.

113. Navigator: person navigating, operating bridge equipment and manoeuvring the ship.

114. Normal conditions: when all systems and equipment related to navigation operate within design limits, and environmental conditions such as weather and traffic do not cause excessive workload to the officer of the watch.

115. Officer of the watch: person responsible for safe navigating, operating of bridge equipment and manoeuvring of the ship.

116. OMBO: one man bridge operation.

117. OMBO ship: one man bridge operated ship.

118. Radar plotting: the whole process of target detection, tracking, calculation of parameters and display of information.

119. Sea-going ship: ship navigating on the high seas, i.e. areas along coasts and from coast to coast.

120. TCPA: time to closest point of approach.

121. Tracking: is the process of observing the sequential changes in the position of a target, to establish its motion.

122. Watch alarm: alarm that is transferred from the bridge to the master and the back-up navigator in case of any officer of the watch deficiency (absence, lack of alertness, no response to another alarm/warning, etc.).

123. Wheelhouse: enclosed area of the bridge.

124. Workstation: position at which one, or several tasks constituting a particular activity are carried out.

D4. TECHNICAL REQUIREMENTS

100. Bridge Layout

101 The bridge configuration, the arrangement of consoles and equipment location shall enable the officer of the watch to perform navigational duties and other functions allocated to the bridge as well as maintain a proper lookout from a convenient position on the bridge, hereafter referred to as a 'workstation'.

102. A workstation for navigation and traffic surveillance/manoeuvring shall be arranged to enable efficient operation by one person under normal operating conditions. All relevant instrumentation and controls shall be easily visible, audible and accessible from the workstation.

103. For the purpose of performing duties related to navigation, traffic surveillance and manoeuvring, the field of vision from a workstation shall be such as to enable observation of all objects which may affect the safe conning of the ship. The field of vision from a workstation shall be in accordance with the guidelines on navigation bridge visibility, as specified in IMO Resolution A708 as it applies to new ships. For other functions, other workstations may be arranged singularly or in combination, provided the field of vision complies with the foregoing.

104. The bridge layout design and workstations are to enable the ship to be navigated and manoeuvred safely by two navigators in cooperation.

105. External sound signals from ships and fog signals that are audible on the open deck, shall also be audible inside the wheelhouse; a transmitting device shall be provided to reproduce such signals inside the wheelhouse (recommended frequency range: 70 to 700 Hz).

106. The requirements and guidelines of ISO Standard 8468 shall be regarded as a basic reference for the design of the bridge layout.

200. Bridge Instrumentation and Controls

201. The instrumentation and controls at the workstation for navigation and traffic surveillance/manoeuvring shall be arranged to enable the officer of the watch to:

a. determine and plot the ship's position, course, track and speed;

b. analyse the traffic situation;

c. decide on collision avoidance manoeuvres;

d. alter course;

e. change speed;

f. effect internal and external communications related to navigation and manoeuvring, radio communication on the VHF;

g. give sound signals;

h. hear sound signals;

i. monitor course, speed, track, propeller revolutions (pitch), rudder angle and depth of water;

j. record navigational data (may be manually recorded from data available at the workstation).

202. Equipment to be fitted: Irrespective of their size, gross tonnage and date of construction, all OMBO ships are in any case to be equipped with the instrumentation and controls described under D4.203 to D4. 205 hereafter.

203. Safety of navigation: Collision-Grounding: The ship is to be equipped with an ARPA system including, or associated with, a collision avoidance system, meeting the requirements of IMO Resolution A422(XI). The ARPA function may be independent or built into the radar equipment. The system is to be based on the assumption that all floating objects may come onto a collision course with own ship if the object's course is changed up to 45° with its speed maintained. A warning shall be given to the navigator at a time which shall be adjustable in the range of 6 to 30 minutes, having regard to the time to danger (TCPA). The whole equipment is to feature the following capability:

a. true motion and relative motion modes,

b. daylight-visible display,

c. automatic acquisition and tracking of 20 radar targets,

d. guard zone system, featuring adjustable parameters, notably warning and alarm set for CPA and TCPA,

e. simulator function showing the likely effects of a course or speed change in relation to tracked targets,

f. incorporated self-checking properties.

204. An automatic pilot is to be provided and monitored by an off-course alarm addressed to the navigator, in case of malfunction. This alarm shall be derived from a system independent from the automatic steering system. An overriding control device shall be provided at the navigating and manoeuvring workstation. Alternatively, track piloting equipment may be considered.

205. The navigator is to be given an alarm in case of deviation from the planned route. This alarm is to be

adjustable having regard to the time to danger of grounding.

206. Pre-warning is to be given at the approach of a way-point.

207. An alarm is to be initiated when the water depth beneath the ship is less than a predetermined value.

300 Position fixing

301. Ships are to be provided with position fixing systems appropriate to the intended service areas.

302. At least two independent radars shall be provided. One of them shall operate within the X-band.

303. A gyro compass system is to be provided.

304. A speed log system is to be provided.

305. An echo sounding system is to be provided.

400. Controls – Communication

401. A propulsion plant remote control system is to be provided on the bridge.

402. A whistle control device is to be provided.

403. A window wiper and wash control device is to be provided.

404. A main workstation console lighting control device is to be provided.

405. Steering pump selector/control switches are to be provided.

406. An internal communication system is to be provided.

407. A V.H.F. radiotelephone installation is to be provided.

408. The systems or controls under Items D4.401 to D4.407 above are to be fitted within the reach of the officer of the watch when seated or standing at the main navigating and manoeuvring workstation.

409. A wheelhouse heating/cooling control device is to be provided.

410. A NAVTEX automatic receiver and recorder is to be provided.

500. Prevention of Accidents caused by Operator's Unfitness

501. Bridge safety system

a. A vigilance system is to be provided to indicate that an alert officer of the navigational watch is present on the bridge.

b. Any system used for verification of the officer of the navigational watch's alertness shall not cause undue interference with the performance of bridge functions.

c. The system shall be so designed and arranged that it could not be operated in an unauthorized manner, as far as practicable.

d. Any system used for periodic verification of the officer of the navigational watch's alertness shall be adjustable up to 12 minute intervals and constructed, fitted and arranged so that only the ship's master has access to the component for setting the appropriate intervals.

e. The system shall provide for the acknowledgement by the officer of the navigational watch at the navigating and traffic surveillance/manoeuvring workstation and other appropriate locations in the bridge from where a proper lookout may be kept.

f. Such a system shall be connected to the alarm transfer system described in D4.502 below.

g. An alarm is to operate on the bridge in the event of a failure of the bridge safety systems.

h. The requirements of D4.501.a to D4.501.g do not prevent RBNA from accepting any technical systems that adequately verify or help maintain the alertness of the officer of the watch at intervals up to 12 minutes.

502. Alarm/warning transfer system – communications

a. Any alarm/warning that requires bridge operator response shall be automatically transferred to the master and, if he deems it necessary, to the selected back-up navigator and to the public rooms, if not acknowledged on the bridge within 30 seconds. Such transfer is to be carried out through the systems required by F4.504 and D4.509 where applicable.

503. Acknowledgment of alarms/warnings shall only be possible from the bridge.

504. The alarm/warning transfer shall be operated through a fixed installation.

505. Provision is to be made on the bridge for the operation of a navigation officer call-alarm to be clearly audible in the spaces of D4.502.a.

506. The alarm transfer system shall be continuously powered and shall have an automatic changeover to a standby power supply in case of loss of normal power supply.

507. At all times, including during blackout, the officer of the watch shall have access to facilities enabling two way speech communication with another qualified officer. The bridge is to have priority over the communication system.

508. The automatic telephone network is acceptable for this purpose, provided that it is automatically supplied during black-out situation and that it is available in the locations specified in D4.502.a.

509. If, depending on the shipboard work organization, the back-up navigator may attend locations not connected to the fixed installation(s) described in D4.502.a, he shall be provided with a wireless portable device enabling both the alarm/warning transfer and two way speech communications with the officer of the watch.

600. Equipment Design and Reliability

601. **Environmental conditions**: Shipborne navigational equipment specified in IMO Publication 978-88-04E 'PERFORMANCE STANDARDS FOR NAVIGATIONAL EQUIPMENT' shall be capable of continuous operation under the conditions of various sea states, vibration, humidity, temperature and electromagnetic interference likely to be experienced in the ship in which it is installed.

602. Equipment which has been additionally specified in these Rules is to comply with the environmental conditions specified in Part III Title 63 Section 8, A.2.

603. Documentary evidence in the form of Certification and/or test results is to be submitted to RBNA's satisfaction. Where acceptable evidence is not available, the following requirements (IACS UR E10) shall be complied with:

a. Part II, Title 11, Section 7, Chapter G, G5.400;

b. Part III, Title 63, Section 7, Chapters B and C; and

c. Part III, Title 63, Section 8, Chapter A.

700. Design – reliability

701. **Power supply**: Local distribution panels shall be arranged for all items of electrically operated navigational equipment. These panels are to be supplied by two exclusive circuits, one fed from the main source of electrical power and one fed from an emergency source of electrical power. Each item of navigational equipment is to be individually connected to its distribution panel. The power supplies to the distribution panels shall be arranged with automatic changeover facilities between the two sources. Failure of the main power supply to the distribution panels shall initiate an audible and visual alarm.

702. **Loss of power**

a. Following a loss of power which has lasted for 30 seconds or less, all primary functions are to be readily reinstated.

b. Following a loss of power which has lasted for more than 30 seconds, as many as practical primary functions shall be readily reinstated.

703. Where computerized equipment are interconnected through a computer network, failure of the network shall not prevent individual equipment from performing their individual functions.

800. Ergonomical recommendations

801. **Lighting**: The lighting required on the bridge shall be designed so as not to impair the night vision of the officer on watch. Lighting used in areas and at items of equipment requiring illumination whilst the ship is navigating is to be such that night vision adaptation is not impaired, e.g. red lighting. Such lighting is to be arranged so that it cannot be mistaken for a navigation light by another ship. It is to be noted that red lighting is not to be fitted over chart tables so that possible confusion in colour discrimination is avoided.

802. **Noise levels**: The noise level on the bridge shall not interfere with verbal communication, mask audible alarms or be uncomfortable to bridge personnel.

803. **Vibration level**: The vibration level on the bridge shall not be uncomfortable to the bridge personnel.

804. **Wheelhouse space heating/cooling**: Unless justified, wheelhouse spaces are to be provided with heating and air cooling systems. System controls are to be readily available to the officer of the watch.

900. Navigator's safety

901. There are to be no sharp edges or protuberances on the surfaces of the instruments and equipment installed on the bridge which could cause injury to the navigator.

902. Sufficient hand-rails or equivalent thereto are to be fitted inside the wheelhouse or around instruments and equipment in the wheelhouse for safety in bad weather. Adequate means are to be made for anti-slip of the floor, whether it be dry or wet.

903. Doors to the bridge wings are to be easy to open and close. Means are to be provided to hold the doors open at any position.

904. Where provision for seating is made in the wheelhouse, means for securing are to

CHAPTER T
INSPECTIONS AND TESTS

T1. TESTS AND EVIDENCE

100. Tests and evidence according to the category of the system

101. Tests and evidence are to be in compliance with the table Table T.T1.101.1. Definitions and notes related to the Table T.T1.101.1 are given in T2.

M = Evidence of the manufacturer submitted to the Classifier upon request
S = Evidence verified by the Classifier
W = To be witnessed by the Classifier
* = The level of activities to be witnessed by the Classification to be determined during the assessment required by T 2,102.

TABLE T.T1.101.1 - TESTS AND EVIDENCE ACCORDING TO A CATEGORY OF THE SYSTEM

No.	Tests and evidence	Category of the System		
		I	II	III
1.	**Evidence of the quality system**			
	Quality plan for the program		M	M
	Inspection of the components (hardware only) for subcontracted		M	M
	Quality control in the production		M	M
	Final reports of the tests	M	M	S
	Traceability of the software	M	M	S
2	**Description of the software and hardware**			
	Description of the software		M	S
	Description of the hardware		M	S
	Analysis of the failure – for functions related with the safety only			S
3	**Evidence of test of Software**			
	Evidence that the software has been tested in accordance with the quality procedures		M	S
	Analysis on the existence and conformity of the programming procedures for safety-related functions			S
4	**Tests of Hardware**			
	Tests according to Part III Title 63 Section 8		W	W
5	**Tests of Software**			
	Tests of modules		M	S
	Tests of subsystems		M	S
	Tests of system		M	S
6	**Tests of performance**			
	Test of integration		M	W
	Fault simulation		W	W
	Factory acceptance Test	M	W	W
7	**Tests on board**			
	Complete test of the system	M	W	W
	Test of integration		W	W
	Operation of wireless equipment for electromagnetic compatibility demonstration		W	W
8	**Modifications**			
	Tests after modifications	M	S/W	S/W

T2. DEFINITIONS AND NOTES RELATED TO TABLE T.T1.101.1, TESTS E EVIDENCE

100. Evidence of the quality system

101. Software quality plan: a plan for the activities of a lifecycle is to be developed in which are defined in the relevant procedures, responsibilities and system documentation, including configuration management.

102. Inspection of the components (hardware only) of subcontractors: evidence that components and / or sub assemblies are in accordance with the specifications.

103. Quality control in production: evidence of quality assurance measures in production.

104. final reports of tests: finished product test reports and documentation of the test results.

105. Traceability of software: modifications of the contents of programs and data, as well as change of the version, shall be carried out in accordance with a procedure and is to be documented.

200. Description of Hardware and software

201. Description of Software: the software is to be specificated, namely:

a. Description of the basic program and of communications fitted on each hardware unit.

b. Description of the software application (not program listing)

c. Description of the functions, performance, constraints, and dependencies between modules or other components.

202. Description of the Hardware, namely:

a. Block diagram of the system, showing the arrangement, input and output devices, and interconnections;

b. Diagrams of connections

c. Details of the input and output devices

d. Details of the power supplies

203. Failure mode analysis for safety-related functions only (FMEA). The analysis must be carried out using appropriate means, namely:

a. Fault tree

b. Risk analysis

c. FMEA or FMECA

204. The goal is to demonstrate that for simple faults, the system will fail within safety standards and operating systems will not be lost or degraded beyond acceptable performance criteria specified by the Classifier.

300. Evidence of software test

301. Software testing evidence according to the quality plan: procedures for verification and validation of the activities are to be established, namely:

a. Test Methods

b. Test the production of the programs

c. Simulation

302. Analysis concerning the existence and fulfillment of program procedures for safety-related tasks: specific quality assurance methods shall be designed to meet the verification and validation requirements, namely:

a. Diversity of programs

b. Analysis and test of the program to detect formal errors and discrepancies in the specification

c. Simple structure

400. Hardware tests

401. Tests according to Part III, Title 63, Sections 7 and 8 – Test specifications for approval of type - Special considerations can be made and approved by other Classifier member of IACS.

500. Software testing

501. Module test: testing of software modules are to provide evidence that each module performs the function for which it was designed and does not perform other functions not designed.

502. Tests of subsystems: subsystem testing are to verify that the modules interact correctly to perform the specified functions, and if does not perform other functions not designed.

503. Tests of systems: systems testing shall chck that the modules interact correctly to play the specified functions, and if does not perform other functions not designed.

600. Performance Tests

601. Integration testing: testing of programmable electronic systems is to be carried out using software tested and satisfactorily and, as far as possible, the components specified for the system.

602. Simulation of failures: Failures shall be simulated as realistically as possible to demonstrate if the fault detection system is adequate, and what is the response of the system. The results of any tests of failure analysis are to be analyzed.

603. Manufacturer acceptance: acceptance testing at the manufacturer (FAT) shall be carried out in accordance with the schedule of tests accepted by the Classifier. The tests are to be performed aimed to demonstrate that the system meets the requirements of the Classifier.

700. Tests on board

701. Complete test of the system: the tests are to be carried out when the system be complete, including the hardware components installed with the final application of the software in accordance with the schedule of approved tests.

702. Integration testing: testing performed on board are to chck that the correct functionality was achieved with all integrated systems.

703. The first operational tests shall be performed to set and record the operating capacity of each individual system, including transducers, actuators, display and locking instruments, alarms and other items of the control. The tests shall include the operation and exchange between all methods of manual and automatic remote control. The records are to be documented.

704. For wireless data transmission equipment, dock and sea tests are to be performed - to demonstrate that the transmission of radio frequency does not cause failure of any equipment, and that the system does not fail as a result of electromagnetic interference during the specified operating conditions.

705. Note: when be observed that the electromagnetic interference caused by wireless data transmission equipment cause failures of equipment required for category II or III, the arrangement and / or equipment are be changed to prevent the occurrence of failures.

800. Modifications

801. Tests after modifications: modifications in relation to the approved system are to be notified in advance and carried out to the satisfaction of the Classifier.

T3. ADDITIONAL TESTS FOR THE AUT-F

100. Additional verifications and simulations

101. In addition, for AUT-F systems perform:

a. Check the fire detection system;

b. Verify the proper condition of operation of the fire detection in economizers, gas boilers equipped with filleted tubes, etc.;

c. Verify proper operating condition of integrated computing systems used for monitoring, control and safety of the machinery in particular;

d. Visual inspection;

e. Functional operation of the control station;

f. Transfer of control between stations;

g. Alarm inhibition function;

h. Alarm recognition procedures; and

i. Internal and external fault simulation of the integrated system, including loss or variation of the power supply.

T4. INTEGRATION TESTING: FOR ELECTRONICALLY CONTROLLED DIESEL ENGINES

100. Scope

101. The integration tests shall verify that the response of the complete system of mechanics, hydraulics and electronics is as specified for all expected operating modes. The scope of these tests is to be accepted by the Society for selected cases based on FMEA required in Part II, Title 11, Section 5, Subchapter E3.

102. After completion of the program for running-in, prescribed by the manufacturer, the engines are to be subjected to tests as specified in this Chapter.

200. Scope of testing

201. Main propulsion engines turning fixed propellers.

a. At the speed assigned to engine by: at least 4 hours and at the engine speed corresponding to the normal continuous cruise power: at least 2 hours.

b. At speed n = 1.032 no: 30 minutes (where the motor adjustment permits, see Part III, Title 62, section 5, Subchapter H4, Item 203b)

c. On on-load minimum speed

d. In starting and reversing manoeuvres

e. in the opposite direction of propeller rotation during the docking or in the sea trials at a engine speed of at least n = 0.7 no: 10 minutes

f. monitoring systems, alarm and security.

202. Main propulsion engines which drive controllable pitch propellers or reversing gearboxes. Controllable-pitch propellers are to be tested with various pitches of propeller.

203. Single unit main engines that drive power generators for propulsion. The tests to be conducted at a nominal speed and with a constant adjustment of the controller of:

a. 100 % power (rated propulsion power): at least 4 hours and at normal continuous cruise propulsion power: at least 2 hours.

b. 110 % power (rated propulsion power): 30 minutes.

c. In the opposite direction of rotation of the propeller at a speed of at least 70 % of the nominal speed of the propeller: 10 minutes

d. Starting manoeuvres

e. Monitoring, alarm and safety systems

204. NOTE: The tests are to be based in the rated Power of the electric motors of propulsion.

300. Auxiliary prime movers

301.Engines that move generators or important auxiliaries are to be subjected to an operational test for at least 4 hours. During the test is required that the group in question to work at its nominal power for an extended period. It is to be demonstrated that the engine is capable of supplying 100 % of its rated power, and in the case of on-board generators is to be taken into account the time needed to perform the system generator overload protection.

302. The adequacy of the engine burning residual or from other special fuels are to be demonstrated, whether the installation of machinery is arranged to burn such fuels.

303. In addition, the scope of the tests can be expanded into account special operating conditions, such as tow, trawling etc.

T5. TESTS AND INSPECTIONS FOR SYSTEMS WITH NOTATION OF CENTRALIZED NAVIGATION CONTROL (CNC) [IACS UR N1]

100. Testing of the equipment after installation onboard

101. After fitting on-board, the installations are to be submitted to the tests deemed necessary to demonstrate correct operation. Some tests may be carried out at the quayside, while others are to be effected at sea trials.

102. On-board tests and sea trials are to be carried out in accordance with the test procedures submitted in advance to the Society for approval. Tests and trials are to be performed under the supervision of the Surveyors.

200. Surveys

201. Periodical surveys are to be carried out to the Surveyor's satisfaction, in order to verify that the equipment and arrangements required for the class notation are being maintained in good working order.

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