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Recommendations on the Proactive Use of Voyage Data Recorder Information

(Revised edition August 2020)

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Oil Companies International Marine Forum
29 Queen Anne's Gate
London SW1H 9BU
United Kingdom
Telephone: +44 (0)20 7654 1200
Email: enquiries@ocimf.org

www.ocimf.org

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The Oil Companies International Marine Forum (OCIMF)
Founded in 1970, the Oil Companies International Marine Forum (OCIMF) is a voluntary association of oil companies having an interest in the shipment and terminalling of crude oil, oil products, petrochemicals and gas, and includes companies engaged in offshore marine operations supporting oil and gas exploration, development and production.

Our vision is a global marine industry that causes no harm to people or the environment.

Our mission is to lead the global marine industry in the promotion of safe and environmentally responsible transportation of crude oil, oil products, petrochemicals and gas, and to drive the same values in the management of related offshore marine operations. We do this by developing best practices in the design, construction and safe operation of tankers, barges and offshore vessels and their interfaces with terminals and considering human factors in everything we do.

Acknowledgments
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Contents

Glossary

Best practice OCIMF views this as a method of working or procedure to aspire to as part of continuous improvement.

Cloud means an online virtual space that is subscribed user accessible where data are uploaded to with variable capacity that is defined by the provider and user's demand.

Configuration data describes the vessel's equipment, its installation on the vessel and its relation to the VDR. Storage and playback software use this data to store the data record and to convert the data record into information that assists casualty investigation during playback.

Final recording medium means the items of hardware on which the data is recorded such that access to any one of them would enable the data to be recovered and played back via suitable equipment. In the International Maritime Organization (IMO) Resolution MSC.333(90) *Recommendations on Performance Standards for Shipborne Voyage Data Recorders (VDRs),* the combination of a fixed recording medium and float-free recording medium and long-term recording medium, together, is recognised as the final recording medium. (In the previous IMO resolution on VDR performance standards, the final recording medium could either be a fixed or float-free device).

Fixed recording medium means a part of the final recording medium which is protected against fire, shock, penetration and a prolonged period on the ocean floor. It is expected to be recovered from the deck of the ship that has sunk. It has a means of indicating location.

Float-free recording medium means a part of the final recording medium which should float free after sinking. It has a means of indicating location.

Guidance Provision of advice or information by OCIMF.

Long term recording medium means a permanently installed part of the final recording medium. It provides the longest record duration and has a readily accessible interface for downloading stored data.

Playback equipment means any data medium with playback software, operational instructions and any special parts required for connecting a commercial off-the-shelf laptop computer to the VDR.

Playback software means a copy of the software program to provide the capability to download the stored data and play back the information. The software should be compatible with an operating system available with commercial off-the-shelf laptop computers and where non-standard or proprietary formats are used for storing the data in the VDR, the software should convert the stored data into open industry standard formats.

Recommendations OCIMF supports and endorses a particular method of working or procedure.

Signal source means any sensor or device external to the VDR, to which the VDR is connected and from which it obtains signals and data to be recorded.

Voyage data recorder (VDR) means a complete system, including any items required to interface with the sources of input signals, their processing and encoding, the final recording medium, the playback equipment, the power supply and dedicated reserve power source.

Abbreviations

AIS	Automatic Identification System
BMP	Best Management Practices
BNWAS	Bridge Navigational Watch Alarm System
CCTV	Closed Circuit Television
CPA	Closest Point of Approach
ECDIS	Electronic Chart Display and Information System
EMSA	European Maritime Safety Agency
EU	European Union
FDR	Flight Data Recorder
GDPR	General Data Protection Requirement
IEC	International Electrotechnical Commission
IMO	International Maritime Organization
ITOPF	International Tanker Owners Pollution Federation
MFD	Multi-Function Display
OCIMF	Oil Companies International Marine Forum
RDI	Response Deviation Indicator
RNA	Remote Navigation Assessment/Audit
SMS	Safety Management System
S-VDR	Simplified Voyage Data Recorder
TCPA	Time to Closest Point of Approach
TMSA	Tanker Management and Self Assessment
USB	Universal Serial Bus
VDR	Voyage Data Recorder

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IEC 61996-1:2013 Maritime navigation and radiocommunication equipment and systems – Shipborne voyage data recorder (VDR) – Part 1: Performance requirements, methods of testing and required test results (IEC)

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1 Introduction

Since 2002 (new build) or 2006 (existing) tankers in excess of 3,000 gross tonnes on international voyages have been required to be fitted with a Voyage Data Recorder (VDR) or Simplified Voyage Data Recorder (S-VDR), respectively. When VDRs were first fitted, the data was typically only reviewed reactively following an accident or incident. However, in 2013 reflecting on the longstanding experience of proactive use of Flight Data Recorder (FDR) data to enhance safety in the aviation industry, the Oil Companies International Marine Forum (OCIMF) published *Recommendations on the Proactive Use of Voyage Data Recorder Information*.

New VDRs fitted since 2014 have had to meet updated performance requirements (see IMO Resolution MSC.333(90) *Revised Performance Standards for Shipborne Voyage Data Recorders (VDRs)*. This publication updates the 2013 OCIMF information paper to consider the impact of these updated requirements, along with the experience of using VDR data proactively, particularly related to the assessment of human factors considerations.

Recommendations are made as to how to obtain the maximum benefit from the proactive use of VDR data.

1.1 Background

1.1.1 Tanker incident statistics

Collisions, contact damage/allisions and groundings are commonly categorised as navigational incidents when assessing incident statistics.

The European Maritime Safety Agency's (EMSA) *Annual Overview of Accident Statistics 2019* indicated that from 2011 to 2018 navigational casualties represent more than 54.4% of the overall casualty events, with collisions (26.2%), contacts (15.3%) and grounding/stranding (12.9%).

Table 1 provides the details of the relative percentages of the causes of oil tanker casualties in EMSA's statistics from 2011 to 2018. These figures show that navigational casualties accounted for 48.7% of the total oil tanker casualties reported by EMSA during that period.

Although at 48.7% the percentage of navigational incidents for oil tankers is less than the equivalent overall figure (54.4%), it is still close to the figure of around 50%, which was noted in OCIMF's *Recommendations on the Proactive Use of Voyage Data Recorder Information* (based on 1978-2011 statistics). These results indicate that the percentage of navigational incidents has remained virtually constant over the period despite the advances made in bridge training and the provision of technological aids.

From the EMSA statistics it also appears that over the period 2011-2018, tankers have experienced a slightly higher relative percentage of collisions (32%) than shipping overall (26%).

Cause of Casualty	% (2011-2018)
Capsizing/Listing	0.12%
Collision	31.98%
Contact	9.77%
Grounding/Stranding	6.98%
Damage/Loss of equipment	21.86%
Fire/Explosion	4.30%
Flooding/Foundering	1.05%
Hull failure	0.12%
Loss of control	23.60%
Other	0.23%
TOTAL	100.00%

Table 1: *Causes of oil tanker casualties 2011-18 (Source: EMSA)*

1.1.2 Oil spill statistics

Consideration of the causes of oil spills over a period of five decades (figure 1) reveals that after five decades, grounding and allision/collision, combined, continue to account for more than 50% of oil spills, and that while the proportion due to groundings appears to be decreasing, the proportion due to allision/collisions has increased.

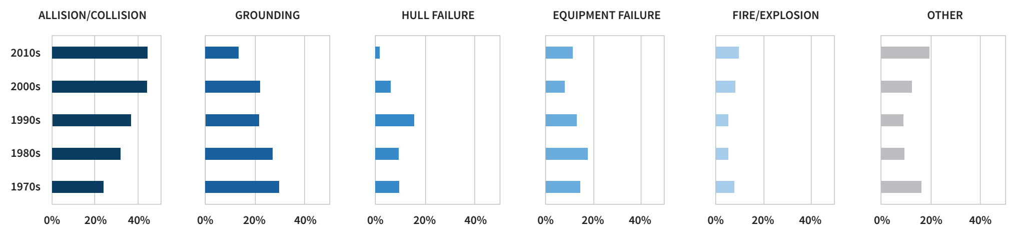

Figure 1: *Causes of spills per decade, 1970-2018 (Source: International Tanker Owners Pollution Federation (ITOPF))*

1.1.3 Statistics on causes of marine accidents

It has been estimated that 75-96% of marine accidents can involve human error (see Allianz Global Corporate & Specialty's *Safety and Shipping 1912-2012. From Titanic to Costa Concordia*). In addition, analysis of almost 15,000 marine liability insurance claims between 2011 and 2016 showed human error to be a primary factor in 75% of the value of all claims analysed (see Allianz Global Corporate & Specialty's *Safety & Shipping Review 2019*). It is evident that the major causes of collisions and groundings will be human factors and navigation-related rather than due to factors such as equipment failure or weather. This indicates that there is opportunity to reduce the incidence of such accidents further. One of the ways this could be achieved is via VDR data, either through the promotion of lessons learned from previous incidents, or by proactive review of VDR data on a regular basis, e.g. by conducting remote navigational assessments and audits.

1.1.4 Statistics on vessel activity at time of navigation incidents

The OCIMF SIRE incident repository (as of 25 November 2019) contains 394 records related to navigational incidents. When reporting an incident into this database, it is possible to include a description of the incident along with further items such as primary and secondary consequences, type of activity, location, severity and root cause(s).

The type of location in which incidents happened is particularly interesting as it provides an insight into where the risk of navigational incidents is greatest during a voyage. The distribution of navigational incidents in different location types is shown in figure 2. Considering the rates at which vessels will be in each location type, it appears that the risk of navigational incidents is greatest when in port areas and restricted waters (effectively all the location types shown except for 'Coastal Waters' and 'Deep Sea'). Navigational assessments and audits could have a greatest impact on incident statistics if focussed on these locations.

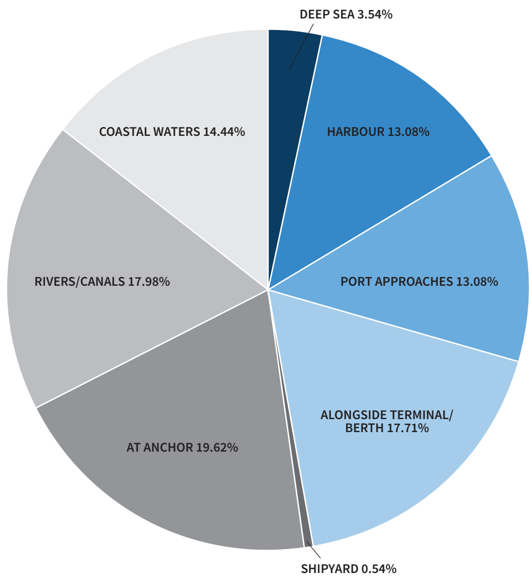

Figure 2: *Vessel location at the time of navigational incident (Source: OCIMF SIRE incident repository)*

1.2 Revised VDR carriage requirements

The International Maritime Organization (IMO) published revised performance standards for shipborne VDRs, which were adopted in May 2012 under Resolution MSC.333(90). The IMO recommended that governments ensure that VDRs installed on or after 1 July 2014, conform to performance standards not inferior to those specified in the annex to this resolution.

VDRs and S-VDRs installed before 1 July 2014, could continue to meet the original specifications, i.e. IMO Resolutions A.861(20) and MSC.163(78) respectively, as amended by Resolution MSC.214(81).

While there was no requirement to retrofit the new specification VDRs to existing ships, in practice replacement of older VDRs is becoming more common as existing VDR models reach the end of their support life. Some shipowners/operators have proactively upgraded or renewed old VDRs as a best practice measure, anticipating reduced spare part/service availability, as well as to proactively undertake navigational assessment and audits more effectively (see OCIMF's *A Guide to Best Practice of Navigational Assessments and Audits*).

The most significant changes in the revised performance standards were associated with the new requirements to record data for longer periods, and the inclusion of additional data input sources. These aspects are considered below.

1.2.1 Data retention

One of the most significant changes in the revised performance standards from the data analysis viewpoint was that the VDR should now be equipped with a long term recording medium, which will retain data for at least 30 days/720 hours.

The performance standard also requires that there should be a data output interface based on an internationally recognised format (e.g. ethernet, Universal Serial Bus (USB), Firewire, etc.) which should enable the download of data for a user-defined period of time.

The original IMO resolution on VDR performance standards only required data to be stored for a minimum of 12 hours. As a result, data was often overwritten before it could be saved or downloaded. The requirement for a significantly extended recording period means that data should always be available and can be retrieved following the vast majority of incidents, without anyone having to remember to save the data for up to 30 days after the event. It also offers increased scope to analyse the data for trends over longer time periods and undertake navigational assessments of bridge team behaviours and audits against the Safety Management System (SMS) Navigational policy, as a proactive measure.

In addition to the long term recording medium, the revised requirements also require that the VDR is fitted with both fixed and float-free recording media (capsules), which should retain the last 48 hours' data. Previous IMO performance specifications only required either fixed or float-free recording media to be fitted and retain the last 12 hours' data. This change increases the chances of data being recoverable in the event of a major accident where the ship sinks or catches fire.

1.2.2 Additional data types

The revised performance standards also included requirements to record the following additional data types:

- **Electronic Chart Display and Information System (ECDIS):** The revised performance standards require that the VDR records the ECDIS display in use at the time as the primary means of navigation, along with information on the source/version of the chart data being used. ECDIS screenshots are recorded at 15-second intervals. The advantage of using the screen display information recorded by the VDR is that it shows exactly how the ECDIS was set up and used. (Most ECDISs typically record the ship's track but do not have a record of the screen area being viewed, etc., which makes it impossible when using the ECDIS to replay data to recreate exactly how the ECDIS was being used on board).
- **Radar:** The original VDR performance standard only required one radar to be recorded, and in many cases this radar was not being actively used at the time of the incident. The revised performance standard requires both the X-band and S-band radar screens to be recorded.
- **Automatic Identification System (AIS) data:** Previously AIS data was only required to be recorded by Simplified Voyage Data Recorders (S-VDRs), when they were retrofitted to ships where there was no digital output from the radar. The revised performance standard requires all AIS data to be recorded. When using data recorded by the VDR to retrospectively assess safety of navigation, review of AIS data can be useful in identification of potentially hazardous navigational situations. In this context, it can be used as described in section 2.4 on using remote VDR data analysis to automatically identify any events where other vessels' Closest Point of Approach (CPA)/Time to Closest Point of Approach (TCPA) values infringe pre-defined thresholds, making it easier to implement this form of analysis.
- **Electronic logbook:** Where an electronic logbook meeting the IMO's standards is fitted, the information from the logbook should be recorded by the VDR.
- **Inclinometer:** Only one other additional data item was added in the specification update. This was the requirement to record the output of an electronic inclinometer, if installed, so that the ship's rolling motion could be reconstructed when replaying the data. However, this is only required if there is already an electronic inclinometer fitted, and there is no requirement to fit any new sensor to meet the revised VDR performance standards.

2 Proactive use of VDR data

There are several ways in which VDR data should be used proactively to enhance safety of navigation.

2.1 Communication of lessons learned

Following the completion of a navigational incident investigation, the VDR data can provide an effective way of accurately animating events as a replay video so that they can be easily watched, and the key findings understood by others. In this way, the lessons learned from an incident can be efficiently communicated across a fleet with the objective of preventing similar incidents in the future. VDR data can also be used to analyse security-related incidents where invariably navigational manoeuvres are warranted to evade threats when a vessel is en route.

2.2 Onboard review of data

The onboard review of VDR data and information by Masters and bridge teams using the VDR manufacturer's playback equipment and software is a simple way for the team to collectively assess their own performance and identify any areas where enhancements may be needed. This approach allows the replay to be paused and discussed in a way that would not be possible in real-time and can be particularly useful when the team are undertaking challenging navigational activities (e.g. calling at a port for the first time, busy canal transits, pilotage waters, etc.). It is recommended that consideration be given to including this review process in the SMS at regular intervals or upon major changes of bridge team members.

2.3 Remote navigational assessments and audits

OCIMF's *A Guide to Best Practice for Navigational Assessments and Audits* provides owners, operators and Masters with best practice guidance on how to conduct a navigational assessment. While an audit can verify onboard compliance with SMS and industry regulations, an assessment can provide additional assurance about navigational standards, best practices and bridge team behaviours including human factors.

Navigational assessments also supplement the navigational chapter from the Ship Inspection Report Programme (SIRE) to verify bridge team culture and best practices. These should be undertaken to cover all aspects of the voyage: berth to pilot, at sea and pilot to berth.

Section 5.2 in OCIMF's *A Guide to Best Practice for Navigation Assessments and Audits* addresses remote navigational assessments using VDRs and section 5.3 refers to proactive use of VDRs.

Navigational assessments using VDR data could be undertaken on board by vessel Masters with their bridge teams, by vessel operators in managing offices, or by using services of an independently contracted third-party company. VDR data will be replayed and analysed against the company SMS, industry best practices and regulatory requirements.

The VDR data is normally used to cover one or more high-risk sections of the voyage, such as canal transits, pilotage during arrival/departure and/or passage through high traffic density areas such as the Singapore/Malacca Straits or the English Channel.

Companies should develop remote navigational assessment questionnaires and checklists that consider human factors aspects in a way that is not currently possible in computer-based analysis (such as those described in section 2.4). This can include but is not limited to aspects such as:

- Bridge resource management.
- Watch hand-over procedures.
- Master-Pilot information exchange.
- Behavioural and procedural compliance.
- Watchkeeping practices at sea, at anchor and during pilotage.

- Human factors including machine interface.
- ECDIS procedures and practices including use of overlays.
- Alarm management and alarm fatigue.

As outlined in section 5.2 of OCIMF's *A Guide to Best Practice for Navigational Assessments and Audits*, Remote Navigation Assessment/Audit (RNA) offers advantages to traditional onboard audits, including:

- Allowing the assessment to be made in a more natural environment, without any influence due to the presence of an external assessor on the bridge.
- Making a navigational assessment where the trading pattern of the vessel makes it difficult to perform a traditional assessment. (This aspect is also acknowledged in the Tanker Management Self Assessment (TMSA) section 5.4.1 in OCIMF's *A Guide Best Practice Guidance for Navigational Audits*).
- Ensuring onboard familiarity with the process of saving and downloading data from the VDR so that, if ever required, data will be available following an incident.

RNAs should, however, not be used as a substitute to replace traditional onboard navigational audits. Traditional onboard navigational assessments/audits are likely more effective at picking up bridge team practices, behaviours and interactions, and also provide an opportunity for the auditor to interact with the bridge team to understand the reasoning behind particular actions and provide coaching if required. Consequently, it is recommended to plan a navigational assessment strategy which includes a mix of both traditional and RNA. Using this approach, remote assessments can also be used to follow up and verify the correction of non-conformances found during a traditional assessment or to identify specific areas that would benefit from further assessment or coaching by traditional auditors while on board after completion of an audit.

Section 5.2.2 in OCIMF's *Tanker Management and Self Assessment 3 – A Best Practice Guide (TMSA3)* also requires that 'a procedure is in place for appropriate shore-based personnel to conduct navigational verification assessments'. The associated guidance on best practice recommends that a review includes items such as passage plans and navigational records. In the past such reviews have been largely paper-based, which can make it difficult to guarantee their accuracy.

However, the latest generation of VDRs is now required to store screenshots from the ECDIS which is in use at that time as the primary means of navigation on board. If there are multiple ECDIS displays in use, and the VDR cannot identify which one is the primary means of navigation, then it should record all of them.

The recording of ECDIS screenshots by the VDR makes it easier to check that the passage plan has been correctly entered into the ECDIS and followed by the ship. The RNAs should use the ECDIS screenshots recorded by the VDR rather than the ECDIS replay software to replay the data recorded by the ECDIS. The ECDIS screenshots recorded by the VDR show the way the ECDIS was actually being used on the bridge, while the ECDIS replay software can generally only confirm where the ship went, as the user can change the viewing options while the data is being replayed.

In addition, the bridge team's use of features such as radar overlay can also be reviewed. The review can highlight any odd behaviour in the use of the system, or even how the system itself is operating. For example, in the screenshots shown in figure 3 both the primary and secondary ECDIS have radar overlaid. However, while the radar overlay for ECDIS 1 shows the overlaid radar is correctly positioned, the display for ECDIS 2 shows an offset between key features. This discrepancy would unlikely have been detected if simply using the ECDIS to replay data when the ship was alongside.

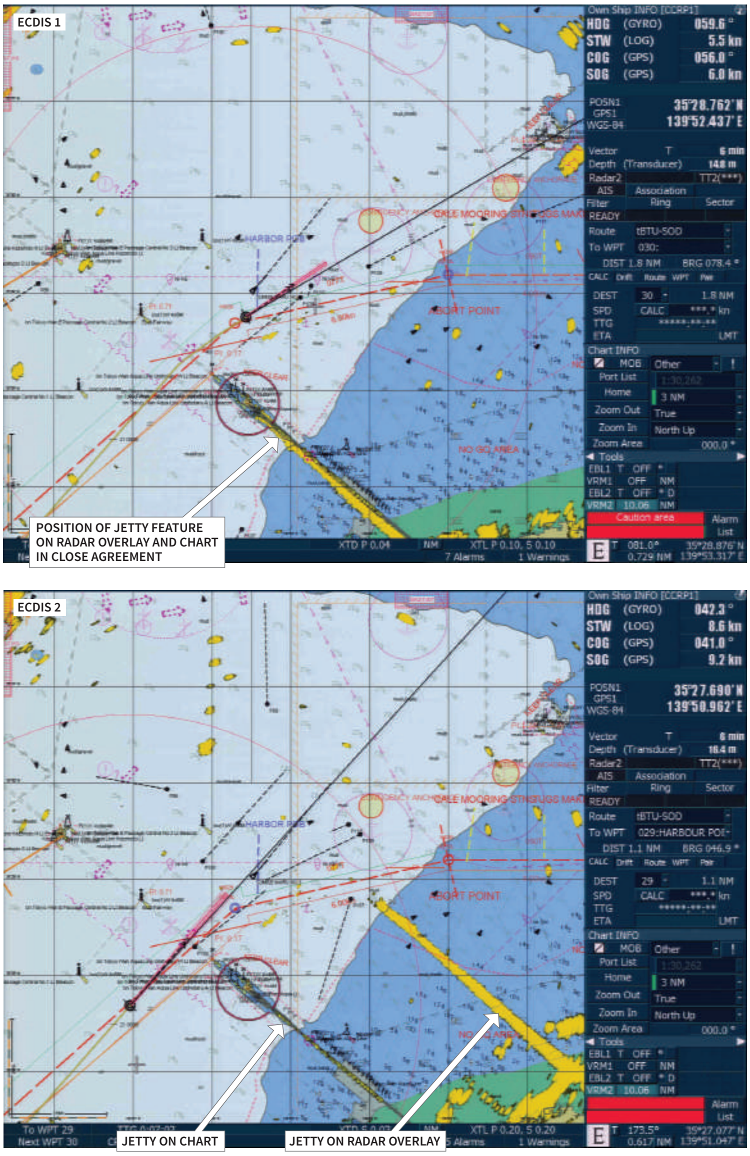

Figure 3: *ECDIS screenshots illustrating radar overlay discrepancy*

It is recommended that careful consideration is given to the issue of VDR data protection from the perspective of both physical data security and the protection of personal data. Personal data is any information that relates to an identified or identifiable living individual. Personal data can also be different pieces of information which when collected together can lead to the identification of a particular person. In many jurisdictions personal data is afforded additional legal protection. In Europe the General Data Protection Regulation (GDPR) introduced in 2018 provides additional legal protection for personal data. VDR recordings will contain personal data. When putting in place measures to ensure data security and protection of personal data for VDRs companies are recommended to ensure that these measures also encompass, and do not prevent, the use of remote navigational assessments and audits.

2.4 VDR data analysis and navigational assurance software

Software associated with VDR analysis and navigational assurance may be programmed with a range of rules to detect events within the VDR data. The rules can range from fairly simple ones which check the value of a single variable, such as whether the depth below keel is less than a predefined limit, to more complex ones which may require significant processing/fusion with other data sources. For example, checking that the ship has followed the correct procedure for a particular Traffic Separation Scheme (TSS) or has not deviated from the approved voyage plan may require links to data from charts and route plans. Typical navigation safety-related events include checking for:

- Inadequate under keel clearance for the speed recorded at that time.
- Excessively high rate of turn for the speed recorded at that time.
- Engines full astern.
- Telegraph delay.
- TSS adherence.
- Close-quarters encounter with another vessel.

The following provides practical examples of VDR analysis and assessment that relate to the prevention of grounding.

2.4.1 Example 1: Analysis of depth below keel

A tanker operator's procedures stated that the depth below the keel should not be less than five metres at normal service speed. Figure 5 shows an illustrative event that was automatically detected through analysis of the VDR data. The depth below keel (blue line) may be seen to remain at about three metres for a period of about 20 minutes, while the ship's speed, shown as over the ground (pink line) and through the water (red line), remains consistently high.

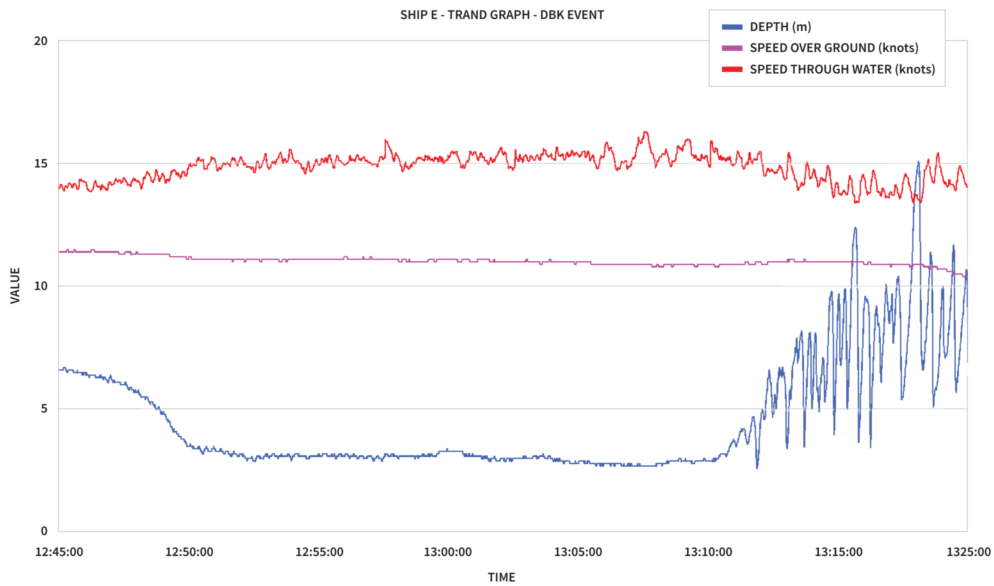

Figure 4: *Example – analysis of depth below keel*

The data illustrated in figure 4 related to a single arrival at a particular terminal. To determine what action should be taken, it was necessary to undertake further analysis to identify, e.g. whether this was a standard or exceptional event at the terminal, whether it only happened with certain pilots or Masters or during particular combinations of weather and/or tidal conditions.

2.4.2 Example 2: Incorrect manipulation of bridge controls

A ferry company introduced a VDR analysis rule to monitor whether Masters were allowing sufficient time for a bridge control command, e.g. propeller pitch or rudder movement, to take effect before the order was countermanded. A Response Deviation Indicator (RDI) was included in the VDR analysis software to enable cases where this was happening to be automatically identified. A high RDI value indicated that insufficient time was being allowed for the system to respond to a command before it was countermanded.

The results of processing the VDR data from eight consecutive entries to a particular port are shown in figure 5. The higher RDI values for alternate entries to the port indicate that the bridge controls were not used effectively for those arrivals.

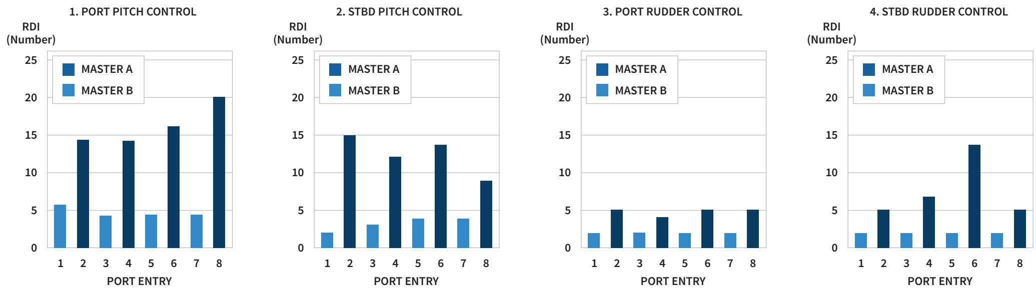

Figure 5: *Response Deviation Indicator (RDI) for eight port entries*

The ‘A’ and ‘B’ annotation of the results depicted in figure 5 identifies the Master in charge of the ship and clearly shows the high incidence of misoperation of the controls by Master A.

It was revealed that Master A had previously been in command when the same ship had run aground at the port. The cause of the grounding had been identified as inappropriate use of the bridge controls at a time of high tidal flow and strong winds. Prompted by the results of the VDR analysis, the ferry company arranged for Master A to receive suitable re-training. Without the information provided by the VDR analysis, there was no appreciation that the problem still existed, risking the possibility of further incidents.

2.5 An overall strategy for proactive analysis

In addition to conventional onboard navigational assessments, it is recommended that a mix of the proactive analysis approaches described above are used, as each has strengths/weaknesses. For example, the computer-based analysis of the VDR data described above can analyse VDR data continuously and even provide 24/7 coverage if required. However, there may currently be limitations to analyse audio and bridge team interactions automatically, but these can be manually analysed. One approach could be to use the computer-based analysis to detect the occurrence of particular events, and then manually analyse the data around the time of their occurrence with the aim of better understanding why the events happened. Figure 6 provides an overview of the suggested process.

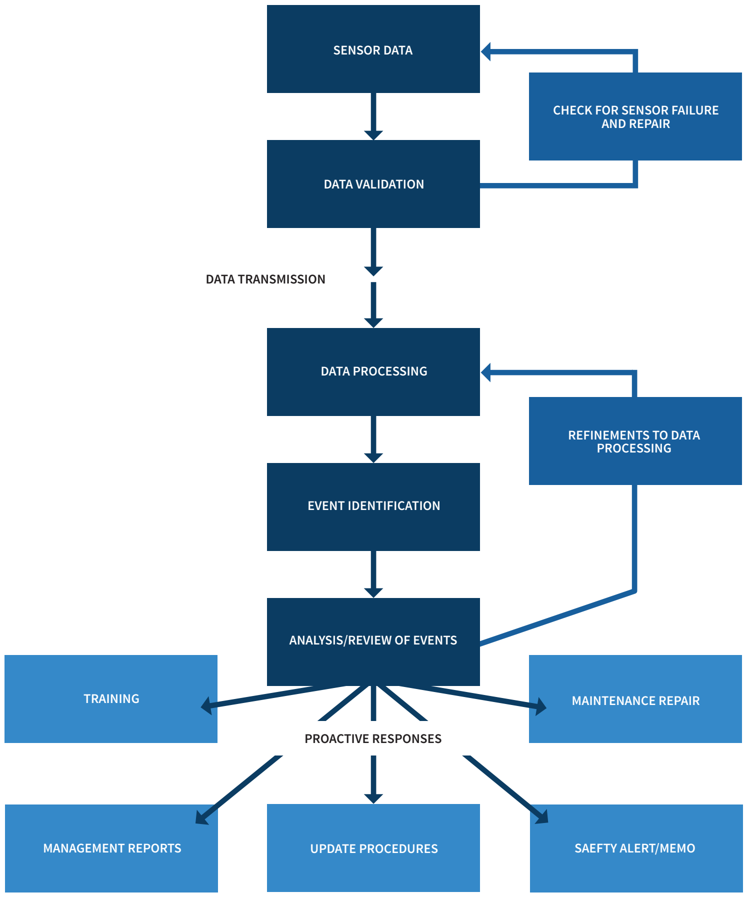

Figure 6: *Summary of VDR analysis and navigational assurance process*

3 Challenges associated with using VDR data

3.1 Data being overwritten

The original VDR specification only required the last 12 hours' data to be stored. This has meant that in many cases data has not been available following an incident, making it more difficult to determine the causes for the accident. This was the case in a recent major collision between an oil tanker and a bulk carrier. Following the collision, it was found that the bulk carrier's VDR data was overwritten because no action had been taken to preserve the data within 12 hours of the incident happening. The oil tanker caught fire, and it was about a week before anyone was able to get on board to recover the VDR's protective memory capsule. Fortunately, the tanker's capsule recorded significantly more than 12 hours' duration and data related to the incident was recovered.

The investigators also recovered VDR data from ships close to the site of collision that were fitted with VDRs meeting the latest performance specification, and so had 30 days' data available.

It is recommended that consideration should be given to extending the recording duration of ships which are fitted with VDRs that only record 12 hours' data. In addition, steps should be taken to ensure the Master and bridge team are familiar with specific VDR procedures for saving and downloading VDR data. The process of carrying out regular RNAs can help in this respect, since it involves saving and downloading VDR data, and confirming that the required data is being correctly recorded and can be suitably retrieved as and when required.

3.2 Data not being recorded

Typically, the VDR data is only examined following an incident or accident. As a result, when an incident does happen, it is not uncommon to find that the VDR was not fully operational at the time of the incident and some or all data was not recorded correctly.

The VDR specification requires that 'each item of the recorded data is checked for integrity and an alarm given if a non-correctable error is detected'. However, typically this check only appears to relate to data which it has received, and although there is a requirement for annual performance testing of the VDR which should detect such issues, there continues to be many cases where for some reason a complete source of data is simply found to be missing or recording incorrect values when the data is analysed. Again, the process of proactively carrying out RNAs can be invaluable in detecting such issues, helping to ensure that good quality data is available in the event of an incident.

The original VDR specification only required one radar screen to be recorded. As a result, it has often been found that the radar screen that was being recorded by the VDR was not the radar that was being actively used at the time of an incident. In such cases, the only radar information that is available provides a display that may not be optimised for the conditions, with no indication of how the radar was actually being used, and in some cases has even been on standby at the time of interest. The most recent VDR specification removes this issue by requiring that both radars are recorded. Many of the previous generation VDRs can be upgraded to record more than one radar, and this can be a worthwhile enhancement in order to overcome this issue.

3.3 Multifunction display units

Some modern bridges are now being equipped with Multifunction Display (MFD) units, where an individual screen may be configured to show radar and/or ECDIS data, or other functionality. Each display that is recorded by the VDR should transmit information over a network connection to the VDR about the source of the data that is being displayed (i.e. X-band, S-Band radar or ECDIS), the location of that screen and an optional indication of whether it is active or not.

The VDR is required to record one image from each class of display (i.e. X-band, S-band or ECDIS) at least once every 15 seconds. Where, for example, multiple screens are showing X-band data, then the VDR should record them all at the same rate with at least one image from any of those displays being recorded at least every 15 seconds. So, if there were two displays showing X-band radar, then each display may only be recorded at 30-second intervals. This means that the update rate for each display would be decreased, and so there is a greater chance of missing any rapid changes that the radar operator may have made during that 30-second interval.

3.4 Cloud services and data security

Transmission and analysis of VDR data via the Cloud could be an option as part of a proactive approach to VDR analysis since it can enable the following:

- Remote downloading and analysis of data. This can be for rapid analysis of data following an incident, or to make data available for RNA purposes.
- Remote assessment of the health of the VDR.
- Centralised storage and monitoring/analysis of any events that may have been detected using automated VDR analysis software.

In the first two bullets it is normally necessary to transfer data from all the sources recorded by the VDR (i.e. sensor, radar/ECDIS and audio contents), which can potentially generate large quantities of data. However, for incident analysis, and navigation and remote health assessment purposes, the data is only required to cover relatively short periods of time on an occasional or as required basis, making it a viable proposition given current transmission bandwidths and costs.

Centralised storage and monitoring/analysis functionality requires VDR data content to be sent continually from the ship. However, this functionality only requires a small subset of the VDR dataset (i.e. selected sensor values and/or event details) to be sent, again making it a viable proposition.

Given the need to connect the VDR to the internet in order to send the data, the potential sensitivity of the recorded data, and the fact that the modern VDRs may have network connections to the ship's ECDIS or other critical shipboard computer systems, it is vital to consider cyber-security aspects.

Current generation VDRs that offer remote connectivity should already incorporate suitable security measures such as firewalls and sending the data over encrypted connections. However, care should also be taken to ensure cyber security measures are in place and any items such as USB memory sticks or laptop computers which are temporarily connected to the VDR for downloading data are encrypted and checked for viruses or malware before connecting them to the VDR.

3.5 Emerging trends in navigational assessments

When analysing VDR audio content, one of the biggest challenges can be knowing who is talking and where they are located on the bridge. Although not a statutory requirement, many ships are now being fitted with bridge Closed Circuit Television (CCTV), which could assist in the analysis of the VDR data in this regard. CCTV data is generally recorded on a stand-alone storage device and CCTV data could be merged with VDR data when it is being replayed, as shown in figure 7.

CCTVs, if fitted, should be capable of providing good resolution video during day as well as low-light conditions.

Additionally, there are systems available with provision to input data received from CCR and ECR such as relevant audio feeds, loading computer records, automation system data, etc. that could also be fed into the VDR.

Figure 7: *Replay of merged VDR and CCTV data*

4 Summary of recommendations

4.1 Equipment-related

The most recent IMO VDR performance standards (IMO Resolution MSC.333(90)) offer increased scope for proactive use of VDR data to enhance navigational safety. This is because they provide for:

- Increased data retention periods (i.e. at least 30 days/720 hours of data retention as standard in the long term recording medium, as opposed to the 12 hours' data retention required by the previous IMO VDR/S-VDR performance standards.
- A wider range of data inputs, including both X- and S-band radars, ECDIS and AIS.
- An output interface which allows the download of data for a user-defined time period.

It is recommended that vessels fitted with VDRs which meet the earlier (i.e. prior to July 2014) performance standards should consider upgrading their VDRs to meet the most recent IMO VDR performance standards.

4.2 VDR data analysis-related

To gain the maximum benefit from proactive use of VDR data to enhance navigational safety, it is recommended that consideration be given to a combination of different approaches that may include:

- Communication of lessons learned from any navigation-related incidents.
- Onboard review of VDR data by the bridge team.
- RNAs to supplement traditional onboard audits.
- VDR data analysis software, i.e. software to identify and quantify events in the VDR data.

It is recommended that operators develop procedures and questionnaires to undertake RNAs where they are performed in house, because this will ensure adequate coverage by each assessment/audit, and also enforce a degree of uniformity between different assessors/auditors. The process of performing RNAs should also be used to ensure that there is familiarity on board with saving/downloading VDR data, and for confirming that the VDR is operating correctly.

In all cases where VDR data is being analysed, consideration must be given to ensure GDPR requirements are being met, cyber-security mitigations are in place and suitable measures have been taken to mitigate against any potential issues.

Our vision

A global marine industry that causes no harm to people or the environment

Oil Companies
International Marine Forum
29 Queen Anne's Gate
London SW1H 9BU
United Kingdom

T +44 (0)20 7654 1200
E enquiries@ocimf.org

ocimf.org