

Replay Software of Voyage Data Recorder for Real Marine Accident

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Abstract- replay software of Voyage Data Recorder is essential for a critical application, Voyage data recorder (VDR), popular name-black box, is used for recording all kinds of navigation information. The recorded data is used for analyzing causes of major and minor incidents happened during ships' voyage. Voyage Data Recorder, or VDR, is a data recording system designed for all vessels required to comply with the international maritime organization IMO's International Convention safety of life at sea SOLAS requirements [1] (IMO Res.A.861(20)) in order to collect data from various sensors on board the vessel. It then digitizes, compresses and stores this information in an externally mounted protective storage unit. The protective storage unit is a tamper-proof unit designed to withstand the extreme shock, impact, pressure and heat, which could be associated with a marine incident (fire, explosion, collision, sinking, etc). This research realizes the importance of obtaining these stored data and use it for the accident analysis, specially because of this paper is real case, it is represented by one of the team who extract the data and replay the software in a computer and monitor the real time operating status of the relevant device. This has been done by downloading and replaying the data of real black box for a ship which was sunk in red sea.

Index Terms-IMO-SOLAS- VDR-SIGNAL PROCESSING.

I. INTRODUCTION

The protective storage unit as shown in fig .1 may be in a retrievable fixed unit or free float unit (or combined with EPIRB) when the ship sunk in marine incident. The last 12 to 18 hours of stored data in the protected unit can be recovered and replayed by the authorities or ship owners for incident investigation. Beside the protective storage unit, the VDR system may consist of recording control unit and data acquisition unit, which connected to various equipment and sensors on board a ship.

Although the primary purpose of the VDR is for accident investigation after the fact, also there is some call it voyage event recorder (VER), there can be other uses of recorded data for preventive maintenance, performance efficiency monitoring, heavy weather damage analysis, accident avoidance and training purpose to improve safety and reduce running cost.

Simplified Voyage Data Recorder (S-VDR), as defined by the requirements of IMO Performance Standard MSC.163 (78)[2], is a lower cost simplified version VDR for small ships with only basic ship's data recorded.

II. THE INFORMATION RECORDED IN THE VDR

The information recorded in the unit some time also called black box for ship, the typical configuration is shown in fig .2 it includes the following information:-

- GPS- Date, Time and Position.
- Speed log – Speed through water or speed over ground.
- Gyro compass- Heading.
- RADAR* - as displayed or AIS data if no off- the-shelf converter available for RADAR video.
- Bridge audio – including bridge wings.
- Echo sounder *- depth under keel.
- VHF radio communication.
- Main alarms*- all IMO mandatory alarms.
- Hull openings*- status of hull doors as indicated on the bridge.
- Water and fire doors *- status as indicated on the bridge.
- Hull stress*- acceleration and hull stress.
- Rudder * -order and feedback response.
- Thrusters * -status, direction, amount of thrust % or RPM.
- Anemometer and water vane*- wind speed and direction.



Fig. 1. VDR Data Recorded

Data marked with * may not be recorded in S-VDR, except Radar and Echo Sounder if data & standard interfaces available.

III. VDR JUSTIFICATION AND SOME EUROPEAN HISTORY

The IMO mandated VDR because:-

- Number of vessels lost without explanation.
- Number of lives lost
- Public pressure.

In 1980 Derbyshire vanished

In 1987 Herald of Free

Enterprise capsized

In 1994 the Estonia sank. [3]

IV. DIFFERENCE BETWEEN VDR AND S-VDR

There is no principle difference between a voyage data recorder (VDR) and a simplified voyage data recorder (S-VDR). [4] The difference is the amount of information required to record. The VDR requires more data to be recorded than the S-VDR.

Date and Time: referenced to UTC with an indication of the source. The source could be the GPS.

- Ships position: in latitude and longitude with the datum used. The source could be the GPS.
- Speed: through water or speed over ground with indication of which it is. The source could be the speed log.
- Heading: as indicated by the ships compass.
- Bridge audio: as picked up by one or more microphones positioned on the bridge so that conversation at or near the conning stations, RADAR displays, chart tables, etc. is adequately recorded. As far as practicable, the positioning of microphones should also capture intercom, public address system and audible alarms on the bridge.
- VHF communication: relating to ship operation should be recorded.
- RADAR data: electronic signal information from within one of the ships RADAR installation with recording of all the information which was actually being presented on the master display of that RADAR at the time of recording.
- AIS data: if it is impossible to obtain RADAR data by using a commercially available interface then AIS target data should be recorded as a source of information regarding other ships. AIS information may be recorded additionally as a beneficial secondary source of information on both other and own ship. AIS information may be recorded additionally as a beneficial secondary source of information on both other and own ship. AIS data is not mandatory, but an option when it is possible to obtain RADAR data by means of a commercially available interface.
 - The additional data : Items listed by IMO with the requirement set out in resolution have to be recorded if the data are available in NMEA0183 format using

approved sentence formatters. The additional data listed by IMO with the requirement in resolution are:-

- Echo sounder.
- Main alarms.
- Rudder order and response.
- Engine order and response.
- Hull openings status.
- Watertight and fire door status.
- Acceleration and hull stresses.
- Wind speed and direction.

The addition data any or all shall only have to be recorded if the data are available on the bridge and the data signals are available in NMEA0183 format. Hence, the principle difference between VDR and S-VDR lays in the requirement for recording of additional data.



Fig. 2. Typical Configuration for VDR

V. VDR CAPSULE

The self-developed Protective Data Capsule is more inexpensive and competitive. The Protective Data Capsule is a special one with high technology, which can be produced by only a few manufacturers in the world. IEC61996 specifies that the final recording medium for the VDR must be installed in the capsule in accordance with the following standards:-

- 1- Penetration: an object with a prick of 100mm diameter and a weight of 250kg falling from 3 meters above.
- 2- Impact: 50g semi-sine pulses for continuous 11ms.
- 3- Fire-resistance: 260o low temperature for 10 hours, and 1100o high temperature for 1 hour.
- 4- Pressure in deep sea: 30 days at 60 M pa (6,000 meters depth) under sea and 30days dipping.

The main and supplementary power supply work with 110V/220V 50Hz/60Hz without any manual configuration. The control panel ensures that the machine can continue to work with supplementary power of 24V when the main power supply fails. After the ship loses its emergency power, the battery will supply the power and go on to record audio data

for over 2 hours. The maintenance-free batteries can be used for 3 years. AC input range: 110V/220V 50Hz/60Hz, The DC input range: 24v.

VI. REPLAY SOFTWARE FOR REAL CASE

The capsule we have has 5 P.C.B. cards inside, the first three cards are storage media type MOSFET for digital data storage, the capacity of the memory was 3*5 M bite, and these cards have ser. Number 345,346,347, the card number four was used as a control card and has the software that ensures complete retrieval and display of all recorded data, Also there was an additional fifth card which used for temperature registration. With a friendly human-machine interface, this software is easy to use and install. The online replay function monitor the real-time operating status of the relevant devices in the bridge. The data of the portable document compressed (PDC) was downloaded and replayed to investigate the incidents and to analyze the functioning monitor. The digital extracted data was in the form of sequence number, time, and data in 2 k packet. The sequence number consist of 32 bit (4*8 in hex decimal), the time consist of 32 bit(4*8 in hex decimal), the data consist of 8 bits and could be (video, audio, or instrument like GPS).all the previous data was in hexadecimal format. For example for the time 8bits were 3113FoBB which mean time 23:30 in second of February 2006 by G.M.T it equivalent to 1:30 third of February 2006 Egyptian time. The total time of recording in our case was about 17 hours. The start time of the record was 8:11:13 at 2nd of Feb. 2006 to 1:33:13at 3rd of Feb. 2006.



Fig. 3. Replay Control Bar

VII. MONITORED DATA

The extracted digital data was collected in 50 file each file cover period of time with start time and date till end with time and date as shown in fig.3. , the files were transferred from hexadecimal to binary, then this data was transferred to audio and video data using software [C:/CPM RECOV>d2 record]. offered by the company Broad gate the producer of the capsule, then we use the output for monitoring the data we want to see using the monitor panel as shown in fig.3 the output can be any combination as shown in fig.4 chosen from the list, RADAR picture as shown in fig.5 ,GPS indicate Date and time: Referenced to UTC with an indication of the source, the source is the GPS, Ship's position: In latitude (LAT) and longitude (LON) with the datum used, Speed: Through water or speed over ground with indication of which it is, as shown

in fig.6, bridge audio - Including bridge wings, VHF radio communications as shown fig.7, Depth, Helm Command/Rudder Response, Thruster Demand/Achieved, Engines, Alarms, Hull Opening and Doors, 61162 Data, Speed, Course, Longitudinal Speed, Wind Speed, Wind Direction, Heading, Water Temperature, Rate of Turn, Commanded Heading, Set, Drift, Speed(km/h), also a serial of data format as shown in fig 8 can be obtained. All this work was done in marine accident investigation branch (MAIB) in UK.

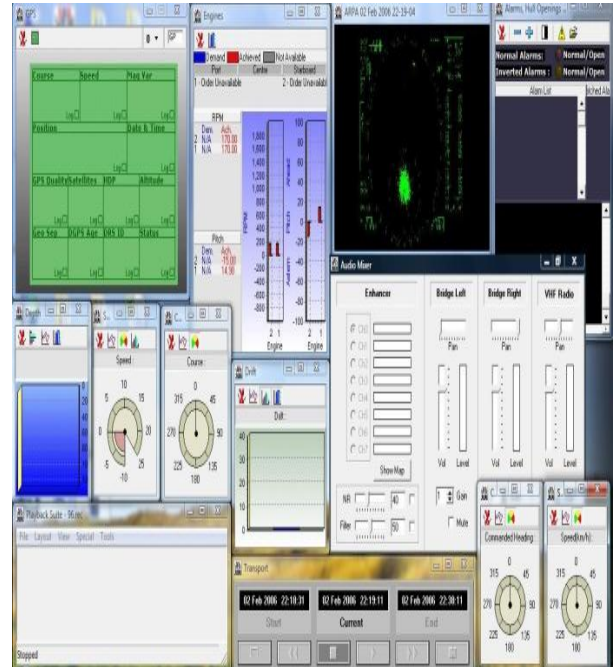


Fig. 4. Monitored data

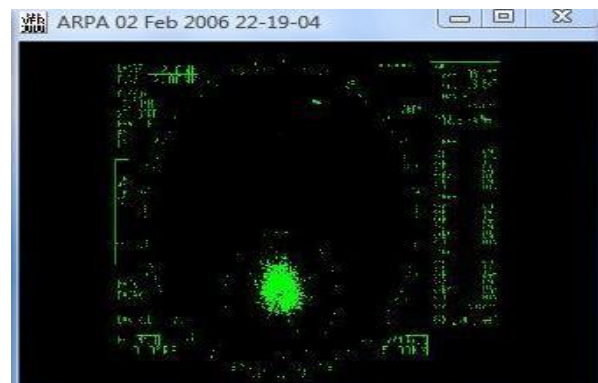


Fig. 5. Zoomed Radar Image or RADAR - As Displayed

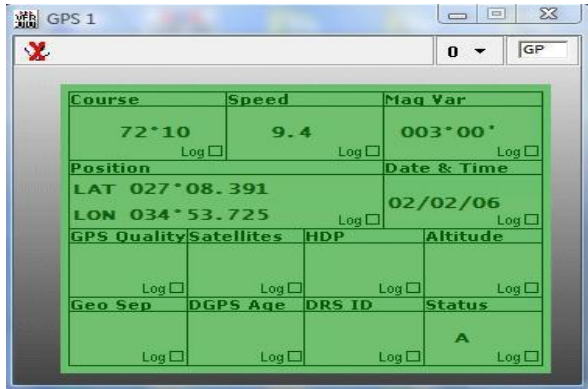


Fig. 6. GPS Image

VIII. CRITICAL TIMES AND POSITIONS

In this works, from the extracted data we demonstrate some of obtained critical data:-

DEPARTURE:-

Time of departure 6: 45: 50 Egypt time Dates 2-2-2006
 LAT 027° 33' 760// LON 035° 32' 760//

FIRE: - the recorded speed 11 knots

Time of fire 9:9:59 Date 2-2-2006
 LAT 027° 19' 976// LON 035° 10' 584//

SENDING STRESS:- the recorded speed 6 knots

Time of stress 1:30:29AM Date 3-2-2006
 LAT 027° 08' 940// LON 034° 54' 945//

SUNK:- the recorded speed 9.4 knots ,slant 25, curse 72° 10'

Time of Sunken 1:33:13AM Date 3-2-2006
 LAT 027° 08' 391// LON 034° 53' 725//

The previous time positions show the implication of the paper.

VIII- CONCLUSION

In this works we demonstrate that we were able to read the data stored from all mentioned sensor using human-machine interface including both the video and audio data, these data were collected in fifty files, and representing the real time data for all kinds of navigation information and these data were enough to give us information about all what was happen, So it was very helpful for accident investigating. A certificate from MAIB shows that this work was done by the author in Fig.9.the name of the ship was deliberate removed.

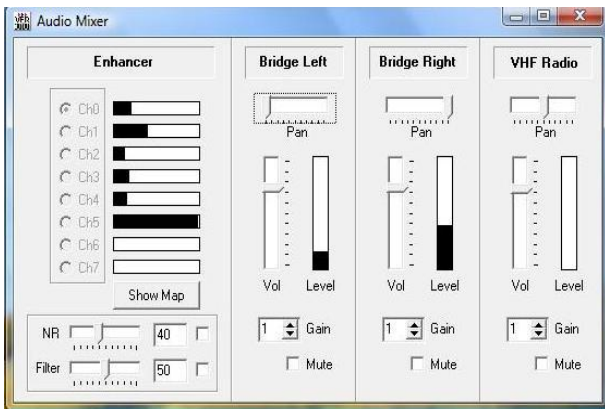


Fig.7. Bridge Audio - Including Bridge Wings, and VHF Radio Communications.

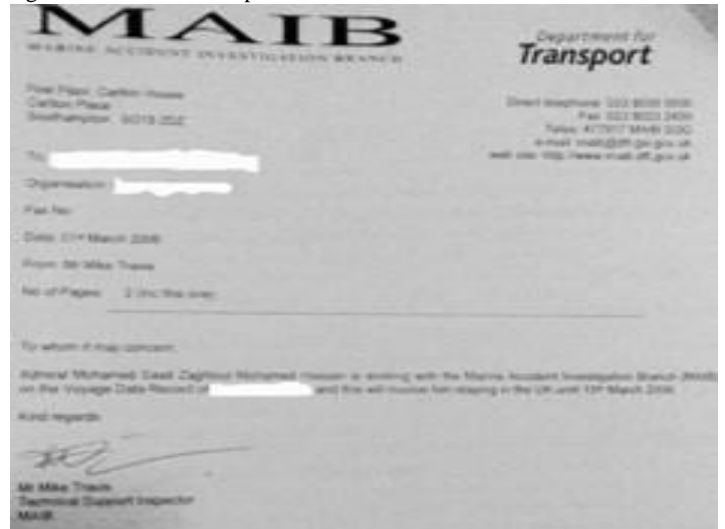


Fig. 9. Certificate from MAIB

ACKNOWLEDGEMENT

The author wishes to acknowledge the assistance and support of vice admiral Tamer Abd El Aleem.

REFERENCES

- [1]- SOLAS chapter V Regulation 20(adopted 5th of December 2000).
- [2]- SOLAS VDR regulation 18.8 of SOLAS chapter V requirement. (adopted 5th of December 2000).
- [3]- http://www.maib.dft.gov.uk/cms_resources/daggri.pdf.
- [4]- IMO through MSC at its 79th session in December 2004.

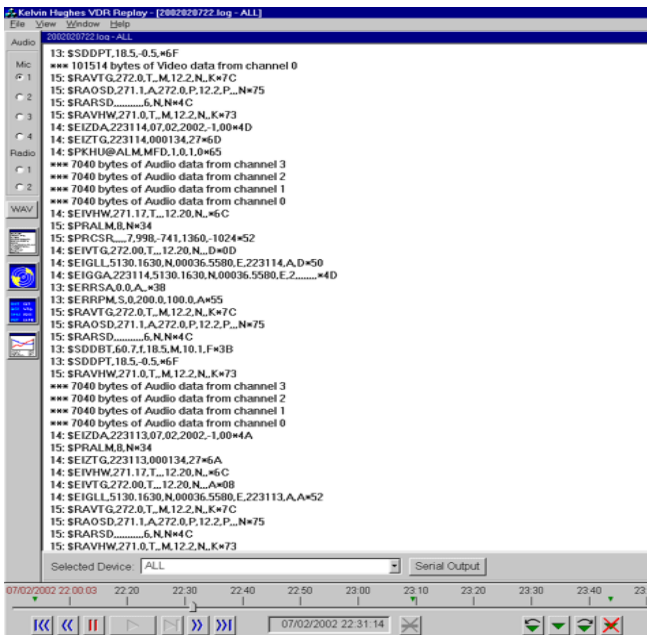


Fig. 8. Serial Data Display