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MONITORING STABILITY OF THE SHIP USING HARDWARE AND SOFTWARE EQUIPMENT

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Abstract: "The boat is safe in the harbor; but boats were not made for this." quote John A. Shedd
The ship performance is often given by the ability to "survive" the problems that may arise far from shore. Both, passengers and loads, may suffer if ship stability is endangered. The main goal now is to improve and secure shipping using the latest technology in terms of monitoring and recording the optimum operational parameters of a vessel. Computer-assisted calculation units used for monitoring ship stability is not a requirement in default ships equipment, but is becoming increasingly useful use for new technologies to prevent and solve problems that arise due to the instability of the vessel. We are talking about equipment that will not replace existing measures and technology but will work together to supplement the information parameters about stability of the ship at any time during navigation. Improving monitoring systems throughout the transport loads can be a difficult operation on a Heavy ship, computer-assisted systems can however perform calculations in record time and can provide extra safety measures for the entire ship (including crew and passengers).
Keywords: *safety of the ship, computer-assisted system, technology development.*

ECDIS PART OF **INTEGRATED COMMAND SYSTEM -** CONCEPT OF "INTEGRATED BRIDGE SYSTEM"

The concept of integrated operational control systems has become increasingly common on the board of many ships. With these navigation systems, collision prevention and planning of journey can now be managed from a single position. The radar, maps and AIS system are all connected, providing the user with all information and functions provided by these devices. This proved to be a revolutionary step with important consequences in electronic navigation system development and a new beginning for modern navigation and also safe navigation.

Integrated system control is defined as a combination of interconnected systems in order to allow access from a single control point to all the received information from the sensors and control the information in order to increase the efficiency and safety of the ship management with an appropriate, qualified personnel.

Officers responsible for maritime navigation charts have the following three main duties:

Navigation - watch officers must process information from several different sources. They take GPS positioning from receivers or hyperbolic Bearings receivers and measured distance by the radar or other appropriate navigation equipment, and after all analyzes they can put on paper map obtained information. After plotting information on a map, watch officers, evaluate the results and determine whether the vessel is in safe position, taking into account the route of the ship and prospect of future positions. The rating is the most important step of the navigation process. Correct execution of this step is first consequence of prowess watch officer and on the other hand is how well the current situation is represented on the navigation map. This representation is a function of both sides: one who read the sensors and navigation sensors accuracy.

Avoiding collision –Watch keepers assess the contact situation and calculate the nearest point of collision from different targets. Also all taken decisions must be in accordance with COLREG.

Ship Management – Watch keepers lead activities that are part of individual routine on the ship. Integrated Control is designed to reduce the time spent on gathering information for navigation by eliminating manual processing, use of a main display to help him assessing the situation of sailing in a short time. Preliminary studies show that the time spent by officers as a percentage of the total cart value decreases significantly when Integrated Systems Command is used by watch officers, and significantly increase the time spent driving the ship and avoid collision.

System components

The name used "**integrated command**" includes equipment combinations and specifically designed software for the needs of each vessel. There for integrated command are different. The main components are as follows:

Hard Drive with CPU and network - this subsystem is responsible for information processing for received ship's navigation sensors and information exchange between different system components. This component receives signals from navigation sensors. Information about ship position, data from potential targets in close proximity and information from the gyrocompass, which can be integrated with an electronic map to show full centralized navigation details on a display that, can be accessed directly by the officer. This system processes the information and also provides the ability to control the functions of embedded systems.

Electronic base maps - electronic map is placed in the middle of any Integrated System Command. The electronic map display system must meet the specifications of the International Maritime Organization to hold the requirements of Electronic Chart Display and Information System, all other systems are known as Electronic Chart System. Integrated Control System can receive electronic maps from the manufacturer equipment or authorized agencies. Electronic maps can display data categories in a way more advanced than conventional maps. Paper maps are usually limited to four colors and they always contain the same information. The electronic map can display a few colors and can display only user needs data. Although electronic maps are part of ECDIS equipment, they must always display the minimum data required by IMO. Navigation map database consists of basic navigation indicator components, obstructions, facilities of ports, shore line, permanent boundaries and topographic features. Other elements such as communication networks, power network sand detailed bathymetric lines of radar reflection devices may also be available. They all allow the user to customize the map to the arising needs in different sailing situations, thing you can't do on printed paper.

• **Display system** - this component displays the ship's position on the electronic map and connected sensor values of the system. Display the course and speed; you can enter data to issue warning messages such as minimum depth below the keel or deviation from the road. Plotting of ship's position in relation to a predetermined course. Enables display of motion in two ways: relative or true. In the ***relative motion***, ship remains fixed in the center of the screen and the map is moving. This requires a strong enough hardware unit so that all the displayed data on the screen can be updated and displayed in each plotting moment. In ***real movement***, the map remains, and the ship moves over it. Every time the ship approaches to the screen edge, it will refresh the ship on the opposite side. A separate window can be used to display alphanumeric information such as: main route, speed and deviation from the road. It can also be used to display small-scale maps for the area you are going to surf or to view other areas while the main window shows the current position of the ship tracks.

• **Planning Post** - sailors made up travel plans at this station. It generate great circle routes, rhomb lines, road map, distances, time and the way points. After the route was

establish and checked it is saved so can be opened later and
•**Control Post** - some Integrated Systems Command are equipped with a subsystem that automatically adjust course and speed to follow planned route. If there is such a system on-board navigation process is reduced to its monitoring and only in case of collision situation or other situation involving the safety of the ship, it will act on the system.

ECDIS is the main piece of Integrated Command System

• **Digital data transfer** - for **ECDIS** standard equipment performance, IMO ruled that the National Hydrographic Offices have to distribute official electronic charts for use in ECDIS. A preliminary data transfer standard, known as DX 90, was proposed by the IHO, who also discussed the usefulness of this standard. Regarding recommended standard data transfer, each hydrographic office producing such data has to decide what standard to use. To ensure data security for ECDIS equipment, databases from unofficial sources are not allowed to remove, replace or modify the data written by authorized hydrographic offices.

• **ECDIS warnings and alarms** - since the ECDIS is an intelligent system that combines several different functions in a single computer system and provides the ability to be programmed to emit audible alarm or display warnings when some parameters are reaching the limits. This helps the navigator to monitor the dangers of sailing.

IMO standards require that these alarms to be available on ECDIS:
- Deviation from the established route;
- Approaching a way point or another critical point;
- Use of a positioning system that uses a different system than the geodetic reference system;
- Exceeding the established way limits;
- Display maps at a scale too large;
- Positioning system failure;
- Intersect of the Ship safety contour;
- Failure or malfunction of the system.

Alarms consist in visible and audible signals. Seafarers can set some values, such as deviation distance from the road. All ECDIS equipment it is able to generate basics alarms. For the specific use of the ECDIS system, sailors have to be trained on board of the vessel.

Measurement Units - ECDIS equipment will display units like:
- **Position**: latitude and longitude will be shown in minutes and tenths of minute, degrees, based on WGS-84 reference system;
- **Depth**: will be shown in feet and tenths of a meter. The arms and legs may be used only as a temporary unit when maps used contain data in these units or when time does not permit immediate conversion from English system to metric system;
- **Height**: meters (preferred) or feet;
- **Distance**: nautical miles and tenths of a mile or feet;
- **Speed:** knots and knots tenths.

Information priority - ECDIS requires selecting displayed information. The minimum and required number of information categories and their priority in descending order of priority is as follows.
- Warnings and messages;
- Hydrographic offices data;
- Information notices for sailors;
- Hydrographic offices warnings;
-Radar information;
-Information about the user;
- Information about the manufacturer.

IMO standards for ECDIS equipment require that the user to be able to uncheck the radar image on the electronic map using a minimum of operations.

• **Calculation requirements** - ECDIS equipment must be capable of minimum following calculations:
- The geographical coordinates and them display;
- Datum transformation in WGS-84's, from a local datum;
- True azimuth and distance between two geographical positions;
- Geographical position, distance and azimuth to a given point;
- Projection calculation and distance and great circle and rhomb way.

Standard Performances for Integrated Bridge Systems were adopted by IMO in 1996 (Resolution MSC.64 (67)). SOLAS Chapter V adopted in December 2000 and entered in use in July 2002states the requirements imposed by 19-thrule for new navigation system. When a subsystem fails have to be brought immediately to the attention of the officer in charge of a navigational watch by audible alarms or visual, and do not cause damage to any other subsystem. In case of failure of an IBS component, other individually components should be enabled.

1. INTRODUCTION

IBS is defined as a combination of systems that are interconnected in order to allow centralization access to sensors information or control station in order to increase safety and ship management by qualified personnel.

IBS in addition to meet the functional requirements of IMO Resolution A.694 general requirements contained in (17) must comply with standard performance.

2. SYSTEM REQUIREMENTS

IBS must support the execution of two or more of the following:
- planning the voyage;
- The system control;
- Goods loading, unloading and quality control;
- Safety and security;
- Communications.

General Requirements

IBS must comply with all IMO requirements and recommendations. The parts that execute multiple operations must meet specific requirements for each function. Each part of the IBS must meet Resolution A.694 (17) and all its associated standard technical tests. Consequently, IBS must meet these requirements without further tests. *Note: The term "component" is used to define - for example - an individual module, equipment or subsystem. The failure of a component should not affect the functionality of other components except for those parts that directly depend on the damage.*

Integration- IBS must meet the following integration requirements of functions:

Functionality- IBS must ensure effective operation mode for a single device.

Displaying information on a continuous basis must be reduced to the minimum required ship safety.

Additional information should be available and accessible immediately. When multiple functions or commands are used and needed for safe navigation of the ship, they should be doubled and unchanged between.

Each **integral part** must provide details of functional status, potential and validity of essential information. IBS should be able to use this information anytime.

An **alternative source** of essential information must be available if the main source is lost. Information source (sensors, calculation results, manual adjustments) must be displayed continuously or when it is required.

Data sharing - IBS interface must comply with international shipping standard interface;

Exchanged data must be compatible with the performed operations on the ship;

The integrity of network data flow must be ensured;

A connectivity fault should not affect the independent equipment operationally within IBS;

Assessment in case of failure;

Immediately fault analysis must be executed after its production.

Operational Requirements

Human factors

- IBS should be easy to work with by staff that holds an appropriate certificate;
- Interface must be designed to be easily understood in a consistent style for all integrated equipment by the operator.

- Multifunctional displays, when used, shall be continuously color and capable to display information about tracked areas, (accessible by the user);
- For unexpected actions, IBS should seek confirmation from the human operator;
- System management must ensure that only one user can access the functions of IBS in a given time, more than that, other operators should be informed about this.

Technical Requirements

• Sensors - in order to ensure proper operation of the system, employees must ensure consistent interface compatibility communication according to international maritime standard and provide operational status updates, potential and validity of essential information.

• Alarm Management - minimum requirements in this regard is found in "Code on Alarms and Indicators" 1995 (resolution A.830 (19)). Specific alarm management and functional groups must be provided on IBS. The number of alarms and types of alarming sounds should be kept as a low priority by providing the indicators in this regard. Alarms shall be displayed and functional restrictions result be easily understood. Indicators should be explanatory.

Functionality - always must be clear from where the essential functions can be accessed;

• Reboot and closing - if you are running a normal locking system, IBS should return to normal when it is restarted. After an interruption of power supply, IBS must be capable of operating in full, even if not all subsystems have been recovered. IBS should not increase the recovery time after refueling individual subsystems energy. If the power supply stops, IBS should restore the configuration that was in use and continue automatic operation, if possible.

• Power supply - IBS and all of it subsystems must meet IMO requirements.

IBS must be supplied from:

-emergency power supply with automatic change to permanent supply system without causing accidental interruption of IBS;

-intermediate source of electricity for a period longer than 1 minute;

-if necessary, parts of IBS should be supplied from the emergency source of electrical power.

CONCLUSIONS

The most ship's bridge equipment devices follow their own philosophy of displaying information and announcing warnings or alarms when determining safety- or operation- critical states. The technical navigation systems are used on board vessels in a different manner. Very often these systems have an integrative mode of operation. However, they have actually a life of its own depending of the equipment manufacturers. The sense and handling of the announced warnings or alarms in complex situations is not acceptable in ship handling procedures, because of the device-centric decision-making process.

Integrated Bridge System is one of the newest devices used on board of the ship with the latest technology, especially designed to increase safe navigation and to ease officer's work. Firms with tradition in the production of marine equipment, such as Raytheon Marine, Kelvin Hughes, Electrotech, promoted the system and it is already imposed on the market as a navigation solution for the future. The entire integrated bridge unite top up the existing ship equipment via hardware and software. Information received from this equipment are processed and displayed through programs as easy and useful to use.

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