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THE INFORMATION MANAGEMENT FOR MARITIME ACCIDENT RECONSTRUCTION USING VOYAGE DATA RECORDER SYSTEM

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Abstract: *In the recent year it has increased the volume of maritime transport, so that led to the involvement of more ships in the industrial sector, increasing maritime accidents, of which some were even causing losses of life. To face this issue and to increase security on the sea, the International Maritime Organization (IMO) has agreed to implement a data recorder on board, similar to the black boxes used on aircraft, called "white boxes". This paper has the purpose to explain the system VDR (Voyage Data Recorder) for a casualty. Analysis was performed in a case study on a marine casualty and the results of its reconstruction were concluded that the VDR system can be optimized.*
Keywords: *maritime accidents, security, VDR, reconstruction.*

Introduction

A Voyage Data Recorder purpose(VDR) is to store, in a secure and retrievable form, information regarding vessel movements, physical status, command and control ship for a specified period to a maritime incident having consequences on the ship. This information is used in a subsequent investigation to identify the causes of the incident. International Maritime Organization approved a change in official documents obliging the equipment of vessel types with a VDR or at least with an S-VDR (Simplified Voyage Data Recorder).
International Electro-technical Commission (IEC) is a worldwide organization for standardization of electrical equipment on board. The objective of this organization is to promote international cooperation in all matters relating to standardization in the electric and electronic field. For this purpose and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, publicly available specifications (PAS) and guides necessary to the ships.
Their preparation is entrusted to technical committees; any IEC National Committee may participate in the preparation of the subjects. TheIEC61996-2International Standard was developed by IEC technical committee80:"maritime navigation and radio-communication equipment and systems." This standardIECPAS61996-2cancels and replaces the first edition published in 2005 constitutes a technical revision and incorporates the recommendations of IMO plus new means for extracting data from S-VDR.
IEC 61996 consists of the following parts under the general title *Maritime navigation and radio-communication equipment and systems – Ship borne voyage data recorder (VDR)*:

- Part1: Performance requirements, methods of testing and required test results;
- Part 2: Simplified voyage data recorder (S-VDR) – Performance requirements, methods of testing and required test results.

The S-VDR has been introduced by IMO for fitting to existing ships as a simplified alternative to the voyage data recorder (VDR) which is required for all new ships. The specification for S-VDR differs significantly from that for VDR in two areas:

a. the requirements for monitoring certain sensors are reduced when the data is not provided in IEC 61162 format;
b. the requirements for the protective S-VDR capsule are different from the VDR capsule, both for the fixed and float-free versions.

Around 90% of international trade is carried in maritime transport industry. Shipping is considered as a safe but also economic and ecological environment benign form. Although accidents attract public attention very quickly, statistics show that there is a slow and steady decline in the last 10 years according to reports from the "Allianz Global Corporate & Specialty". The decade following the trend of improving the overall security of maritime transport, an evolving trend since the beginning of the twentieth century. Shipping is a highly regulated area and these rules have been consolidated in the last two decades. The principles underlying transport regulations are harmonized national rules based on international conventions and resolutions IMO data organization. Among these regulations, SOLAS is seen as the most important international treaty concerning the safety of merchant ships. Its main objective is to specify minimum standards for construction, equipment and operation of ships. It is divided into 12 chapters. In response to overthrow the ferry "Herald of Free Enterprise" in 1987, IMO adopted in 1993 ISM Code (International Safety Management).

This code applies a safety management system to be established by the owner or person in charge of a ship. Because of the ISM Code, shipping industry work is hampered by the use of any specific check-list sites each activity involving all staff, from the simple sailor to general manager. ISM Code became mandatory for passenger ships and ships of dangerous goods in 1998, then for the rest of the fleet in 2002. Meanwhile, the IMO International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW-Standards of Training, Certification and Watchkeeping) for seafarers has the following recommendation: "Resource management on the bridge" or otherwise correct allocation and use all available resources on the bridge. The Manila amendments to the STCW Code, which entered into force on 1 January 2012, are a further step to control the human factor by bringing new additions to this resource management on the bridge.

Format and volume data stored by a VDR

The amount of data that is produced by a VDR or S-VDR system in a given time will determine the amount of storage space required for the data to be saved or stored and also the necessary mechanisms for the transfer of such data transmission elsewhere, e.g. to the shore.

There are three basic types of data we record with VDR system, namely, audio, radar images and data from sensors or control devices (of steering response or reply to telegraph). Current specifications performance not require a specific format for data stored internally by the system. The exact amount of space needed to store data in the system is based on the number of sensors used and methods used for data compression.

The number of sensors varies depending on the installer and the method of compression varies according to the each manufacturer. Therefore, it can't say definitely how much memory is required to store a given amount for a period of time.

However, all systems be certified to be able to hold 12 hours of data protection cap particularly designated. Most systems in the capsule protective hand machines are equipped with 2 GB of memory about where we can conclude that for typical sensors and compression methods, 12 hours of recorded data should take less than 2 GB of memory. Moreover, considering the different types of data, it can be inferred that most of the storage elements is occupied by audio and radar images, where specific data from sensors occupies a relatively small percentage, as shown in Figure 1.

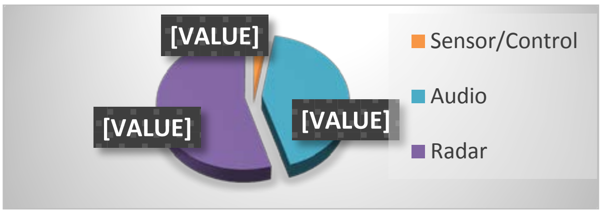

Figure 1: Group information in the space allotted for VDR's hard drive

The figure 1 shows how these control data/sensors uses only 2.7% of the available spaceon a hardof aVDR. Unlike audio data and radar images (which are already compressed byn methods arranged by the manufacturer) occupies 42.63% and 54.67% respectively.

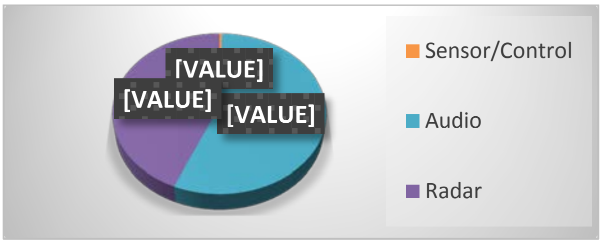

Figure 2: Group information in the space allotted for VDR's hard drive with compressed data from the sensors

The figure 2 presents the percentage reduction in data storage from sensors and radar images compression methods, the amount that can reach up to0.41%and43.63% thereby providing a higher percentage for audio data, namely 5593%.

Analysis and validation of results accident reconstructions based on information provided by VDR (Voyage Data Recorder)

The literature confirms the need for continuous research in the field of maritime accidents. Human error is wide spread in Navy and also in merchant marine. Some investigators agreed that previous check-lists it exposing human error factors as an important factor for defining and putting ships on land, but few ships have recorded incident data to make analysis by HFACS chain.

In 2002 a statistic study showed that human error contributes to79% of tanker accidents, 89%-96% collision and 75% collision of ships hit a bollard. Research into accidents has shown that it would be increasingly more to do more research in this area and to find strategies to combat these inconsistencies with the wishes ship owners.

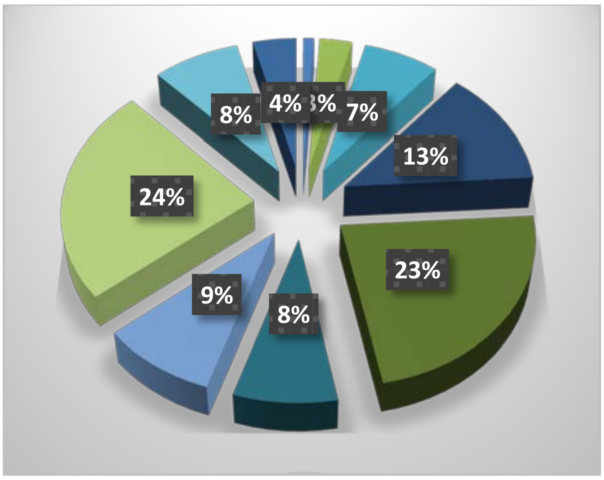

Figure 3:The presentation of the percent collision factors

Case study: Collision of the ships "CONSOUTH" and "PIRIREIS"

29 April 2013 04.43 hours the merchant vessel "CONSOUTH" and "PIRIREIS" were colliding at sea about 82 nautical miles ESE of Sapientza Island (island located at the end of the NW Peloponnissos-Greece). At the collision moment, the hydro-meteorologicalconditions were reported as good (wind speed 2 on Beaufort scale, small sea level and good visibility), the action taking place during the night.

Merchant vessel M / V CONSOUTH was registered under the flag of Antigua & Barbuda and was sailingfrom Tuzla (Turkey) on April 26, 10.00a.m with tanks ballasted after finishing all the certificated operations by the Register of Certification and was on his way to the port Marshaxlokk, Malta with a crew of 16 members. On April 29, at about 04.00 a.m second officer changed the watch officer and took the command on watch between 04.00-08.00 a.m.

Commercial ship "CONSOUTH" was en route to 265 ° and had a cruising speed of 12.5 knots. During the changing between the two officers on watch were not mentioned special observations on the navigation situation, just that the merchant vessel "PIRIREIS" was identified by radar ARPA target at a distance of 17 Nm starboard bow bearing on a course of 087 °, a speed of 10 knots and a CPA (Closest point of approach) estimated as being 0.65 Nm. At 04.15a.mwhile the ship "PIRIREIS" was at a distance of 10 Nm from the ship "CONSOUTH" in bearing starboard bow, watchkeeping officer decides to change the way to the new course of 263 ° so as to increase the CPA 0.8 Nm. By that time until shortly before the collision there were no other navigation events. On the 3rdwatchkeeping was not installed a bow lookout. Merchant vessel "PIRIREIS" became visible at a distance of 7 Nm and the information ARPA navigational radar this target would have passed starboard to starboard at a safe distance of about 0.8 mm.

On April 29, 2013 merchant vessel "PIRIREIS" was under the Cook Islands flag with a crew of 17 members and had planned the route Annaba (Algeria) – Ukrain, loaded with 12577 tons of chemical fertilizer. The voyage along had a short stay in port for bunkering Marshaxlokk. On April 29, 2013 at 00.00 a.m the second officer took the watchkeeping between 00.00-06.00 a.m. As said by the second officer, the master of the vessel remained in his accommodation during this watchkeeping. It was reported that navigational watch was quiet and the merchant vessel "CONSOUTH" was identified as a target at a distance of 10 Nm away from "PIRIREIS" in a way the port bow bearing of 260 ° and an estimated speed of 14 knots. According to the watchkeeping the second officer estimated that this target will pass through the port aboard a CPA about 1 Nm.

In the case presented above it was collected the information stored S-VDR on board the CONSOUTH and the VRD information stored on board the PIRIREIS could not be recovered due to the impossibility of immersion after the collision. To reconstitute the accident were used S-VDR data from the ship CONSOUTH and identified several positions from other vessels through their AIS system.

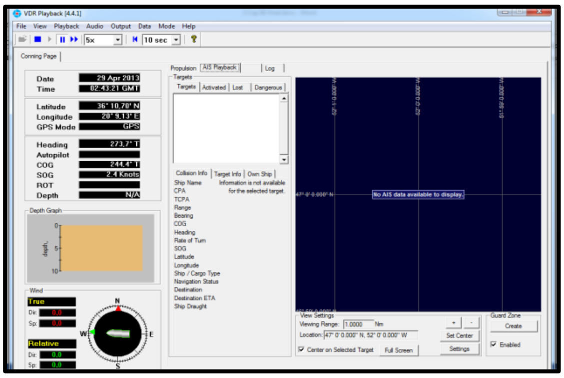

Figure 4: The S-VDR information stored on the ship "CONSOUTH"

Figure 4 presents the motion parameters displayed when CONSOUTH ship collided, which can be distinguished by latitude and longitude position, the date and time that happened (after UTC), GPS positioning system after course, speed and variation bearing to bow indicating a measure to avoid the very last moment. Allthrough this software can playback the stored information, we can playback the audio information from the bridge and communications by VHF. In therightof figure 4it can be recorded the AIS system (Automatic Identification System) which currently did not record data collision in the accident area.

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Because we do not have the radar image from the S-VDR system, we can't distinguish vessels appearance before the collision to decide which side is to blame more.

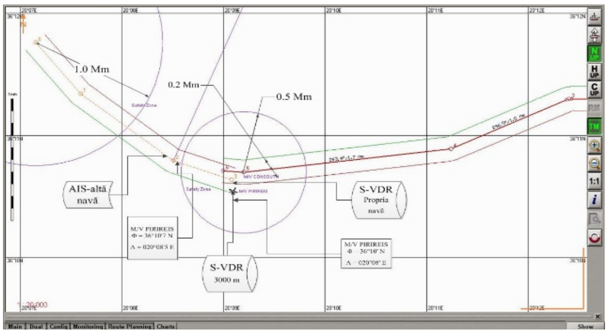

Figure 5: Reconstitution accident collision between M/V CONSOUTH and M/V PIRIREIS

Because of all data stored on this S-VDR still have doubts regarding the appointment of the defendant, the author propose improving the system by integrating a video signal generated by several cameras placed around the navigation bridge.

These cameras has to cover the all area of 360°and shall be arranged under the laws of location of lights on vessels in at least four sectors. Also not to interfere with navigation lights or light arrangement in the cameras, we can use infrared segment.

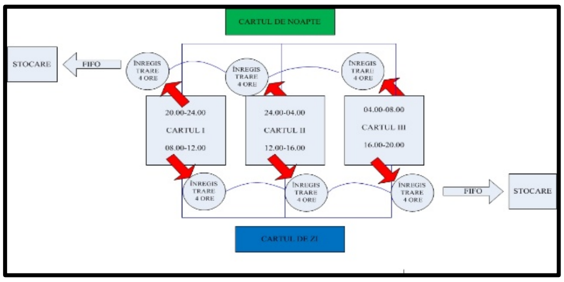

Figure 6: Proposal for a re-writable data storage from 4 to 4 hours

Storage capacity would become more rigorous in this regard because space is limited and can be prone damage. Thus we can perform data recording four in four hours so that we have a greater storage capacity but to rewrite every eight hours.

Using infrared segment we can distinguish with certainty the aspect of the ship, even more to have a complete picture of the hydro-meteorological situation during the accident and determine if meteorological phenomena had an external impact to the accident.

CONCLUSION

Most of the data stored in the VDR are formed of radar data and audio data. Compared with the data stored in the ship's motion sensors, they occupy a space of about 3% and could occupy a smaller volume and whether the data should be compressed (approximately 0.5%).

The costs of developing, testing the manufacturing and VDR systems would be significantly reduced if you would remove the requirement for data storage and audio radar because the current generation of VDR / S-VDR requires storage space capsule 2GB for protection 12 hours but if we reduce radar and audio data would need storage capacity of 100 to 200 MB for 12-hour period which would mean that it could store up to 18 days in the space of 2 GB allocated in capsule.

If one were to use the data compression model would be able to store sensory data from up to 120 days. Also recommend the use of data storage systems much larger to store data for more than 12 hours as if the incident happened at a time and 12 hours have passed the data can be rewritten will lead to data loss VDR system .

Following the case study analyzed we could identify some possible errors and the author can improve VDR system with a larger storage medium and integrate into it via infrared surveillance system. Such monitoring equipment has the ability to identify objects on the sea surface, hence the appearance, bearing of vessels and could occupy a larger space VDR system therefore the author propose storing data from 4 to 4 hours during each watchkeeping on the FIFO (First In - First Out) principle. With this information we can determine with certainty the guilt of each vessel involved in a maritime event and simplify the work of investigators assigned to shipping accidents.

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