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Control, Supervision and Maintenance of Navigation Command Equipment

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Abstract. The paper's theme is to make checklists on the control, supervision and maintenance of equipment in the navigation command. Based on the checklist models used on board the ship, the procedures for checking the navigation equipment and the steering gear shall be studied. Four checklist models used on board Maersk ships are presented: checklist for preparing the deck before entering port operations, checklist for preparing deck before leaving port, check-list for the radio installations that are part of the Global Maritime Distress and Safety System - GMDSS, as well as the checklist for checking and testing the steering installation.

1. Introduction

It is very important to use a checklist. Checklists reduce decision fatigue by acting as our memory. It also can eliminate mistakes - following a checklist reduces the potential for errors by ensuring the correctness of each step, every time. When multiple people complete the same tasks, a checklist is essential to ensure that the task will be made in the same way. Checklists also reduce errors by clearly laying out exactly what needs to be done so that nothing is missed.

Checklists are an easy way to check navigation equipment and steering gear, as they reduce the risk of human error. Checklists help to ensure consistency and completeness in the fulfilment of work tasks. Efficient inspection of each navigation equipment and steering gear as well as their preventive maintenance can be the decisive factor in avoiding navigation incidents that may occur because of a possible failure.

The requirements for equipping ships with navigation control equipment are set out in Regulation 19 - "Transport requirements for navigation systems and equipment carried on ships", in Chapter V - "Safety of navigation", of the SOLAS Convention - "Transport requirements for navigation systems and equipment transported on ships". Navigation equipment is one of the main objectives of checklists for order preparation, these being checked before each enter or exit manoeuvre from the port.

The procedures in the checklist for verifying the steering gear are explained in Regulation 26 - “Checking the steering gear”, in Chapter V of the SOLAS Convention. The checklist for the preparation of the bridge deck before the port entry manoeuvring operations is completed at a time interval of 1-2 hours before the arrival at the place of embarkation of the port pilot. This is completed by the Officer on Watch, who checks all navigation equipment as well as other instruments necessary to maintain the safety of navigation. The four safety parameters of navigation will be introduced: the shallow water contour (Shallow Contour), the safety isobaths (Safety Contour), the safety depth (Safety Depth) and the depth contour (Deep Contour). They must be changed at least three times during a voyage: on departure, during the underway and on arrival at the destination port. These parameters are very important for alerting the Officer on Watch to the situations in which the ship is to enter the area with shallow waters related to the draft of the ship, thus preventing their failure [1 - 3].

The checklist for verifying and testing the steering gear is completed in no more than 12 hours before underway departure by the deck officer which performs the test on the navigation command. The procedures for checking the steering gear from the wheelhouse shall be carried out by the engine officer who performs the tests required by the SOLAS Convention, in Regulation 26 of Chapter V. After completing the checklist, this is recorded in the ship's logbook.

The power supply system of the equipment from the control compartment and the engine compartment is made in alternating current and in direct current - for the emergency system [4 - 6]. The naval electric power system through the power plants realizes the distribution of the electric energy that supplies the navigation equipments and must have well established parameters [7 - 9].

2. Control and supervision of navigation equipment

The integrated deck is one of the newest equipment used on board the ship, created to increase the safety of navigation, facilitate the work of officers, and is made with the latest technology. Using hardware and software components, the integrated deck brings together all the existing onboard equipment. The information received from these equipments is processed and displayed through computer programs [10 – 13].

Integrated bridge systems are designed to include various devices and equipments. Among them one can mention: radar, special monitors that display electronic maps, autopilot, gyrocompass, sensors for determining wind speed and direction, sensors for barometric pressure and temperature, equipment for determining position, communications equipment, etc. These integrated bridges include facilities such as: weather bulletin reception systems, online automatic electronic map correction systems. The watch officer can view all this data from any position on the control deck by simply rotating one monitor.

An example of a system used by the integrated bridge is the Voyage Management System. It is based on data inputs and outputs from all devices and instruments, these being processed to be able to present at any time a clear situation of the ship's condition, cargo, navigation hazards, equipment condition, etc.

The Electronic Chart Display and Information System (ECDIS) – figure 1 - is a navigation equipment that provides the display of selected information from an electronic navigation map system with position information from a navigation system, to assist seafarers in planning and executing the established route. The monitor has a special feature – a picture-in-picture presentation. Graphic coverage includes the ship's own symbol, routes and waypoints. The map can rotate depending on the road, bow or true north. It also receives information on course, speed and position from a variety of GPS and gyrocompasses and can provide comprehensive route planning, the possibility of calculating the estimated time of arrival, speed required, etc. As technical performances it can ensure route planning and monitoring; autopilot control; display of ARPA targets, radar or renewed maps;

networking with other devices on board the ship; displaying the compass path, true north as well as alternative routes, etc.

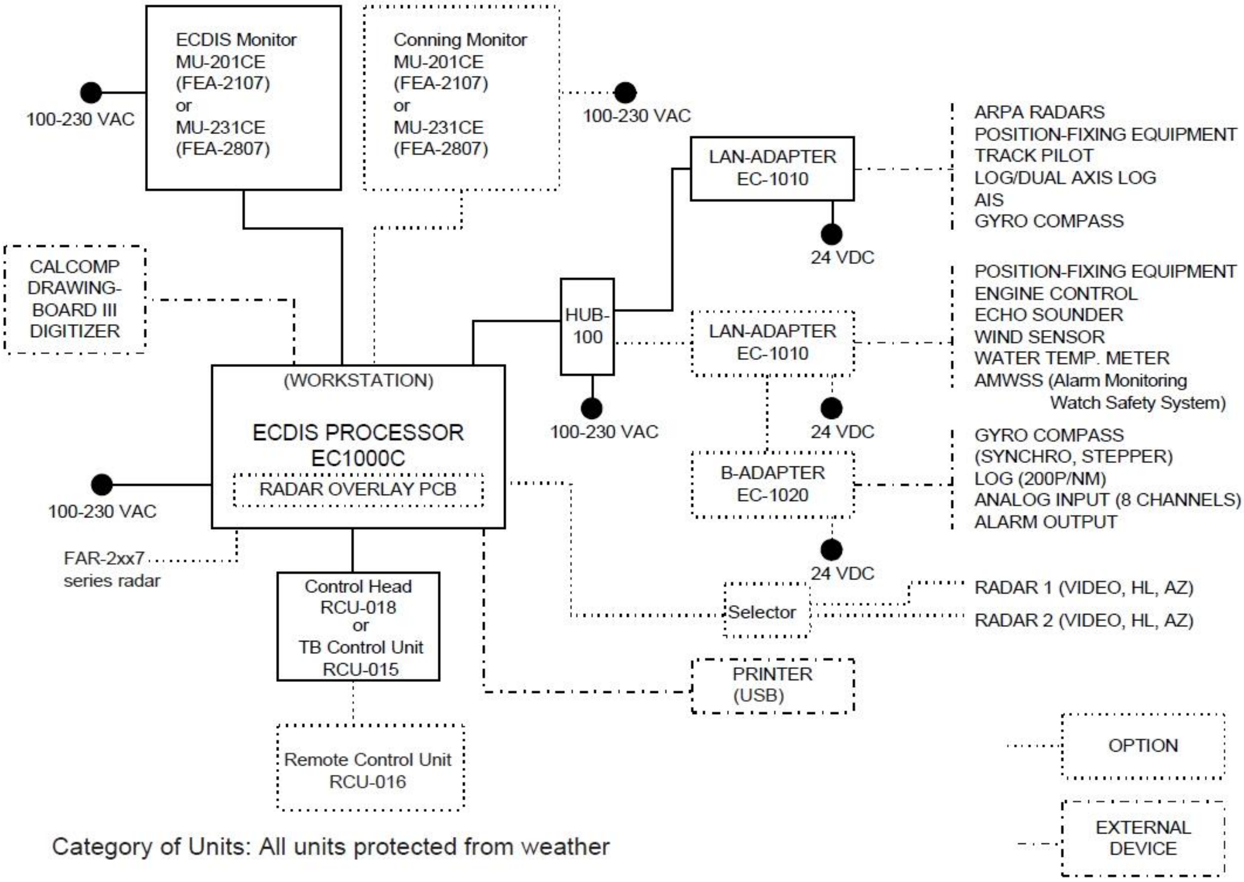

Figure 1. ECDIS operating diagram, Furuno model FEA-2807 [4]

ECDIS equipment and other necessary equipment for its optimal operation must be capable of being supplied from an emergency power supply in accordance with the requirements set out in Chapter II-1 of the 1974 SOLAS Convention. Changing the power source, or interrupting the power for 45 seconds, must not cause the equipment to be reset manually. The ECDIS is equipped with a 5A fuse, located in the back of the processing unit, which has the role of protecting it from overvoltage or the occurrence of reverse polarity current. In the event of a burned fuse, the cause of this must be found out before it can be replaced. At the same time, there is a lithium battery on the central processing unit, which has the role of saving data when the power supply is turned off. When the battery voltage is low, to prevent possible data loss in the event of a power leak, it must be replaced by an authorized technician [14 - 20].

The equipment on which the study was conducted is produced by the Japanese company Furuno, model FEA-2807. ECDIS must meet the minimum requirements set out in IMO Resolution: MSC. 232 (82) – "Revised performance standards for electronic chart display and information systems - ECDIS" [19-24].

Global Positioning System (GPS), through the 24 satellites located at an altitude of 20183 kilometres, aims to accurately determine the position of the receiver. The satellites of the GPS system, being equipped with atomic clocks, provide the ship with precise information about universal time -

UTC. The Differential Global Positioning System (DGPS) determines the position of the receiver with a higher accuracy (from 10 centimetres to 1 meter) compared to that obtained only from the satellites of the GPS system (10 - 15 meters). The DGPS system, in addition to the data received from the satellites, calculates the precise position with the help of differential corrections transmitted from a fixed receiver (base station), located at a known coordinate point.

The equipment on which the study was conducted is a DGPS receiver, model GP-150, produced by the Japanese company Furuno. The GPS must meet the minimum requirements set out in the IMO: MSC resolutions. 112 (73) - " Revised performance standards for shipborne global positioning system receiver equipments" and MSC. 114 (73) - " Revised performance standards for shipborne DGPS and DGLONASS maritime radio beacon receiver equipment" [18], [22], [25], [26].

The GPS receiver must be able to determine the position of the ship accurately within a maximum of 2 minutes if its power supply has been switched off for 60 seconds. In the event of a short circuit, the receiver must be equipped with a protection that prevents it from being damaged or its connections to the other navigation equipment with which it is interconnected.

The equipment must be fitted with an alarm system if the dilution of the position accuracy has a value above the accepted limit, if the position of the vessel has not been determined at an interval of more than 1 second or if the position of the vessel is no longer determined with high accuracy via differential GPS system (DGPS). The GPS receiver is equipped with a 2A fuse, which has the role of protecting it from overvoltage or the occurrence of reverse polarity current. In the event of a burned fuse, the cause of this must be found out before it can be replaced. At the same time, the GPS receiver contains a CR2450 lithium battery, which saves data when the power supply is turned off. The battery life is estimated to be three years. When the battery voltage is low, the receiver will indicate this, requiring it to be replaced [4-13] - Figure 2.

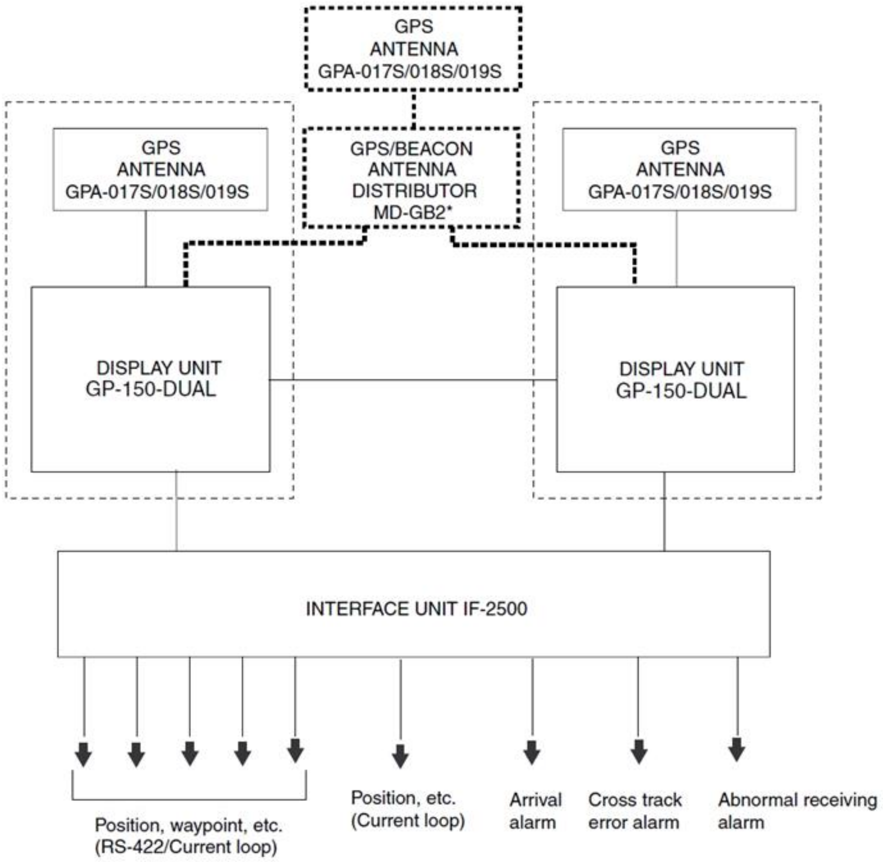

Figure 2. GPS operation diagram, Furuno model GP-150 [6]

3. Checking the ship's steering gear

The steering gear is the installation that must ensure the observance of the road imposed on the ship, or the change of road, by applying vertical moments of rotation that act simultaneously with the axial force that propels the ship. The components of the steering gear are: the element of control (ship’s wheel), the control transmission (connection between the ship’s wheel and the power machine), the power machine (rudder machine), the power transmission (the connection between the rudder machine and the execution elements), one or more elements of execution, the governing body (rudder).

The procedures in the checklist for verifying the steering gear are explained in regulation 26 “Checking the steering gear” in Chapter V of the SOLAS Convention.

The steering gear shall be checked and tested within a maximum of 12 hours before underway departure by the deck officer who prepares the navigation command, as well as by the engine officer in the wheelhouse.

4. Conclusions

Checklists are an integral part of the Safety Management System (SMS). A good knowledge of it by the officers is necessary for determining the checklist which needs to be used for various tasks or operations on board the ship. When completing a checklist, it is necessary for the watch officer to be well acquainted with the navigation equipment that follows to be checked, to know how it works, and to follow the procedures for diligently checking each piece of equipment, so that no details are overlooked, the safety of navigation depending on the proper functioning of this equipment.

Navigation equipment, like any kind of electronic equipment, is susceptible to various malfunctions and errors. This can be prevented by applying preventive maintenance procedures at a certain time interval, usually specified by the equipment manufacturers.

Preventive maintenance is the sum of checks and actions taken to ensure optimal operation of the equipment on the navigation control. The advantages of applying these preventive procedures are:

- Optimal and continuous operation of navigation equipment.
- Early identification of parameters with abnormal values - before the occurrence of failures.
- Remediation of conditions that may cause possible malfunctions in due time.
- Prolonging the service life of the equipment.
- Reducing repair costs.

However, in some cases, over time, the performance of this preventive maintenance may not prevent the failures of certain components of the equipment, so it is necessary to perform a corrective maintenance. This involves the detection, location and operational remediation of the fault in order to restore the normal operation of the system. This can be done either on board the ship by the crew, or by teams of land technicians.

The steering gear, being vital for the proper functioning of the ship, must be subjected to a very careful check, observance with all procedures on the checklist is imperative, so as to eliminate the risk of a navigation incident caused by the possible occurrence of a rudder damage that could have been prevented by performing these procedures.

A good officer must be familiar with the operation of navigation equipment, be familiar with the specific characteristics of the equipment model that is in the ship's equipment, and with the periodic maintenance procedures that must be carried out to maintain them in good working order.

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