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# VDR & S-VDR


## A Practical Guide to Marine Voyage Data Recorders for Newbuilds and Retrofits

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CHAPTER 1

# Black Boxes for Ships

For a good many years, data and cockpit voice recorders have been required on commercial aircraft. These “black box” devices – which are actually bright orange – have been invaluable tools for investigating accidents and determining remedial actions.

In the 1980s, several major maritime disasters, notably the sinking of the passenger ship *Estonia* with the loss of more than 900 lives, led the maritime industry to consider adopting similar technology for ships. As a result, during the 1990s the International Maritime Organization (IMO) developed specifications for a marine Voyage Data Recorder (VDR), which would record and store data from shipboard sensors and systems, as well as voice recordings from the bridge and VHF radio communications, for retrieval after an incident at sea.

IMO Resolution A.861 (20) was adopted by the IMO in May 1999. It established a deadline of 2002, after which new ships must be fitted with an approved VDR. The VDR carriage requirements included retrofits to passenger and ro-ro passenger ships built before 2002, but did not provide for retrofits to older non-passenger cargo ships.

In 2005, the IMO amended Resolution A.861 to add a requirement for retrofitting a Simplified VDR (S-VDR) on all existing cargo ships over 3,000 gross tons. The modified specification for the S-VDR recognizes the difficulties in interfacing to the existing analog sensors on older ships.

The VDR or S-VDR is designed to record and store, in a secure and retrievable form, information concerning the ship’s position, movement, physical status and command and control for the period leading up to and following an incident. The data must be stored automatically in an approved protective capsule.

In this booklet, we will explain the carriage requirements, performance standards, interfacing requirements and certification procedures for VDRs and S-VDRs.



CHAPTER 2

# Carriage Requirements

VDR and S-VDR carriage requirements are spelled out in IMO Resolution A.861 (20), "Standards for Shipborne Voyage Data Recorders."

To assist in casualty investigations, ships, when engaged on international voyages subject to the provisions of regulation 1.4, shall be fitted with a voyage data recorder (VDR) as follows:

- Passenger ships constructed on or after 1 July 2002
- Ro-ro passenger ships constructed before 1 July 2002, not later than the first survey on or after 1 July 2002
- Passenger ships other than ro-ro passenger ships constructed before 1 July 2002, not later than 1 January 2002
- Ships other than passenger ships, of 3,000 gross tonnage and upwards, constructed on or after 1 July 2002

Thus, all existing passenger and ro-ro passenger ships, and all new cargo ships of 3,000 or more gross tons built since 1 July 2002, are now required to be fitted with a VDR.

The IMO Resolution was amended in 2005 to add the following carriage requirements for retroffiting existing cargo ships with a VDR, which may be a simplified VDR (S-VDR).

- In the case of cargo ships of 20,000 gross tonnage and upwards constructed before 1 July 2002, at the first scheduled drydocking after 1 July 2006, but not later than 1 July 2009.
- In the case of cargo ships of 3,000 gross tonnage and upwards but less than 20,000 gross tonnage constructed before 1 July 2002, at the first scheduled drydocking after 1 July 2007, but not later than 1 July 2010.

Administrations may exempt cargo ships from the application of the carriage requirements when such ship will be taken permanently out of service within two years after the implementation date.

Administrations may also exempt ships, other than ro-ro passenger ships, constructed before 1 July 2002 from being fitted with a VDR where it can be demonstrated that interfacing a VDR with the existing equipment on the ship is unreasonable and impractical.

The VDR or S-VDR required by these regulations must meet performance standards that are not inferior to those adopted by the IMO, and must be type approved in accordance with procedures spelled out in IMO A.861 (18).

| Ship Type | New ships built on or after 1 July 2002 | Existing ships built before 1 July 2002 |
|---|---|---|
| Passenger | VDR | VDR |
| Ro-Ro Passenger | VDR | VDR |
| Cargo Ships over 20,000 grt | VDR | S-VDR at 1st drydocking after 1 July 2006, but not later than 1 July 2009 |
| Cargo Ships 3,000-20,000 grt | VDR | S-VDR at 1st drydocking after 1 July 2007, but not later than 1 July 2010 |

CHAPTER 3

# Performance Standards

Detailed performance standards for VDRs and S-VDRs are contained in IEC 61996, published by the International Electrotechnical Commission.

The performance standards state that the VDR or S-VDR should continuously maintain sequential records of preselected data items relating to the status and output of the ship's equipment and command and control of the ship.

The specification for S-VDR differs from that for the VDR in two areas:

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

Both the VDR and S-VDR are required to record date and time, ship's position, speed and heading, bridge and VHF audio and radar playback. In the case of the S-VDR, AIS output may be an acceptable substitute for the radar picture under certain circumstances. Additional data sources are required with the full VDR.

See Chapter 4 for a detailed listing of VDR and S-VDR interface requirements.

The final recording medium for a VDR or S-VDR should be installed in a protective capsule of either a fixed or float-free type, which should meet all of the following requirements:

- Be capable of being accessed following an incident but secure against tampering
- Maintain the recorded data for a period of at least 2 years following termination of recording
- Be fitted with an appropriate device to aid location



See Chapter 5 for detailed specifications for protective data capsules.

The VDR or S-VDR equipment must be designed so that, as far as is practical, it is not possible to tamper with the selection of data being input to the equipment, the data itself nor that which has already been recorded. Any attempt to interfere with the integrity of the data or the recording should be recorded.

The recording method should be such that each item of the recorded data is checked for integrity and an alarm given if a non-correctable error is recorded.

To ensure that the VDR or S-VDR continues to record events during an incident, it should be capable of operating from the ship's emergency source of electrical power. If the ship's emergency power fails, the VDR or S-VDR should continue to record bridge audio from a dedicated reserve source of power for at least two hours. Recording should be continuous. All stored data items should be retained for at least 12 hours. After that, older data items may be overwritten with new data.

CHAPTER 4

# Interface Requirements

IEC 61996 provides detailed information on the required data sets for VDR and S-VDR. The following is a summary.

The following items are required for both VDRs and S-VDRs:

**Date and Time.** Date and time, referenced to Coordinated Universal Time (UTC), obtained from a source external to the ship or from an internal clock at least once per hour. The recording must indicate which source is in use. The recording method must be such that the timing of all other recorded data items can be derived on playback with a resolution sufficient to reconstruct the history of the incident in detail.

**Ship's Position.** Latitude and longitude, up to a resolution of 0.00001 minutes of arc, and the datum used. The identity and status of the source must be recorded so that they can be determined on playback.

**Speed.** Speed through the water or over the ground, up to a resolution of 0.1 knot, with an indication of which is being used.

**Heading.** Ship's heading with a resolution up to 0.1 degrees, as derived from the ship's compass.

**Bridge Audio.** Recorded from one or more microphones placed so that conversations at or near the conning stations, radar displays, chart tables and other work stations may be adequately recorded. The microphones should also capture, when practical, the input and output of intercom, public address systems and audible alarms on the bridge.

**Communications Audio.** VHF communications relating to ship operations, including transmitted and received audio signals. This must be independent of the bridge audio.



**Radar/AIS Data** (Post-Display Selection). Electronic signal information from one of the ship's radars, which records all the information actually presented on the master display of that radar at the time of recording. This includes range rings or markers, bearing markers, electronic plotting symbols, radar maps, any parts of the electronic chart or map that were selected, the voyage plan, navigational data, navigational alarms and the radar status data that were visible on the display. The recording method must be such that it will present a faithful replica of the entire radar display on playback. The S-VDR specification provides an allowance for limitations of bandwidth compression techniques that are essential to the working of the S-VDR. The S-VDR standard also states that if there is no commercial
off-the-shelf interface available to obtain radar data the S-VDR may be permitted to substitute AIS data in its place. If radar data is recorded, AIS information may be recorded additionally as a beneficial secondary source of information.

The VDR performance standard requires the following additional data items to be recorded. The S-VDR is not required to record these data sets if they are not available in a digital serial data output format (IEC 61162), but they must be recorded when the data is available in accordance with international digital interface standards using approved sentence formats. When existing sensors and systems are upgraded to provide NMEA serial data output, they must be interfaced with the S-VDR to comply with the annual recertification.

**Depth.** Depth beneath the keel, up to a resolution of 0.1 meter, including the depth scale currently being used.

**Main Alarms.** Status of all IMO mandatory alarms, recorded by the bridge audio and as a data parameter where practical.

**Rudder Order and Response.** Up to a resolution of 1 degree.

Status and settings of the ship's autopilot must also be recorded.

**Engine Order and Response.** Up to a resolution of 1 rpm, or 1 degree of pitch. This includes bow and stern thrusters if fitted.

**Hull Openings (Doors).** This must include all IMO mandatory status information required to be displayed on the bridge.

**Watertight and Fire Doors.** This also must include all IMO mandatory status information required to be displayed on the bridge.

**Wind Speed and Direction.** Either true or relative wind, with an indication of which.

| VDR | S-VDR |
|---|---|
| • Date and Time (GPS)<br>• Ship's Position (GPS)<br>• Speed (Speed Log)<br>• Heading (Gyro Compass)<br>• Bridge Audio & VHF Communications | • Date and Time (GPS)<br>• Ship's Position (GPS)<br>• Speed (Speed Log or GPS)<br>• Heading (Gyro Compass)<br>• Bridge Audio & VHF Communications |
| • Radar Display Image | • Radar Display Image and/or AIS (can substitute AIS for Radar Display with class waiver) |
| • Water Depth (Echosounder)<br>• Wind Speed and Wind Direction<br>• Main alarms (as required by class)<br>-Steering Alarms<br>-Engine Alarms<br>-Fire Detection Alarms<br>• Rudder Order and Response<br>• Heading Keeping Information<br>• Engine Order and Response<br>• Ship Control and Indication Statuses<br>• Hull Openings, Watertight and Fire Door Status (if fitted)<br>• Accelerations and Hull Stresses (if fitted) | • Any other Serial (NMEA) format per IEC 61162 |



## IMO Mandatory Alarms on the Bridge

- Main and auxiliary steering gear power units
- Main and auxiliary steering gear control system
- Steering gear, low hydraulic fluid level
- Propulsion machinery remote control system failure
- Propulsion machinery low starting air pressure
- Automatic shut-down of propulsion machinery
- Fault requiring action by or attention of the Officer of the Watch
- Alarm system normal power supply failure
- Watertight door low hydraulic fluid level
- Watertight door low gas pressure, loss of stored energy
- Watertight door electrical power loss
- High water alarm
- Shell door position indicator
- Local automatic halon release
- Fire detection in automated or remotely controlled machinery space
- Fire detection or automatic sprinkler operation
- Smoke detection system power loss
- Smoke detection
- Halon system loss of container
- Halon system electric circuit fault or power loss
- Halon system hydraulic or pneumatic pressure loss
- Personnel alarm

CHAPTER 5

# Protected Data Capsules

The final recording medium must be installed in a protected capsule of either a fixed or float-free type. In both cases, the unit must maintain the recorded data for a period of at least two years following termination of recording, and be of a highly visible color and marked with retro-reflective material. The capsule must be capable of being accessed following an incident but secure against tampering.

For a fixed data capsule installation, the following survivability specifications apply to both VDR and S-VDR:

- Impact shock – 50g for 11 milliseconds
- Fire – 1100°C for 1 hour and 260°C for 10 hours
- Deep sea pressure and immersion – 24 hours at 6.000 meters depth, and 30 days at 3 meters depth

The VDR specification also requires the following:

- Penetration – 250 kg mass dropped 3 meters impacting with 100 mm diameter pin

The fixed capsule must have a release mechanism to facilitate recovery underwater by a diver or ROV, and must be equipped with an acoustic underwater beacon with a battery life of at least 30 days.

For a float-free capsule (S-VDR only), the following specifications apply:

- Homing transmitter operating on 121.5 MHz
- Flashing light
- Capable of resolving and transmitting position with a minimum of 4 seconds of arc
- Battery life of at least 7 days for transmitter




## Fixed or Float-Free

The choice between a fixed or float-free capsule will be governed by a range of factors. On the one hand, the fixed capsule is designed for a higher level of survivability, meeting more stringent specifications for shock, immersion and fire, and a longer battery life of 30 days, as contrasted with 7 days for the float-free capsule. It also typically has a lower installed cost than the float-free device. On the other hand, the float-free capsule offers easier, faster and lower-cost recovery in the event of a sinking, eliminating the need for a submersible ROV or divers to descend to the ship and retrieve the device. But the float-free device does not meet the same standards for fire resistance, and could be destroyed if the ship burns. Moreover, there may be concerns about the ability of the capsule to float free unhindered if the ship should roll over. The float-free system will also probably have higher installation and life-cycle costs due to the need for a hydrostatic release mechanism, battery replenishment, testing on Cospas-Sarsat frequencies and more frequent replacement. The float-free capsule may also eliminate the requirement for a separate EPIRB.

CHAPTER 6

# Ownership and Recovery of VDR Data

At its 75th session in 2002, the IMO Marine Safety Committee approved guidelines on VDR ownership and recovery. These guidelines are the same for both VDR and S-VDR.

The shipowner will, in all circumstances and at all times, own the VDR and its information. In the event of an accident, the owner of the ship should make available and maintain all decoding instructions necessary to recover the recorded information.

Recovery of the VDR information should be undertaken as soon as possible to preserve the evidence. As the investigator is unlikely to be in a position to instigate this action immediately after the accident, the owner must be responsible, through onboard standing orders, for ensuring the timely preservation of this evidence.

If the vessel is abandoned during an emergency, the master should – where time and other responsibilities permit – take the necessary steps to preserve the VDR information until it can be passed to the investigator.



If the VDR data has not been retrieved prior to abandonment, the flag state will have to decide whether it is practical and cost-effective to retrieve the capsule. If it is decided to recover the VDR, the investigator should be responsible for coordinating its recovery.

In all circumstances during the course of an investigation, the investigator should have custody of the original VDR information. The investigator will be responsible to arrange downloading and readout of the information and should keep the shipowner fully informed. In some cases the assistance of specialist expertise may be required.

A copy of the VDR information must be provided to the shipowner at an early stage. Further access to the information will be governed by the applicable domestic legislation of the flag state and other states involved. Any disclosure of VDR information is governed by Section 10 of the Code for the Investigation of Marine Casualties and Incidents.

## Removable Memory Module

In many cases, such as a minor collision or grounding in which the ship does not sink, it may not be desirable to go to the expense of retrieving data from the protective capsule. The Sperry Marine VoyageMaster II VDR and S-VDR contain a removable memory module (RMM), which records weeks of data on an industrial-hardened disk drive. The RMM can easily be removed from the computer for data analysis. The data is extracted from the RMM using Firewire cable, PC and the VoyageMaster II playback software.

CHAPTER 7

# Commissioning and Certification

A data block defining the configuration of the VDR or S-VDR must be entered into the final recording medium during commissioning. This configuration data must be permanently retained and protected from modification other than by a duly authorized person following any changes to the configuration.

The following information must be included in this data block:

- Type approval authority and reference
- IMO vessel identification number
- Software versions used
- Microphone location and recording port allocation
- Which VHF channels are being recorded
- Source being used for date and time data
- Source of ship's positioning data, and relative location of antenna on ship
- Identification of which equipment is supplying recorded data, sign conventions and identity of all alarm/door inputs
- Automatic insertion of date and time of last amendment

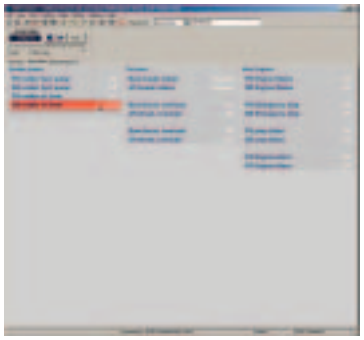
The VDR or S-VDR must be certified by a qualified service engineer at the time of commissioning. It must also be recertified annually on or before the anniversary date of the original installation.

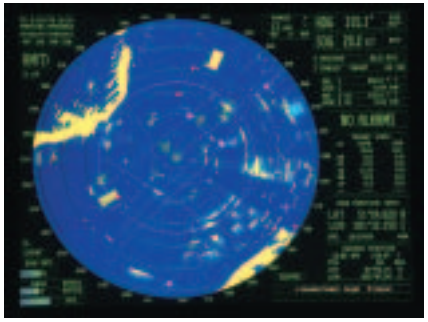
Per SOLAS regulations, the annual certification tests must be conducted by an approved testing or servicing facility to verify the accuracy, duration and recoverability of the recorded data. In addition, tests and inspections are conducted to determine the serviceability of all protective enclosures and devices fitted to aid location. A copy of the certificate of compliance issued by the testing facility, stating the date of compliance and the applicable performance standards, must be retained on board the ship.

CHAPTER 8

# Beyond the Black Box

The VDR provides a wealth of data, which can be used to analyze equipment performance, enhance crew training and improve management practices. The VDR data can also facilitate investigation of "near misses," minor collisions when maneuvering in a restricted harbor, or cargo damage during heavy seas. The VDR recorded data may also be useful in settling insurance claims. It will improve safety at sea by helping to identify mistakes and adopt remedial policies to avoid them in the future.





In order to maximize its usefulness as a fleet management tool, the VDR can be linked with the ship's satellite communication system to download VDR data to shore offices. The availability of VDR data from a ship in distress may be a tremendous aid to search and rescue (SAR) authorities and response teams, yielding valuable and timely information that will help in SAR efforts, arranging for salvage or assistance from technical experts ashore.

The VDR can be interfaced with other shipboard computer systems for storing and utilizing recorded data. In this way, VDR data can be monitored in real-time on tailored graphic screens or played back for analysis of vessel and equipment performance. The playback function can provide a valuable tool for scenario-driven crew training. For instance, the master can play back a particular harbor approach or maneuvering scenario with an eye to identifying shortfalls and improving watchstanding practices.



## Selective Data Storage

The Sperry Marine VoyageMaster and VoyageMaster II VDR and S-VDR systems offer a convenient SAVE function for recording VDR data sets as desired by the crew. The function is accessed by a dedicated SAVE button on the bridge alarm panel. When pressed, the SAVE button reserves and protects a 12-hour data set onto the VDR removable memory module. The data set may then be transferred to a networked workstation for onboard playback or to a communications server for transfer via satellite to shore offices. A library of playback files may thus be established for later use in crew training, incident reporting, accident investigation, performance monitoring or trend analysis. The SAVE function does not interrupt or interfere with the automatic recording and storing of data to the capsule.

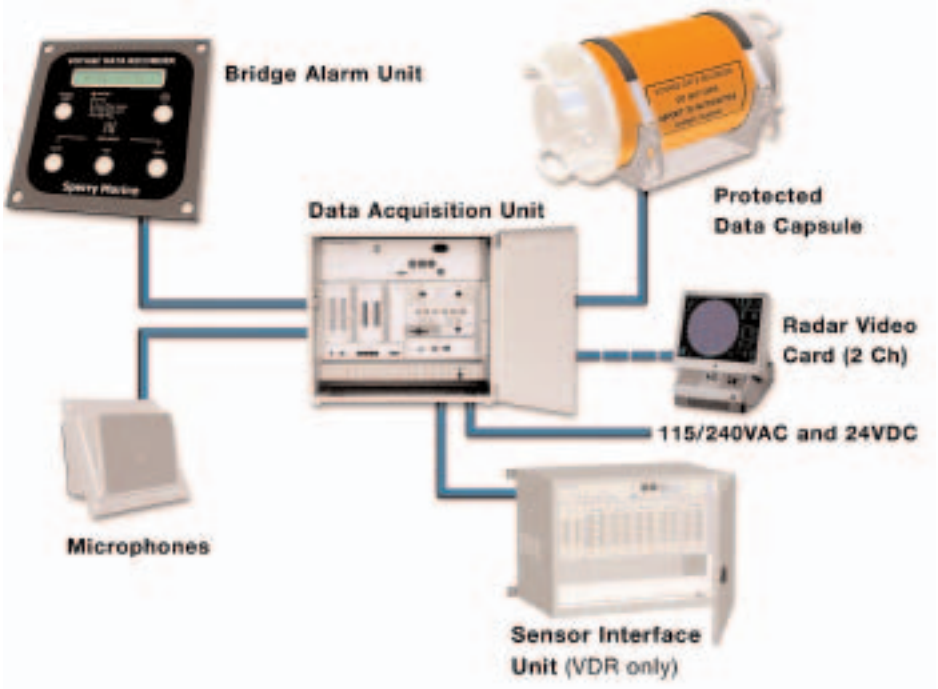
# Solutions for Newbuilds and Retrofits

## VoyageMaster II VDR and S-VDR

The Sperry Marine VoyageMaster II meets all of the specifications in IMO A.861 and IEC 61996. The second-generation VoyageMaster II design uses a flexible modular architecture that not only conforms to IMO requirements, but also provides additional video, audio and signal capabilities. It is type-approved by BSH.

**Data Acquisition Unit.** Tamper-proof locking cabinet containing industrial-grade CPU; audio card; radar/video capture board; uninterruptible power supply with two-hour capacity; eight standard serial data inputs and removable memory module for data retrieval and playback.

**Protected Data Capsule.** Meets all IMO and IEC standards. Holds up to 12 hours of data. Fixed capsule includes underwater beacon, quick-release mechanism for retrieval and 50 meter cable. Float-free capsule also available.




**Bridge Alarm Unit.** Mounted on the bridge. Provides visual and audible alarms. Includes two-line LCD display for alarm codes, and integral SAVE button to store 12 hours of data on the hard drive.

**Bridge Microphone Unit.** Records audio on the bridge. Includes buzzer for self-test every 12 hours. A watertight unit is available for mounting on bridge wings.

**Sensor Interface Unit** (VDR only). Provides signal conditioning for analog, digital and serial inputs. It interfaces with the Data Acquisition Unit via a common Ethernet platform, minimizing long cable runs.

## Worldwide Service

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