PUBLICLY
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SPECIFICATION

IEC PAS 61996-2

Pre-Standard

First edition
2005-07

**Maritime navigation and radiocommunication equipment and systems –
Shipborne voyage data recorder (VDR) –**

**Part 2:
Simplified voyage data recorder (S-VDR) –
Performance requirements –
Methods of testing and required test results**

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MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – SHIPBORNE VOYAGE DATA RECORDER (VDR) –

Part 2: Simplified voyage data recorder (S-VDR) – Performance requirements – Methods of testing and required test results

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IEC-PAS 61996-2 has been processed by IEC technical committee 80: Maritime navigation and radiocommunication equipment and systems.

The text of the PAS is based on the following document:

This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document:

Draft PAS	Report on voting
80/401/NP-PAS	80/406/RVN

Following publication of this PAS, the technical committee or subcommittee concerned will investigate the possibility of transforming the PAS into an International Standard.

IEC 61996 consists of the following parts, under the general title *Maritime navigation and radiocommunication equipment and systems – Shipborne voyage data recorder (VDR)*:

Part 1: Performance requirements – Methods of testing and required test results (currently available as IEC 61996:2000)

Part 2: Simplified voyage data recorder (S-VDR) – Performance requirements – Methods of testing and required test results

This PAS shall remain valid for an initial maximum period of three years starting from 2005-07. The validity may be extended for a single 3-year period, following which it shall be revised to become another type of normative document or shall be withdrawn.

INTRODUCTION

This document is issued as an IEC Publicly Available Specification according to the IEC/PAS approval process. This agreed process allows the new information needed to implement the simplified voyage data recorder (S-VDR) to be placed in the public domain in a shorter time-scale than revising the appropriate International Standards.

The S-VDR has been introduced by the IMO for fitting to existing ships as a simplified alternative to the voyage data recorder (VDR) which is required for all new ships.

This document provides information on the testing requirements for S-VDR as defined in IMO performance standard MSC.163(78).

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.

Annex D provides a cross-reference between this document and IEC 61996 to aid test houses which may already have test results for VDRs which are being submitted as S-VDRs.

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – SHIPBORNE VOYAGE DATA RECORDER (VDR) –

Part 2: Simplified voyage data recorder (S-VDR) – Performance requirements – Methods of testing and required test results

1 Scope

This PAS specifies the minimum performance requirements, technical characteristics and methods of testing, and required test results, for simplified shipborne voyage data recorders (S-VDRs) as required by IMO MSC.163(78). It takes into account IMO resolution A.694(17) and is associated with IEC 60945. When a requirement in this standard is different from IEC 60945, the requirement in this standard takes precedence.

NOTE All text of this standard, whose wording is identical to that of IMO MSC.163(78) is printed in *italics,* and the Resolution and associated performance standard paragraph numbers are indicated in brackets.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-27:1987, *Environmental testing – Part 2: Tests – Test Ea and guidance: Shock*

IEC 60268:1998, *Sound system equipment – Part 16: Objective rating of speech intelligibility by speech transmission index*

IEC 60936-1:1999, *Maritime navigation and radiocommunication equipment and systems – Radar – Part 1: Shipborne radar – Performance requirements – Methods of testing and required test results*[1]

Amendment 1 (2002)

IEC 60936-3: *Maritime navigation and radiocommunication equipment and systems – Radar – Part 3: Shipborne radar with chart facilities – Methods of testing and required test results*

IEC 60945:2002, *Maritime navigation and radiocommunication equipment and systems – General requirements – Methods of testing and required test results*

IEC 61097-2: 2002, *Global maritime distress and safety system (GMDSS) – Part 2: COSPAS SARSAT EPIRB – Satellite emergency position-indicating radio beacon operating on 406 MHz – Operational and performance requirements, methods of testing and required test results*

IEC 61097-7:1996, *Global maritime distress and safety system (GMDSS) – Part 7: Shipborne VHF radiotelephone transmitter and receiver – Operational and performance requirements, methods of testing and required test results*

IEC 61162 (all parts), *Maritime navigation and radiocommunication equipment and systems – Digital interfaces*

IEC 61260:*Electroacoustics – Octave-band and fractional-octave-band filters*

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[1] There exists a consolidated edition 1.1 (2002) that includes edition 1.0 and its amendment.

IEC 61672 (all parts), *Electroacoustics – Sound level meters*

IEC 61993-2, *Maritime navigation and radiocommunication equipment and systems – Automatic identification systems (AIS) – Part 2: Class A shipborne equipment of the universal automatic identification systems (AIS) – Operational and performance requirements, methods of test and required test results*

IEC 61996 (all parts), *Maritime navigation and radiocommunication equipment and systems – Shipborne voyage data recorder (VDR)*

IMO A.658(16): *Use and fitting of retro-reflective materials on life-saving appliances*

IMO A.662(16): *Performance standards for float-free release and activation arrangements for emergency radio equipment*

IMO A.694(17): *General requirements for shipborne radio equipment forming part of the Global Maritime Distress and Safety System (GMDSS) and for electronic navigational aids*

IMO A.810(19): *Performance standards for float-free satellite emergency position-indicating radio beacons (EPIRBs) operating on 406 MHz*

IMO A.830(19):1995, *Code on alarms and indicators*

IMO A.861(20): *Performance standards for shipborne voyage data recorders (VDRs)*

IMO MSC.81(70): *Testing of life-saving appliances*

IMO MSC.163(78): *Performance standards for shipborne simplified voyage data recorders (S-VDR).*

Eurocae: ED56A – *Minimum operational performance specification (MOPS) for cockpit voice recorder system*

VESA:1996, *Video electronics standards association – Discrete monitor timings standard 1.0, Revision 0.7 (DMTS)*

SAE AS8045:1988, *Engineering society for advancing mobility land, sea, air, and space – Minimum performance standard for underwater locating devices – Acoustic-self-powered*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
recorder (S-VDR) (MSC.163(78) 4.1)
complete system, including any items required to interface with the sources of input data, for processing and encoding the data, the final recording medium in its capsule, the power supply and dedicated reserve power source

3.1.2
sensor (MSC.163(78) 4.2*)*
any unit external to the S-VDR to which the S-VDR is connected and from which it obtains data to be recorded

3.1.3
final recording medium (MSC.163(78) 4.3)
any item of hardware on which the data is recorded such that access to it would enable the data to be recovered and played back by use of suitable equipment

3.1.4
playback equipment (MSC.163(78) 4.4)
any equipment, compatible with the recording medium and the format used during recording, employed for recovering the data. It includes also the display or presentation hardware and software that is appropriate to the original data source equipment. Playback equipment is not normally installed on a ship and is not regarded as part of a S-VDR within this standard

3.1.5
dedicated reserve power source (MSC.163(78) 4.5)
secondary battery, with suitable automatic charging arrangements, dedicated solely to the VDR, of sufficient capacity to operate it as required by 4.5.3

3.1.6
resolution
smallest detectable increment between two values

3.1.7
data
any item of information received by the S-VDR for recording, including numerical values, text and audio or radar signals, except where specifically stated or the context dictates otherwise

3.1.8
activation of a suitable alarm
mutable audible alarm and persistent visual indication, given according to the requirements of A.830(19) and IEC 60945

3.1.9
bridge work station
position at which a person is expected to be when performing one of the normal bridge duties at, for example, the following work stations:

- centre line conning
- bridge wing(s)
- main radar
- chart table
- helms
- communication

3.2 Abbreviations

AIS	Automatic identification system
ALR	IEC 61162 sentence: Set alarm state
DPT	IEC 61162 sentence: Depth relative to the transducer
DTM	IEC 61162 sentence: Geodetic datum reference
EPFS	Electronic position fixing system
EPIRB	Emergency position indicating radio beacon
EUT	Equipment under test

GMDSS	Global maritime distress and safety system
GNS	IEC 61162 sentence: GNSS fix data
GNSS	Global Navigation Satellite System
HDT	IEC 61162 sentence: True heading
HDG	IEC 61162 sentence: Magnetic compass heading
HTC	IEC 61162 sentence: Heading/track control command
HTD	IEC 61162 sentence: Heading/track control data
IMO	International Maritime Organization
INS	Integrated navigation system
ITU	International Telecommunication Union
MWV	IEC 61162 sentence: Wind and speed angle
OOW	Officer of the watch
RSA	IEC 61162 sentence: Rudder sense angle
RPM	IEC 61162 sentence: Revolutions per minute
ROV	Remotely operated vehicle
SAR	Search and rescue
SENC	System electronic navigation chart
SINAD	Signal to noise and distortion
STI	Sound transmission index
TXT	IEC 61162 sentence: Text message
VDO	IEC 61162 sentence: AIS - VHF data link own-vessel message
VDM	IEC 61162 sentence: AIS - VHF data link message
VHF	Very high frequency
VBW	IEC 61162 sentence: Dual ground water speed
XDR	IEC 61162 sentence: Transducer measurements
ZDA	IEC 61162 sentence: Time and date

NOTE For IEC 1162 sentences, see Annex A.

4 Performance requirements

Performance requirements described in the following clauses are specified, where relevant, by reference to the numbered paragraphs of IMO MSC.163(78), if not otherwise indicated.

4.1 General

Requirements specified in this PAS are only relevant to equipment designated as an S-VDR and required to meet IMO MSC.163(78).

For equipment designated as a VDR to IMO performance standards defined in resolution A.861(20) refer to IEC 61996.

A table of cross-references between this PAS and IEC 61996 is included in Annex D.

4.2 Purpose

(MSC.163(78) 1)

The purpose of a simplified voyage data recorder (S-VDR) is to maintain a store, in a secure and retrievable form, of information concerning the position, movement, physical status,

command and control of a vessel over the period leading up to, and following, an incident having an impact thereon. Information contained in a S-VDR should be made available to both the Administration and the shipowner. This information is for use during any subsequent investigation to identify the cause(s) of the incident.

4.3 Operational requirements

(MSC.163(78) 5)

4.3.1 Design and construction

(MSC.163(78) 5.1.4)

The design and construction, which shall *be in accordance with the requirements of resolution A.694(17) and international standards acceptable to the Organization*[3], shall *take special account of the requirements for data security and continuity of operation as detailed in* IMO MSC.163(78) *5.2 and 5.3* and in 4.3, 4.4 and 4.5 of this PAS.

4.3.2 Maintenance of sequential records

(MSC.163(78) 5.1.1)

The S-VDR shall *continuously maintain sequential records of pre-selected data items relating to the status and output of the ship's equipment, and command and control of the ship, referred to in* 4.6.

4.3.3 Co-relation in date and time

(MSC.163(78) 5.1.2, 5.4.1)

To permit subsequent analysis of factors surrounding an incident, the method of recording shall *ensure that the various data items can be co-related in date and time during playback on suitable equipment.*

The recording method shall *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 an incident in detail* (see 4.6.1).

4.3.4 Protective capsule

4.3.4.1 Final recording medium

(MSC.163(78) 5.1.3)

The final recording medium shall *be installed in a protective capsule*. The capsule may be designed to remain fixed to the ship in all circumstances. Alternatively, it may be designed to float free automatically if the ship sinks (see 5.2). The capsule may also comply with the requirements of IEC 61996.

4.3.4.1.1 Fixed capsule

(MSC.163(78) 5.1.3.2)

The fixed type protective capsule shall *comply with the requirements set out in resolution A.861(20)* and this PAS *with the exception of the resulting requirements for withstanding penetration*.

4.3.4.1.2 Float-free capsule

(MSC.163(78) 5.1.3.3)

In addition to meeting the requirements of this PAS, *the float-free type protective capsule* shall

[3] Refer to IEC 60945: Maritime navigation and radiocommunication equipment and systems – General requirements, methods of testing and required test results.

a) be so constructed as to comply with the requirements specified in resolutions A.810(19);

b) *be fitted with means to facilitate grappling and recovery* and be designed with due regard to preventing it from being fouled during release;

c) *be so constructed as to minimise the risk of* loss or *damage to the recording medium during recovery operations.*

4.3.4.2 Access to capsule

(MSC.163(78) 5.1.3.1.1)(See also 5.2)

The capsule shall *be capable of being accessed following an incident but secure against tampering.*

The capsule shall enclose the final recording medium. The final recording medium shall not be accessible by standard operating procedures during normal ship operations.

A means shall be provided to retrieve stored information via an external device without opening the protective capsule.

4.3.4.3 Location and identification

(See also 5.2)

4.3.4.3.1 Location

(MSC.163(78) 5.1.3.1.4)(See 5.3)

The capsule shall *be fitted with an appropriate device to aid location.*

4.3.4.3.2 Visibility and marking

(MSC.163(78) 5.1.3.1)

The capsule, together with any outermost shell, *shall be of a highly visible* fluorescent orange *colour, marked with retro-reflective materials* that comply with the relevant requirements of IMO A.658(16) and marked with the legend:

"VOYAGE DATA RECORDER – DO NOT OPEN -

REPORT TO AUTHORITIES"

4.3.5 Assessment of recording medium

Where the storage medium cannot be readily and reliably inspected after an incident, means shall be provided to enable an accident investigator to determine, prior to an attempted replay, whether the storage medium has been subjected to an excessive level of heat, where the survival of the stored data may be in doubt.

4.3.6 Interfaces

(MSC.163(78) 7*)*

Interfacing to the various sensors required shall *be in accordance with the relevant international interface standard,* IEC 61162, *where possible.*

NOTE See Annex A.

The interfaces for bridge audio, communications audio and radar are defined in 5.6.1, 5.7.1 and 5.8.1 respectively.

Any interface units which may be required to convert non-IEC 61162 signals, shall conform to the requirements of IEC 60945.

In all cases, *any connection to any item of the ship's equipment* shall *be such that the operation of that equipment suffers no deterioration, even if the S-VDR system develops faults.*

NOTE No loss of steering or propulsion is allowed.

4.4 Data selection and security

(MSC.163(78) 5.2)

4.4.1 Selection of data items

(MSC.163(78) 5.2.1)

The minimum selections of operational *data items to be recorded by the S-VDR are specified in* 4.6. *Optionally, additional items may be recorded provided that the requirements for the recording and storage of the specified selections are not compromised.*

In addition to the operational data referred to in the preceding paragraph, a data block defining the configuration of the S-VDR and the sensors to which it is connected shall be written into the final recording medium during commissioning of the S-VDR. This configuration data shall be permanently retained in the final recording medium and protected from modification other than by a duly authorized person following any change to the configuration. Any change to the configuration of this data block shall not affect the recording of the mandatory items.

The following system configuration information and data source identity shall be included in this data block:

a) type approval authority and reference;

b) IMO vessel identification number;

c) software version(s) used;

d) microphone locations and recording port allocation;

NOTE This does not imply channelization.

e) VHF communications – which VHF channel(s) recorded;

f) date and time – from which source obtained;

g) ship's position – from which EPFS obtained and relative position on the vessel;

h) other data inputs – identification of which equipment is supplying recorded data; sign conventions and identity of all alarm/door inputs;

i) automatic insertion of date and time of last amendment.

4.4.2 Resistance to tampering

(MSC.163(78) 5.2.2)

The equipment shall *be so designed 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* shall *be recorded.*

4.4.3 Recording integrity

(MSC.163(78) 5.2.3)

The recording method shall *be such that each item of the recorded data is checked for integrity,* for example, it is identical to the data being received, *and an alarm given if a non-correctable error is detected.*

The S-VDR shall automatically continuously monitor the following (see 6.1.10):

a) power supply;

b) record function;

c) bit error rate;

d) microphone functionality.

Malfunction of any of the above shall generate an alarm in accordance with the relevant requirements of IMO A.830(19) at the position from which the vessel is normally navigated. It shall be possible to mute the alarm but a visual indication shall remain until the equipment is serviceable. It shall also indicate its alarm status by means of contacts of a relay (or equivalent) which is held energized in the no-alarm condition.

4.5 Continuity of operation

4.5.1 Operation

(MSC.163(78) 6)

The unit shall *be entirely automatic in normal operation. Means* shall *be provided* to ensure that the *recorded data* can *be saved by an appropriate method following an incident, with minimal interruption to the recording process* and without requiring opening of the protective capsule.

a) Controls for use during the saving process shall be simple to use.

b) The recording process to the final recording medium shall not be interrupted for more than 10 min during the saving process. The data recorded in the final recording medium shall not be erased.

c) The data saved shall be automatically checked to ensure that it is identical to the recorded data on the final recording medium. Any failure shall be indicated.

d) When the saving process is completed, means shall be provided to enable copies to be made of this or of data relating to subsequent incidents.

NOTE "Saving process" means preserving a copy of the data contained in the final recording medium.

4.5.2 Power source

(MSC.163(78) 5.3.1)

To ensure that the S-VDR continues to record events during an incident, it shall *be capable of operating from the ship's emergency source of electrical power.* Whenever electrical power is available the S-VDR shall operate, except as permitted in 4.5.4. (see 6.1.15).

4.5.3 Alternative power source

(MSC.163(78) 5.3.2)

If the ship's emergency source of electrical power supply fails, the S-VDR shall *continue to record bridge audio (see 4.6.5) from a dedicated reserve source of power for a period of 2 h. At the end of this 2 h period all recording shall cease automatically.*

4.5.4 Recording period and duration

(MSC.163(78) 5.3.3)

Recording shall *be continuous unless interrupted briefly in accordance with* 4.5.1 *or terminated in accordance with* 4.5.3. *The time for which all stored data items are retained* shall *be at least 12 h. Data items which are older than this may be overwritten with new data.*

Recording may also be terminated, by means of a key or other secure method.

NOTE This may occur under the following circumstances:

a) during essential maintenance purposes whilst the vessel is in port;

b) when the vessel is laid up.

4.6 Data items to be recorded

(MSC.163(78) 5.4)

4.6.1 Date and time

(MSC.163(78) 5.4.1)

Date and time referenced to UTC, shall *be obtained from a source external to the ship* (for example, an EPFS or radio time signal) if available, *or from an internal clock* at least once per hour. *The recording* shall *indicate which source is in use. The recording method* shall *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*, not worse than 1 s.

4.6.2 Ship's position

(MSC.163(78) 5.4.2)

Latitude and longitude, and the datum used, shall *be derived from a designated EPFS* or INS if available. *The recording* shall *ensure that the identity and status of the source can always be determined on playback.* The ship's position shall be recorded, as available on the ship, up to a resolution of 0,0001 min of arc.

4.6.3 Speed

(MSC.163(78) 5.4.3)

Speed through the water, or speed over the ground (transverse as well as longitudinal in either case, as available on the ship), *including an indication from which it is*, *derived from the ship's* designated *speed and distance measuring equipment*, shall be recorded, as available on the ship, up to a resolution of 0,1 kn.

4.6.4 Heading

(MSC.163(78) 5.4.4)

As indicated by a designated *ship's compass*. The ship's heading shall be recorded, as available on the ship, up to a resolution of 0,1°.

4.6.5 Bridge audio

(MSC.163(78) 5.4.5)

One or more microphones positioned on the bridge shall *be placed, such that conversation at or near the conning stations, radar displays, chart tables, etc.,* (for example, at work stations as defined in 3.1.9 *may be* adequately recorded. *As far as* is *practicable, the positioning of microphones* shall *also capture* the input and output of *intercom, public address systems and* the *audible alarms on the bridge* (bridge-mounted equipment).

(See 5.6 for technical characteristics.)

The audio signals at all work stations shall be recorded continuously. Optionally, means may be provided so that the originating work station can be identified with the audio signal being analysed during playback of the recorded information.

4.6.6 Communications audio

(MSC.163(78) 5.4.6)

VHF communications relating to ship operations shall *be recorded,* independently of the bridge audio. The recording shall include both transmitted and received audio signals and shall be continuous from a directly connected fixed VHF set to be designated at installation.

(See 5.7 for technical characteristics.)

4.6.7 Radar data – Post-display selection

(MSC.163(78) 5.4.7)

This shall *include electronic signal information from within one of the ship's radar installations which records all the information which was actually being presented on the master display of that radar at the time of recording. This* shall *include any range rings or markers, bearing markers, electronic plotting symbols, radar maps, whatever parts of the SENC or other 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* shall *be such that, on playback, it is possible to present a faithful replica of the entire radar display that was on view at the time of recording, albeit within the limitations of any bandwidth compression techniques that are essential to the working of the S-VDR.*

(See 5.8.)

4.6.8 AIS

(MSC.163(78) 5.4.8)

Where there is no *commercial off-the-shelf interface available to obtain radar data then AIS target data* shall *be recorded as a source of information regarding other ships*, otherwise AIS information may be *recorded additionally as a beneficial secondary source of information on both other and own ship.*

The VDM message shall be recorded in such a way that all target data available from the onboard AIS are acquired.

If the VDO message is recorded, this shall be additional to the recording of individual sensor data according to 4.6.1 to 4.6.4.

4.6.9 Other Items

(MSC.163(78) 5.4.9)

Any additional data items listed by IMO with the requirements set out in resolution A.861(20) (4.6.10 to 4.6.17 below) shall *be recorded* where *the data is available in accordance with the international digital interface standards[4] using approved sentence formatters.*

4.6.10 Echo sounder

(A.861/5.4.8)

This shall *include depth under keel,* up to a resolution of 0,1 m as available on the ship. *The depth scale currently being displayed and other status information* shall be recorded *where available.*

4.6.11 Main alarms

(A.861/5.4.9)

This shall *include the status of all* IMO *mandatory alarms on the bridge.*

(See Annex B.)

The status of all IMO mandatory alarms shall be recorded by the bridge audio and as a data parameter where practicable.

4.6.12 Rudder order and response

(A.861/5.4.10)

Both *rudder order and response* angles shall be recorded up to a resolution of 1° as available and permitted on the ship. *Status and settings of* heading or track controller*, if fitted,* shall also be recorded.

———————

4 Refer to IEC 61162.

4.6.13 Engine order and response

(A.861/5.4.11)

This shall *include the positions of any engine telegraphs* or *direct engine/propeller controls,* including shaft(s) r.p.m.(or equivalent), *and feedback indications, if fitted, including ahead/astern indicators. This* shall *also include status of bow* and stern *thrusters if fitted.* RPM shall be recorded up to a resolution of 1 r.p.m and pitch shall be recorded up to a resolution of 1°.

4.6.14 Hull openings (doors) status

(A.861/5.4.12)

This shall *include all* IMO *mandatory status information required to be displayed on the bridge.*

4.6.15 Watertight and fire door status

(A.861/5.4.13)

This shall *include all* IMO *mandatory status information required to be displayed on the bridge.*

4.6.16 Accelerations and hull stresses

(A.861/5.4.14)

Where a ship is fitted with IMO-mandated *hull stress and response monitoring equipment, all the data items that have been pre-selected within that equipment* and are available shall *be recorded.*

4.6.17 Wind speed and direction

(A.861/5.4.15)

This shall *be applicable where a ship is fitted with a suitable sensor. Either relative or true wind speed and direction may be recorded, but an indication of which it is* shall *be recorded.*

5 Technical characteristics

5.1 Co-relation in date and time

(A.861/5.1.2 and 5.4.1)

To ensure that relative timings can be determined within a resolution of 0,1 s, all data items shall, when sampled by the VDR, be recorded with a time index derived from a VDR system clock with an resolution of 0,05 s. The drift of this system clock shall be not more than 1 s in 1 h.

5.2 Particular design requirements for the protective capsule

(MSC.163(78), 5.1.3)

The final recording medium shall *be installed in a protective capsule of either a fixed or float-free type, which* shall *meet all of the following requirements* (IMO MSC.163(78), 5.1.3.1):

a) maintain the recorded data for a period of at least 2 years following termination of recording;

b) be of a highly visible colour and marked with retro-reflective materials.

5.2.1 Fixed protective capsule

(MSC.163(78) 5.1.3.2)

5.2.1.1 Design of the fixed capsule

The capsule containing the final recording medium shall be designed to be installed on the external deck of the vessel.

The capsule shall be designed to protect the stored data against the following (see IEC 61996, 5.4, except penetration):

– shock;

– fire;

– deep-sea pressure and immersion.

5.2.1.2 Release mechanism

The fixed capsule shall have a release mechanism to facilitate recovery under water both by a diver or a remotely operated vehicle (ROV). Possible items to be considered are

a) the use of break-away bolts;

b) release levers;

c) twist lock.

To ensure that the capsule may be retrieved safely after release, suitable large pad eyes or handles shall be incorporated.

NOTE It should be borne in mind that the manipulator jaws of typical underwater recovery machines have a maximum opening of only 300 mm, a gripping force limit of about 1 kN, and a pulling force limit of about 500 N.

5.3 Location beacon(s) for the protective capsule

(MSC.163(78) 5.1.3.1.4)

The capsule shall *be fitted with an appropriate device to aid location*, as follows.

5.3.1 Device for the location of the fixed capsule

The capsule shall include an acoustic underwater beacon meeting SAE AS 8045, operating in the frequency band of 25 kHz to 50 kHz with a battery life of at least 30 days.

5.3.2 Device(s) for the location of the float-free capsule

(MSC.163(78) 5.1.3.3.3)

5.3.2.1 Homing transmitter

The float-free capsule shall include a homing transmitter operating on 121,5 MHz, complying with Annex B of IEC 61097-2, except that a Morse letter "V" (**. . .** –) shall be inserted with a repetition period varying between 47,5 s to 52,5 s, with a dot length (one unit) equal to 115 ms ± 5 %.

5.3.2.2 Light

The float-free capsule shall have a light conforming to the relevant requirements of IEC 61097-2. In addition, this light shall remain activated during daylight hours.

5.3.2.3 Position

The float-free capsule shall be capable of resolving and transmitting its last received position or its current position with a minimum accuracy of 4 s of arc.

5.3.2.4 Combined EPIRB/S-VDR capsule

In the case of a combined EPIRB/S-VDR capsule, this shall, in addition to the requirements of this PAS, meet IEC 61097-2, except as modified herein.

5.3.2.5 Operation of transmitters

(MSC.163(78) 5.1.3.3.3)

The transmitters shall

a) be capable of operating for a minimum of 7 days maintaining the specified duty cycle;

b) if the device includes the capability of being remotely controlled (see note), it shall be capable of transmitting an initial locating signal:

   1) for a period of at least 2 h;

   2) in the case of a combined EPIRB/S-VDR capsule, for at least 48 h, after which time period it shall automatically switch to a stand-by mode; and, in addition,

   3) have the capability of being commanded to transmit further locating/homing signals for a cumulative period of at least 48 h at the specified duty cycle over not less than 7 days/168 h; and

   4) if it does not receive a command to transmit within 5 days/120 h, it shall automatically switch into the transmission mode for at least 48 h.

NOTE A return signal path must be implemented to command and control the locating device signal (after initial activation) to ensure that the 48 h transmission period is achieved over a total time span of 7 days. Therefore, this function may be implemented after such return path and guidance for its use by authorities has been specified and after this standard has been amended accordingly.

5.4 Survivability of recorded data

5.4.1 Long-term retention under normal conditions

The final recording medium shall retain the recorded data for a period of at least 2 years, following termination of recording, under operational and storage conditions specified by the equipment manufacturer. Consideration should be given to the distribution of data within the recording medium.

5.4.2 Survival following an incident

5.4.2.1 Fixed capsule

The capsule shall be designed to ensure that the data held in the final recording medium, shall be retrieved without loss after the capsule has been subjected to the following conditions.

a) Shock

   A half sine-wave pulse of 50 g, with a duration of 11 ms, as specified in Clause 11 of IEC 60068-2-27.

b) Penetration

   Not required

c) Fire

   A low-temperature fire of 260 °C nominal for 10 h, as specified in 5.3.2e of ED56A.

   A high-temperature fire of 1 100 °C nominal for 1 h, as specified in 5.3.2d of ED56A.

d) Deep-sea pressure and immersion

Immersion in sea water at a pressure of 60 MPa (equivalent to a depth of 6 000 m), as specified in 5.3.2f of ED56A.

5.4.2.2 Float-free capsule

The capsule shall be designed to ensure that the data held in the final recording medium, shall be retrieved without loss after it has been deployed and subjected to salt water exposure and shall be fully operational for at least 7 days (MSC.163(78) 5.1.3.3.3).

5.5 Information to be included in the manufacturer's documentation

5.5.1 Installation guidelines

a) Siting of the protective capsule

The protective capsule shall be sited in the vicinity of the bridge on the external deck area of the vessel so as to maximize the probability of its survival and recovery following an incident. The capsule shall be positioned clear of rigging and other potential obstructions and as near to the centreline of the ship as practically possible.

Criteria to be considered when assessing the optimum position shall include, but not be limited to, the following.

1) Separation from fuel or other potential fire sources.
2) Separation from probable sources of mechanical damage.
3) Operational environment for continued serviceability.
4) Accessibility for copying of recorded data and for routine maintenance.
5) Facilitation of underwater removal and retrieval by both divers and ROVs. There shall be a clear unobstructed space in the vicinity of the capsule to allow an ROV or diver to work.
6) In the case of float-free configuration, minimization of the risk of obstruction after release.

b) Siting of microphones

c) Siting of all other components of the S-VDR configuration

d) Entering and updating the static configuration data of 4.4.1

e) The requirement for interface units to comply with 4.3.6

5.5.2 Operation and maintenance manual

The manual shall include the following:

a) instructions on normal operation of the S-VDR;

b) instructions on how to copy data from the equipment;

c) instructions on the action to be taken following the activation of any S-VDR alarm;

d) instructions for downloading and verification of the final recording medium data. These should be carried out whenever maintenance or repair has been carried out on any sensor or on the S-VDR itself, or at least annually;

e) maintenance tasks required to ensure the serviceability and continued seaworthiness of the S-VDR. An analysis shall be performed by the equipment installer to identify those sensors or transducers where the serviceability or accuracy could be degraded and remain undetected. The maintenance tasks to be performed shall take account of this analysis by requiring appropriate functional and calibration checks at suitable intervals;

f) annual re-certification procedure.

5.5.3 Information for use by an investigation authority

The following shall be available:

a) instructions to enable an investigation authority to manufacture any special tools or interface equipment required for retrieval of recorded data from the recorder;

b) details of the necessary actions to be followed for data retrieval from an undamaged protective capsule;

c) details of the necessary actions to be followed for data retrieval from a protective capsule that has been damaged in an incident;

d) details of software required to enable playback of recorded data.

5.6 Bridge audio specifications

5.6.1 Input interface

The microphones forming the bridge audio data source are to be considered to be parts of the S-VDR. The form of the connections, signal levels and impedances, are at the option of the manufacturer. However, for the purposes of testing, each microphone shall be connected via a plug/socket combination, which is referred to hereafter as an **input port**.

5.6.2 Reference signal

The manufacturer shall declare a reference signal, for each microphone input, at the electrical input port of the S-VDR. This shall be defined as a 1 kHz sinusoid at the maximum level for which the equipment is designed to meet this performance specification.

5.6.3 Audio frequency response

Signal levels of both 6 dB and 45 dB below the reference signal level, shall be applied to every bridge area microphone input port in turn. With the frequency swept continuously at a rate not exceeding 0,1 octaves per second, over the range of 150 Hz to 6 000 Hz, the level of signal recovered from the S-VDR shall not vary by more than a total range of 6 dB, on playback. Any other microphone input ports shall have no signals applied at this time.

5.6.4 Quality index

The quality of the recording shall be established for single and multiple microphone inputs.

5.6.4.1 Single microphone

The quality of the recording for each of the bridge area microphone ports shall be established at the electrical equivalent level of 75 dBA. This shall not be less than that corresponding to the quality value for the speech transmission index of 0,85 (see IEC 60268-16), with no signal being simultaneously applied to other microphone ports.

5.6.4.2 Multiple microphones

The quality of the recording for each of the bridge area microphone ports shall be established at the electrical equivalent level of 75 dBA. This shall not be less than that corresponding to the quality value for the speech transmission index of 0,60 (see IEC 60268-16) with all of the other microphone ports having inputs at the electrically equivalent level of 65 dBA.

5.6.4.3 Audio noise level – Signal to no signal

With no signal applied to any bridge area microphone port, the reproduced signal at any replay output shall be at least 48 dB below the output level, which would be produced by an input level equal to the reference signal level. This requirement shall be met across the frequency band as defined in 5.6.3 with the inputs both open- and short-circuited. The above signal to no signal performance shall be met in the presence of out-of-band input signals and also at the reference signal level.

5.6.5 Audio noise level – Signal to noise and distortion

With all other input ports, except the one in use, short-circuited, the reproduced signal to noise and distortion (SINAD) ratio shall be at least 24 dB across the frequency band as defined in 5.6.3 and with input levels in the range of 0 dB to −20 dB relative to the reference signal level for all input ports.

5.7 Communications audio

5.7.1 Input interfaces

The audio connection with the designated VHF equipment shall be in accordance with the requirements of IEC 61097-7. For the purposes of testing, the connection shall be via a plug/socket combination referred to hereafter as the **input port**.

5.7.2 Reference signal

The reference signal level for both transmitted and received communications audio is defined as 0,775 V RMS.

5.7.3 Audio frequency response

With a signal level 6 dB below the reference signal level applied to the VHF radio communications input port of the S-VDR and with its frequency continuously swept at a rate not exceeding 0,1 octaves per second over the range of 150 Hz to 3 500 Hz, the level of the signal recovered from the S-VDR on playback shall not vary by more than 6 dB.

5.7.4 Quality index

The quality of the recording for the VHF radio communications port shall be established and shall not be less than that corresponding to the quality value for the speech transmission index of 0,75 (see IEC 60268-16).

5.7.5 Audio noise level – Signal to no signal

With no signal applied to a VHF radio communications port, the reproduced signal shall be at least 48 dB below the output level produced by an input equal to the reference signal level. This requirement shall be met across the frequency band as defined in 5.7.3 with the input port both open- and short-circuited. The above signal-to-no-signal performance shall be met in the presence of out-of-band input signals and also at the reference signal level.

5.7.6 Audio noise level – Signal to noise and distortion (SINAD)

The reproduced SINAD ratio shall be at least 24 dB across the frequency band as defined in 5.7.3 and with input levels in the range of 0 dB to −20 dB relative to the reference signal level.

5.8 Radar data – Post-display selection

5.8.1 Input interface

5.8.1.1 Source and acquisition

The S-VDR shall be capable of being connected to a buffered video output from the radar display whose image it is to record.

The S-VDR shall record a series of single and complete screen video frames from the dedicated buffered output port of the radar. One complete radar screen video frame shall be acquired at intervals of 15 s or less.

5.8.1.2 Mandatory image input format

The S-VDR shall meet fully the requirements of 6.2.4 with buffered outputs meeting the electrical specifications of VESA DMTS, where that standard refers to display monitors having screen resolutions between 640 × 350 and 1 280 × 1 024 and refresh rates between 60 Hz and 85 Hz.

5.8.1.3 Optional image input format

Optionally the S-VDR may operate with other forms of buffered outputs that have been defined by an individual radar manufacturer. These outputs shall buffer the signals actually used to generate the image screen.

5.8.2 Image outputs

5.8.2.1 Format and resolution

When used with playback equipment specified by the manufacturer, the resolution of the output image shall be equal to, or greater than, the resolution of the image input. The specified playback equipment shall have an output meeting VESA DMTS and a digital output meeting the requirements of 6.2.4.2.

5.8.2.2 Fidelity

The recording shall be subjectively lossless, as determined by the objective tests described in 6.2.4.1 to 6.2.4.6. In addition to those objective tests, the screen display on the playback equipment shall be a subjectively satisfactory facsimile of the original display as determined by the test described in 6.2.4.7.

6 Methods of testing and required test results

6.1 General

6.1.1 Definitions

NOTE For Clause 6 only

6.1.1.1 Equipment under test (EUT)

In this clause, except where specifically stated otherwise, any reference to the equipment under test (EUT) shall be interpreted as comprising all the parts of a shipborne S-VDR configuration including

a) IEC 61162 listener port(s);
b) microphone(s) and associated self-test device;
c) communications audio input(s) unit;
d) radar input unit;
e) control and display unit(s);
f) the final recording medium in its protective capsule;
g) power supply unit(s);
h) all other item(s) declared by the manufacturer; and
i) manufacturer's documentation.

The EUT shall be installed in the test facility using interconnection and input cabling and methods representative of a normal installation, but this material and installation shall not be considered part of the EUT.

6.1.1.2 Standard input data

Except where input data is detailed for individual tests, the following shall be applied for all general performance tests and checks. Test data streams for the audio and radar inputs shall be chosen to exercise the data processing methods. A copy of the data set shall be retained for comparison purposes.

a) Bridge audio – the maximum number of microphones specified by the manufacturer shall be connected to the EUT. Audio signals consisting predominantly of speech at a level of approximately 75 dBA shall be presented to each microphone. A common loudspeaker may be used.

b) Communications audio – the maximum number of communications audio inputs specified by the manufacturer shall be connected to the EUT. Audio signals consisting predominantly of speech at the level specified by the manufacturer shall be presented to each input.

c) Radar data – a test signal shall be presented to the EUT.

d) IEC 61162 data inputs – a representative data signal consisting of a continuous stream of appropriate IEC 61162 sentences shall be applied to each IEC 61162 input port. A timed log shall be kept of the input data to enable comparisons to be made.

6.1.1.3 Full performance test

The recorded data shall be viewed using the playback equipment (see 6.1.2). Sufficient detailed examinations shall be made throughout the specified duration of the recording to ensure that recording was continuous and consistent with the standard input data. Typically, examinations of 30 s duration shall be made on all data channels at intervals of approximately 30 min throughout the duration of the recording.

6.1.1.4 Performance check

An abbreviated qualitative examination shall be made at least once on each data channel at the start of the check and then typically of 30 s duration at intervals of approximately 1 h as appropriate to the individual test.

6.1.2 Playback equipment

The manufacturer shall demonstrate to the satisfaction of the testing authority that the data from the final recording medium can be reproduced following the required tests. The playback equipment is not to be considered as part of the EUT, although the relevant documentation shall be included.

6.1.3 Sequence of tests

Except where specifically stated otherwise, the tests shall all be conducted on a single EUT but may be performed in any sequence agreed between the manufacturer and the test authority.

6.1.4 Requirements to be checked by inspection only

The testing authority shall check, by inspection of the EUT, manufacturing drawings and other relevant documentation to be provided by the manufacturer, compliance with all requirements of Clauses 4 and 5, including those for which no test is specified in this clause. This inspection shall include, but not be limited to, items in the following list. The result of this inspection shall be stated in the test report.

a) Tamper resistance (see 4.3.4.2 and 4.4.2)

Particular reference shall be made to the following:

1) access to any part of the system shall require the use of tools or keys;

2) operation of any controls or keyboard keys, or any combination of these, shall not affect the recording;

3) termination of recording shall only be possible by means of a key or other secure method;

4) recorded data shall be protected against unauthorized access by use of a password.

b) Marking (see 4.3.4.3.2)

c) Location devices (see 4.3.4.3.3, 5.3)

d) Power source (see 4.5.2)

e) Documentation (see 5.5)

6.1.5 Environmental test conditions for normal operation

The special conditions and tests for survival of data after an incident are given in 6.1.13.

The manufacturer shall determine which components of the S-VDR system will be protected or exposed, as defined in IEC 60945.

Prior to and after detailed tests, the equipment shall be subjected to a series of performance checks to demonstrate that it satisfies the relevant requirements of IEC 60945.

It is important to ensure, either by test in the EUT or separately, that the battery of the dedicated reserve power source meets the requirements of 4.5.3 and 6.1.7 at the extreme operating temperatures specified in IEC 60945.

6.1.5.1 Additional performance tests and checks for the float free capsule

(See 4.3.1.)

a) In addition to the tests required by IEC 60945, it shall be verified that the recorded data is not corrupted or destroyed by the transmission of locating and homing signals. For this purpose, the EUT shall be set into the transmission mode for a 12 h period (in a suitable arrangement, in order not to alert SAR facilities) while it holds stored data.

   In the case of a combined EPIRB/S-VDR capsule, the transmission mode shall also be activated while the capsule is recording data.

b) In addition to the performance tests and checks as required by the relevant testing standard IEC 61097-2, the tests and checks according to 6.1.1.3 and 6.1.1.4 shall be performed.

6.1.6 Recording duration

(See 4.5.4.)

6.1.6.1 Test method

The equipment shall operate continuously using normal external electrical power, recording test signals specified in 6.1.1.2 for a duration in excess of 12 h.

6.1.6.2 Required results

By a series of performance checks recording shall be demonstrated to be continuous in compliance with the requirements of the appropriate subclauses of 4.5.

6.1.7 Alternative power source

6.1.7.1 Test method

Whilst operating using normal external electrical power and recording test signals as specified in 6.1.1.2, the power shall be removed for a period in excess of 2 h. The normal external electrical power shall then be restored for a period of 10 min and the test then terminated.

6.1.7.2 Required result

A suitable alarm shall be generated when the normal external electrical power is removed. To conserve battery power, it shall be muted automatically after 2 min, if it has not been acknowledged in that period.

The EUT shall continue to operate from its reserve source of power for 2 h and shall then terminate automatically in accordance with 4.5.3.

After normal external electrical power has been restored, it shall be demonstrated by performance checks that

a) the S-VDR resumes normal operation;

b) 9 h 50 min of recording prior to power interruption has been retained, followed by 2 h of recording of bridge audio, followed by 10 min of normal recording.

6.1.8 Recharging of reserve source of power

(See 4.5.3.)

6.1.8.1 Test method

On completion of the test of 6.1.7, normal external electrical power supply shall be maintained for a continuous period of 10 h. Test 6.1.7 shall then be repeated.

6.1.8.2 Required results

It shall be demonstrated that the reserve source of power was recharged sufficiently to operate the equipment for 2 h, as specified in 6.1.7.2.

6.1.9 Brief interruption of electrical power

(See 4.5.2/4.5.3.)

6.1.9.1 Test method

The test of 6.1.7.1 shall be repeated, but normal external electrical power shall be restored after a period of 3 min instead of 2 h.

6.1.9.2 Required results

The alarm behaviour of 6.1.7.2 shall occur. After normal external electrical power has been restored it shall then be demonstrated by performance checks that

a) the S-VDR resumes normal operation within 1 min after normal restoration of power;

b) at least 11 h 45 min of recording prior to the power interruption has been retained;

c) recording of bridge audio continued during the power interruption.

6.1.10 System integrity

(See 4.4.3.)

For each of the following it shall be demonstrated that a suitable alarm is activated.

a) Power supply

Whilst operating using normal external electrical power, this power shall be removed.

NOTE This test is included in the tests of 6.1.7, 6.1.8 and 6.1.9.

b) Record function, bit error rate

The manufacturer shall demonstrate that if the test data signals (radar, audio and data) are not being correctly recorded on the final recording medium, a suitable alarm is activated. The bit error rate for digital signals shall not exceed 1 in 10^8.

NOTE To avoid the need to create an actual fault condition in the EUT, it is acceptable for this to be checked by examination of documentation.

c) Microphone functionality

The manufacturer shall demonstrate that at least once every 12 h there is an unobtrusive acoustic test of all microphones.

6.1.11 Maintenance of sequential records

(See 4.3.2.)

The manufacturer shall demonstrate that the S-VDR maintains sequential records as required by 4.3.2.

6.1.12 Co-relation in date and time

(See 4.3.3/5.1.)

6.1.12.1 Test method

The S-VDR shall record the test data set of 6.1.1.2 for a period of 30 min. This recorded data shall be replayed.

6.1.12.2 Required result

The time indices of the replayed data shall meet the requirements of 4.3.3 and 5.1.

6.1.13 Design and construction of the protective capsule

(See 4.3.1, 4.3.4, 5.2, 5.4.)

6.1.13.1 Definition of EUT for 6.1.13

For these tests only, any reference to “the EUT” shall mean

a) the protective capsule, complete with all internal fittings;

b) the final recording medium, as normally installed inside the capsule;

c) any power supply units or batteries that normally form part of the capsule contents;

d) all mounting hardware and release mechanism(s), including the automatic release mechanism in the case of a float-free design;

e) in case of a fixed capsule: the acoustic beacon or a mechanically equivalent dummy;

f) in case of a float-free capsule: the locating devices;

g) the normal electrical cable(s) or other means through which data and power is transferred between the main units of the VDR and the final recording medium during normal operation.

6.1.13.2 Test data to be pre-loaded into the final recording medium

Test data signals as specified in 6.1.1.2 shall be recorded for 12 h.

6.1.13.3 Tests and test sequence

6.1.13.3.1 Tests and test sequence for the fixed capsule

The EUT shall be subjected to the tests according to 6.1.13.4, 6.1.13.5 and 6.1.13.7, in the order listed below:

a) shock;

b) low-temperature fire test;

c) high-temperature fire test;

d) deep-sea immersion.

These tests shall be normally carried out on a single EUT. If more than one EUT is used, the following sequences are acceptable:

If two EUTs are used, the sequence of tests shall be:

a) on one unit and b), c) and d) on the other, or

a) b) and d) on one unit and a), c) and d) on the other.

If three EUTs are used, the sequence of tests shall be:

a) on one unit, b) and d) on the second unit, and c) and d) on the third unit.

The deep-sea immersion test can be carried out on the recording medium itself if it can be shown that the recording medium cannot be damaged as a consequence of collapse of the protective capsule.

6.1.13.3.2 Tests and test sequence for the float-free capsule

The EUT shall be subjected to the tests according to IEC 61097-2, followed by 6.1.13.11, and in any order, 6.1.13.6 and 6.1.13.10.

6.1.13.4 Shock

(See 5.4.2.1a).)

NOTE This test is only relevant for the fixed protective capsule.

The EUT shall be secured to the test rig in accordance with the manufacturer's normal installation instructions.

It shall then be subjected to the test requirements of Clause 11 of IEC 60068-2-27, with the following parameters:

a) pulse shape – half sine;
b) tolerances – as Figure 2 of Clause 11;
c) velocity change special case – not applicable;
d) transverse motion – not applicable;
e) method of mounting – fastened to the testing machine or table using the normal shipboard installation mounting arrangements specified by the manufacturer;
f) peak acceleration – 50g, duration of the nominal pulse 11 ms;
g) pre conditioning – nil;
h) initial measurements (see 6.1.3);
i) direction and number of shocks – standard;
j) survive the conditions of shock;
k) acceptance and rejection criteria;
l) not applicable;
m) not applicable; and
n) not applicable.

6.1.13.5 Fire

(See 5.4.2.1c).)

NOTE This test is only relevant for the fixed protective capsule.

The protective capsule shall be subjected to a low-temperature fire test for 10 h at 260º C and a high-temperature test of 1 h at 1 100º C to the requirements of ED56A, amendment 1.

NOTE If an actual acoustic beacon is used during the test, caution should be exercised due to possible explosion of the battery.

6.1.13.6 Shallow sea-water immersion

(See 5.4.2.2.)

This test is to be performed according to 6.1.5.1 and is applicable only to capsules designed to float free.

The float-free release mechanism shall be tested for compliance with the appropriate requirements of IMO A.662(16). It shall be demonstrated that the float-free mechanism is inhibited if the fire exceeds the fire survivability of the radio transmission device as in 4.3.4.3.1.

6.1.13.7 Deep-sea immersion

(See 5.4.2.1d.)

NOTE This test is only required for the fixed capsule.

The protective capsule shall be subjected to the requirements of 5.3.2f of ED56A. Both the 6 000 m 24-hour test described in paragraph 1 and the 3 m 30-day test described in paragraph 2 shall be carried out.

6.1.13.8 Required results

The required results for 6.1.13.4, 6.1.13.5, 6.1.13.6, 6.1.13.7, and 6.1.13.11 are as follows.

After completion of the test sequences, all the release mechanisms shall function according to the appropriate specifications.

After completion of the tests, the stored data shall be retrieved following the manufacturer's instructions, which may include error correcting. Repairs to the final recording medium shall be minimal. Thermal, mechanical or corrosive damage to the recording medium incurred during the test that results in corruption or loss of data, shall constitute a failure. For the purposes of playback, the final recording medium may be removed from the EUT and installed into standard replay equipment as supplied by the recorder manufacturer. Recordings shall meet the requirements of the performance test specification as set out in 6.1.1.3 with at least 99 % of the data being recoverable.

The underwater locator beacon need not survive the fire tests.

6.1.13.9 Aid(s) to location

(See 5.3.)

The acoustic beacon shall be tested for compliance with SAE AS 8045.

If the capsule is designed for float-free operation, the radio transmitter and light shall be tested for compliance to the appropriate parts of IEC 61097-2 and IMO MSC.81(70), but with a required duration of 7 days or as specified in 5.3.2.5.

6.1.13.10 Means to facilitate grappling and recovery

(See 4.3.4.1.2b.)

The float-free capsule shall be checked visually for means to facilitate grappling and recovery. Check that the design of the means to facilitate grappling and recovery does not increase the risk of fouling during release, and that the documentation contains appropriate installation instructions.

6.1.13.11 Data integrity under float-free operation

(See 5.4.2.2.)

The float-free capsule shall be tested to verify that the data stored up to the moment of releasing the capsule is not corrupted by the deployment of the capsule or by the transmission of locating and homing signals.

a) Performance checks shall be performed on the capsule after being released under different deployment scenarios, including
   - having been manually released after manually set to the transmission mode;
   - having been manually released without being set to the transmission mode;
   - automatic release;
   - with different sequences of disconnecting data and power inputs, if relevant.

   These checks may be combined with the tests required according to IEC 61097-2.

b) The EUT, with a full set of data stored, shall be set into the test transmission mode (in a suitable arrangement in order not to alert SAR facilities, and not floating in water, in order to represent the worst-case condition). The beacon transmissions shall be maintained for a duration of 7 days.

6.1.14 Selection of data items

(See 4.4.1.)

The manufacturer shall demonstrate that the configuration data specified in 4.4.1 can be entered, maintained and retrieved.

6.1.15 Power source

(See 4.5.2.)

It shall be confirmed that the S-VDR operates at all times when electrical power is applied.

6.2 Data items to be recorded

(See 4.6.)

6.2.1 Date/time, ship's position, speed and heading

(See 4.6.1/4.6.2/4.6.3/4.6.4:)

6.2.1.1 Test method

The test method and result required are the same for these four parameters.

Present the date/time, ship's position, speed and heading data, one at a time, conforming to the format specified in 4.3.6 to the port designated for the relevant parameter. The data shall be presented at a rate greater than once per second and changed at a rate less than once per second. Record the data for 30 min. Replay the data.

6.2.1.2 Result required

All the changed data shall be accurately reproduced at a rate of at least once per second.

6.2.2 Bridge audio

(See 4.6.5.)

6.2.2.1 Audio frequency response for bridge audio

(See 5.6.3.)

6.2.2.1.1 Test method

The following test equipment is required:

a) sweep frequency audio signal generator;

b) audio power meter;

c) frequency counter.

With all other area microphone port inputs short-circuited, connect the audio signal generator to the port under test and adjust its output to obtain a signal capable of continuously sweeping over the frequency range. Adjust the sweep frequency rate to 0,1 octave per second. Set the level to 6 dB below the reference signal level at the equipment input. Record this signal.

Replay the recording and measure the output level and frequency. Determine the level variation over the frequency band. Repeat for all other area microphone ports.

Repeat the tests with the input set at 45 dB below the reference level.

6.2.2.1.2 Result required

The test results shall meet the requirements of 5.6.3.

6.2.2.2 Quality index for bridge audio

(See 5.6.4.)

6.2.2.2.1 Single port

(See 5.6.4.1.)

6.2.2.2.1.1 Test method

The following test equipment is required:

a) STI signal generator;

b) STI analyser;

c) white noise generator;

d) audio band-pass filter (150 Hz to 6 000 Hz).

With all other area microphone port inputs short-circuited, connect the signal generator to the port under test. Adjust the signal generator to a level equivalent to 75 dBA. Record the signal.

Replay the recording and analyse the STI. Repeat for all other area microphone ports.

6.2.2.2.1.2 Result required

The test results shall meet the requirements of 5.6.4.1.

6.2.2.2.2 Multiple ports

(See 5.6.4.2.)

6.2.2.2.2.1 Test method

With all other area microphone ports having an electrical input equivalent to 65 dBA of band limited white noise, connect the signal generator to the port under test. Adjust the signal generator to level equivalent to 75 dBA. Record the signal.

Replay the recording and analyse the result. Repeat for all other area microphone ports.

6.2.2.2.2.2 Result required

The test results shall meet the requirements of 5.6.4.2.

6.2.2.3 Audio noise level – Signal to no signal for bridge audio

(See 5.6.4.3.)

6.2.2.3.1 Test method

The following test equipment is required:

a) audio signal generator;
b) A-weighted filter to IEC 60651;
c) third octave filters to IEC 61260; and
d) audio power meter.

With all other area microphone port inputs short-circuited, connect the audio signal generator to the port under test. Record the signal.

Operate the recorder for 30 s for each of the following five input conditions, open, shorted, and with three separate out-of-band signals applied. For the out-of-band tests, connect the signal generator to each port under test and set the input signal to the reference signal level. Select, in turn, frequencies of 8 kHz, 10 kHz and 12,5 kHz. Replay the recordings measuring the A-weighted noise level in the third octave bands. Table 1 is an example for entering this data. Enter the noise level in the third octave bands as a ratio relative to the output for the reference signal input, expressed in dB. Record the lowest value in the last row of the table. Repeat the test for the other area microphone ports.

6.2.2.3.2 Result required

The test results shall meet the requirements of 5.6.4.3.

Table 1 – Bridge audio, signal-to-noise measurements

Reference level:_____

Centre frequency of third octave band Hz	Output A-weighted level relative to reference level dB				
			Out of band at reference level		
	Open	Shorted	8 000 Hz	10 000 Hz	12 500 Hz
250					
315					
400					
500					
630					
800					
1 000					
1 250					
1 600					
2 000					
2 500					
3 150					
4 000					
5 000					
Minimum signal-to-no-signal ratio =					

6.2.2.4 Audio noise level – Signal to noise and distortion for bridge audio

(See 5.6.5.)

6.2.2.4.1 Test method

The following test equipment is required:

a) attenuator;

b) band-pass filter;

c) distortion meter.

With the other area microphone ports short-circuited, connect the port under test via an attenuator to the signal source of the distortion meter and record signals at third octave intervals over the band varying the level from the reference level to −20 dB in 5 dB steps recording the signal at each step. Replay the recordings and measure the total harmonic distortion plus noise for each test condition. Table 2 is an example for entering this data. Optionally, the measurement may be made after passing the replayed signal through a band-

pass filter of 150 Hz to 6 000 Hz. Enter the distortion plus noise as a power ratio, expressed in dB. Record the lowest value in the last row of the table. Repeat the test for the other area microphone port.

6.2.2.4.2 Result required

The test results shall meet the requirements of 5.6.5.

Table 2 – Bridge audio, signal to noise and distortion (SINAD) measurements

Reference level: _____

Frequency Hz	Input relative to reference level				
	0 dB	−5 dB	−10 dB	−15 dB	−20 dB
150					
200					
250					
315					
400					
500					
630					
800					
1 000					
1 250					
1 600					
2 000					
2 500					
3 150					
4 000					
5 000					
Minimum signal-to-noise and distortion ratio =					

6.2.3 Communications audio

6.2.3.1 Audio frequency response for communications audio

(See 5.7.3.)

6.2.3.1.1 Test method

The following test equipment is required:

a) sweep frequency audio signal generator;

b) audio power meter;

c) frequency counter.

Connect the audio signal generator to the port under test and adjust its output to obtain a signal which continuously sweeps over the frequency range. Adjust the sweep frequency rate to 0,1 octave per second. Set the level to 6 dB below the reference signal level at the equipment input. Record this signal.

Replay the recording and measure the output level and frequency. Determine the level variation over the frequency band.

6.2.3.1.2 Result required

The test results shall meet the requirements of 5.7.3.

6.2.3.2 Quality index for communications audio

(See 5.7.4.)

6.2.3.2.1 Test method

The following test equipment is required:

a) STI signal generator;

b) STI analyser.

Connect the STI signal generator to the port under test. Adjust the STI signal generator to a level 6 dB below the reference level. Record the signal.

Replay the recording and analyse the STI.

6.2.3.2.2 Result required

The test results shall meet the requirements of 5.7.4.

6.2.3.3 Audio noise level – Signal to no signal for the communications audio

(See 5.7.5.)

6.2.3.3.1 Test method

The following test equipment is required:

a) audio signal generator;

b) A-weighted filter to IEC 60651;

c) third octave filters to IEC 61260;

d) audio power meter.

Connect the audio signal generator to the port under test. Record the signal. Operate the recorder for 30 s for each of the following five input conditions: open, shorted, and with three separate out-of-band signals applied. For the out-of-band tests, connect the signal generator to each port under test and set the input signal to the reference signal level. Select, in turn, frequencies of 5 kHz, 6,3 kHz and 8 kHz. Replay the recordings measuring the A-weighted noise level in the third octave bands. Table 3 is an example for entering this data. Enter the noise level in the third octave bands as a ratio relative to the output for the reference signal input, expressed in dB. Record the lowest value in the last row of the table.

6.2.3.3.2 Result required

The test results shall meet the requirements of 5.7.5.

Table 3 – Communications audio, signal-to-no-signal measurements

Reference level: _____

Centre frequency of third octave band	Output A-weighted level relative to reference level dB				
			Out of band at reference level		
Hz	Open	Shorted	5 000 Hz	6 300 Hz	8 000 Hz
200					
250					
315					
400					
500					
630					
800					
1 000					
1 250					
1 600					
2 000					
2 500					
3 150					
Minimum signal-to-no-signal ratio =					

6.2.3.4 Audio noise level-signal to noise and distortion for communications audio

(See 5.7.6.)

6.2.3.4.1 Test method

The following test equipment is required:

a) attenuator;

b) band-pass filter;

c) distortion meter.

Connect the port under test via an attenuator to the signal source of the distortion meter and record signals at third octave intervals over the band varying the level from the reference level to −20 dB in 5 dB steps recording the signal at each step. Replay the recordings and measure total harmonic distortion plus noise for each test condition. Table 4 is an example for entering this data. Optionally, the measurement may be made after passing the replayed signal through a band-pass filter of 150 Hz to 3 500 Hz. Enter the distortion plus noise as a power ratio, expressed in dB. Record the lowest value in the last row of the table.

6.2.3.4.2 Result required

The test results shall meet the requirements of 5.7.6.

Table 4 – Communications audio, signal-to-noise and distortion (SINAD) measurements

Reference level: _____

Frequency Hz	Input relative to reference level				
	0 dB	−5 dB	−10 dB	−15 dB	−20 dB
150					
200					
250					
315					
400					
500					
630					
800					
1 000					
1 250					
1 600					
2 000					
2 500					
3 500					
Minimum signal-to-noise and distortion ratio =					

6.2.4 Radar data, post-display selection

(A.861/5.4.7)

(See 4.6.7/5.8.)

6.2.4.1 Test objective

The tests outlined in 6.2.4 determine that the S-VDR meets the functional requirements of 4.6.7. They measure errors between input images, generated from a pre-determined test data set, and the output of a S-VDR that has recorded them. Recognizing that, with currently available 'final storage media', the S-VDR must first acquire and digitize an image before it can store it, two different categories of errors are considered:

a) colour errors, where a feature is rendered in a different colour or brightness on the input image compared to the output image; and

b) positional errors, where an image feature is in a different position on the input image compared to the output image.

With regard to colour, the general aim is to permit only those errors that, ideally, a human observer would not notice and which, necessarily, could not introduce ambiguity.

With regard to position, small scaling errors are permitted if the linearity is good: for example, a small overall increase in the size of the image is acceptable, but a scaling of similar magnitude which varies over the image is not. For this reason, a linearity measure is applied in various ways to assess the acceptability of the errors that occur.

The definitions below are for the purposes only of 6.2.4.2 to 6.2.4.6 inclusive.

colour
triple of real values (r,g,b) specifying amounts of red, green and blue respectively, where $0 \le r \le 1$, $0 \le g \le 1$ and $0 \le b \le 1$. As such, 'colour' includes both hue and intensity

image
function which defines a colour for each value of a pair of real numbers (x,y) representing Cartesian co-ordinates, where $0 \le x \le 1$ and $0 \le y \le 1$

pixel
rectangular region of an image where the colour of the image is constant. The region is defined by two pairs (x_0,y_0) and (x_1,y_1) representing the Cartesian co-ordinates of diagonally opposite corners of the rectangle. The sides of the rectangle shall be parallel to the Cartesian axes and $x_0 < x_1$ and $y_0 < y_1$

input image
one of a number of pre-determined test images (see 6.2.4.4). The test images are defined mathematically and are made up of a grid of pixels of various colours

input image resolution
integers X and Y that represent respectively the numbers of pixels on the x and y co-ordinates of the input image(s) with which the S-VDR manufacturer declares the S-VDR will operate

output image
image that is produced by the playback equipment when a recording of the original image is played back

bit-mapped image
image composed entirely of pixels and for each pixel, the products Xx_0, Yy_0, Xx_1 and Yy_1 are integers.

6.2.4.2 The principles of the test

The manufacturer shall declare at what X,Y resolutions of input images, specified in 5.8.1.2 and with which optional inputs, permitted by 5.8.1.3, the S-VDR is designed to operate. All

the test equipment shall operate at sufficiently high resolutions. The EUT is connected as shown in Figure 1.

A test data set (A), representing a pre-determined, bit-mapped, test image is loaded into the input image store (B). That store is then read via an interface that includes a digital-to-analogue converter (C) that, in turn, provides two mandatory output signals and one optional one.

Signals (S1) and (S2) are identical.

Signal (S1) shall meet the VESA DMTS and drives a monitor (D) that has been approved to the same standard.

Signal (S2) provides the input image to the EUT (E) and shall satisfy the requirements of 5.8.1.2.

Signal (S3) is any signal, optionally chosen by the S-VDR manufacturer, in accordance with 5.8.1.3, as an input to the EUT (E).

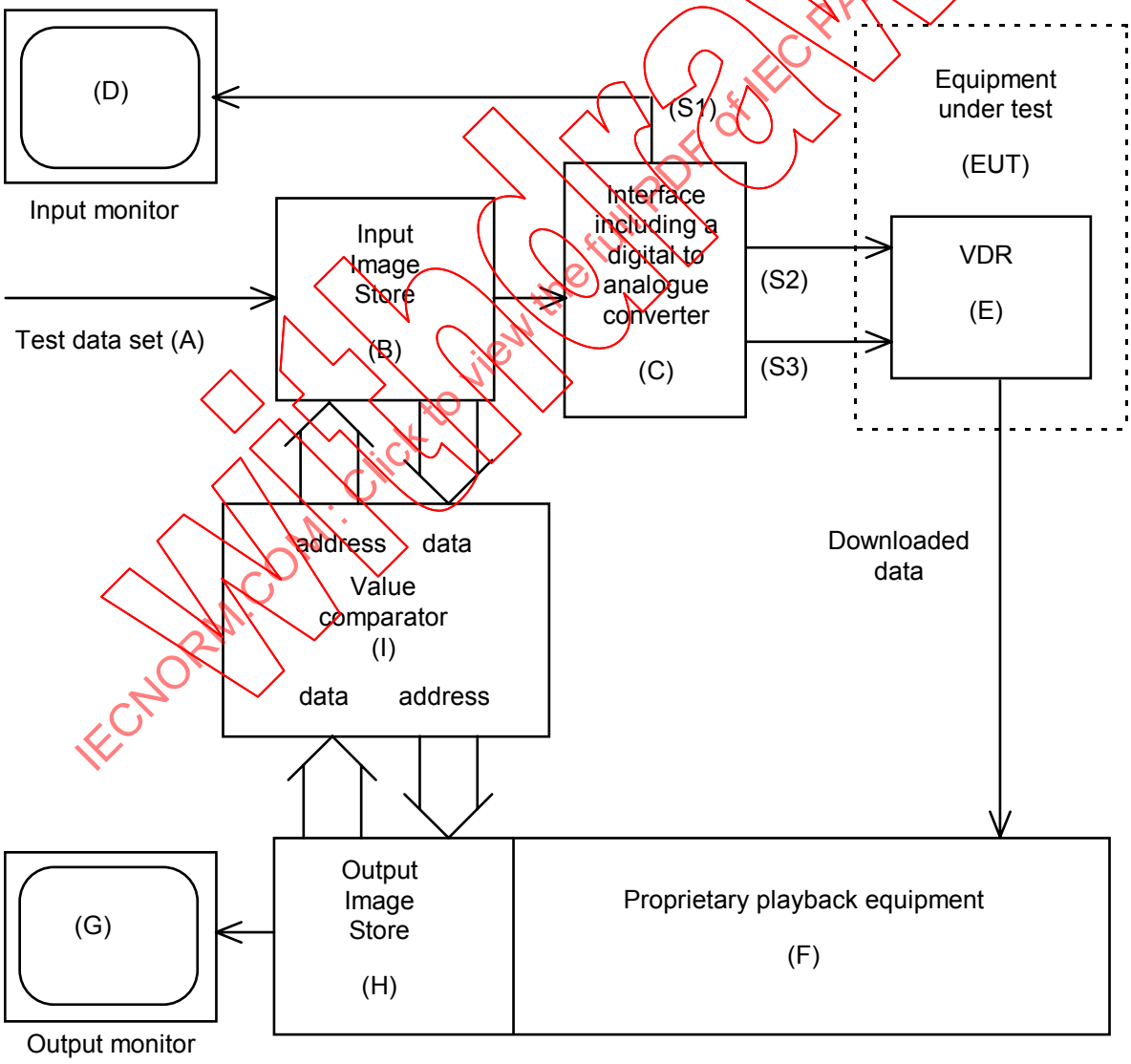

Figure 1 – Test set-up block diagram

During the test, the detailed timings of the video signals shall be varied within the limits allowed by the DMTS and by the additional limits required by 5.8.1.2. Where a S-VDR manufacturer additionally opts to connect to an input image permitted by 5.8.1.3, the timings shall be varied within the limits specified by the radar manufacturer.

The data stored in the final recording medium that relates to the recorded image shall be recovered by a means specified or supplied by the manufacturer as required by 4.3.4.2 and provided as an input to a playback equipment (F) that is also specified or supplied by the manufacturer. That playback equipment shall have two outputs. The first is a video signal meeting the DMTS that is connected to a monitor (G): the second is the digital data from an externally addressed output image store (H) which may be virtual or real.

The essence of the test is that the value comparator (I) obtains the red, green and blue values of some pixel, at an integer address $xX,yY,$ from the input image store (B), and requests the value from output image store (H) for the same address. This is done for every pixel in the input image store.

The contents of the two image stores are divided into small rectangles that are compared individually. The positions of corresponding rectangles in the two images can be shifted slightly relative to one another before comparison to allow for a certain amount of alignment error in the recorded images. The amount of shift is permitted to vary slightly over the image to allow for various non-linearities. Any shift shall be of the whole rectangle and of every address, corresponding to an input image pixel that it contains. Linearity is assessed separately in the x and y directions by considering individually the rows and columns of rectangles.

6.2.4.3 Comparison of images

NOTE Reference should be made to Figure 2.

Errors in colour and position are determined separately: both are defined in terms of differences between the input digital image store (B) and the output digital image store (H). For analytical convenience and to make the test method independent of image resolution, pixel co-ordinates and the amplitudes of the analogue signals representing the values of red (r), green (g) and blue (b) signals are normalized prior to comparison by dividing their actual value by their maximum one.

For example, $r = r_{\text{actual}} / R,\ 0 \le r_{\text{actual}} \le R,\ x = x_{\text{actual}} / X,\ 0 \le x_{\text{actual}} \le X$ etc

All of the tests described in 6.2.4.4 and 6.2.4.5 shall be passed for each of the images in the test set defined in 6.2.4.2.

The x and y axes of the input image are each divided into integer n equal parts, where n = 8.

NOTE To assist comprehension, reference is made in the following text to variable n, although its value is fixed at 8.

Thus the whole image is divided into n^2 rectangles indexed by two integer variables j and k, where $0 \le j \le n - 1$ and $0 \le k \le n - 1$. Rectangle (j,k) has diagonally opposite corners at co-ordinates $(j/n,k/n)$ and $((j + 1)/n,(k + 1)/n)$, and has its edges parallel to the Cartesian axes.

For each rectangle (j,k) a corresponding and equally sized rectangle is chosen in the output image, as specified by the manufacturer. That rectangle has its diagonally opposite corners at real co-ordinates $(p_{jk}/n,q_{jk}/n)$ and $((p_{jk} + 1)/n,(q_{jk} + 1)/n)$, where $0 \le p_{jk} \le n - 1$ and $0 \le q_{jk} \le n - 1$: its edges are parallel to the Cartesian axes. The correspondence between rectangles in the input and output images may be chosen afresh for each rectangle but shall remain constant for each test image. Figure 2 illustrates four of the 64 rectangles, with indicative displacements of the output, for the case when X = 1 280 and Y = 1 024.

6.2.4.4 Pre-determined test images

There are three test images that are specifically designed to work with the test method 6.2.4.3 so as to allow it to satisfy the test objective 6.2.4.1. As such, they are not suitable for use as part of any other test within this specification.

It is required that all of the tests of 6.2.4.4 and 6.2.4.5 shall be passed on test images 1, 2, and on at least three examples of test image 3.

6.2.4.4.1 Test image 1

This shall consist of overlaid horizontal and vertical bands of red ($r = 1, g = 0, b = 0$), green ($r = 0, g = 1, b = 0,$), blue ($r = 0, g = 0, b = 1,$) and black ($r = 0, g = 0, b = 0$). The colours of the bands shall be a repeating sequence of red, fixed-width black, green, fixed-width black, blue and variable-width black. The intersections between the horizontal and vertical bands shall comply with Table 5.

Table 5 – Intersection colours of test images 1 and 2

	Vertical			
Horizontal	**red**	**green**	**blue**	**black**
red	red	green	blue	red
green	red	green	blue	green
blue	red	green	blue	blue
black	red	green	blue	black

The red, green, blue and fixed-width black bands shall be one pixel wide and the variable-width black bands shall have widths that change over the image.

The widths of the vertical variable-width black bands shall be the smallest integer that is greater than the value of the expression $0{,}5 + |\sin(2\pi x/X) \bullet X/20|$ where x is the x co-ordinate of the leftmost edge of the band. The widths of the horizontal variable-width black bands shall be the smallest integer that is greater than the value of the expression $0{,}5 + |\sin(2\pi y/Y) \bullet Y/15|$ where y is the y co-ordinate of the topmost edge of the band.

6.2.4.4.2 Test image 2

This shall be identical to test image 1 except that the expressions for the widths of the vertical and horizontal variable-width black bands shall be:

$0{,}5 + |\cos(2\pi x/X) \bullet X/20|$ and $0{,}5 + |\cos(2\pi y/Y) \bullet Y/15|$ respectively.

6.2.4.4.3 Test image 3

This shall consist of a palettized, pseudo-random collection of pixels having various colours. Each image shall be generated by the following algorithm.

a) Pseudo-randomly select a value for I such that I is a real number on the interval $-1/8 \leq I < 1/8$

b) For each of the variables ρ, γ and β pseudo-randomly allocate one of the probabilities 0,78, 0,16, 0,04 and 0,02 to each of the numbers $1/8$, $3/8$, $5/8$ and $7/8$

c) For each pixel in the image, pseudo-randomly select a value for each of ρ, γ and β, with the allocated probabilities, from the numbers $1/8$, $3/8$, $5/8$ and $7/8$.

d) For each pixel set $r = I + \rho$, $g = I + \gamma$ and $b = I + \beta$.

6.2.4.5 Colour errors

6.2.4.5.1 Test method

For every pair *(i)* of input and output pixels, within each input and output rectangle that each contain (α) such pixels, the colour error ($C\varepsilon_i$) is represented as:

$$C\varepsilon_i = \left[u\left(r_{(\text{in})i} - r_{(\text{out})i}\right)^2 + v\left(g_{(\text{in})i} - g_{(\text{out})i}\right)^2 + w\left(b_{(\text{in})i} - b_{(\text{out})i}\right)^2\right]^{1/2}$$

where u = 0,089401, v = 0,344569 and w = 0,012996, being the squares of the ITU weightings for converting RGB values to luminance values.

The colour test metric (TM_c) is then: $TM_c = \alpha^{-1}\sum_{i=1}^{\alpha} C\varepsilon_i$

6.2.4.5.2 Result required

It is required that $TM_c \leq 0{,}05$ for each of the n^2 rectangles in the image.

6.2.4.6 Positional errors

For each of the n^2 rectangles of the input test image having their corners at j,k, there will be a corresponding output rectangle, whose bottom left-hand corner is at p_{jk},q_{jk}, that was specified by the manufacturer. It will probably be, but not necessarily, the output rectangle that gave the smallest value of Tm_c. It shall be that which passed the tests of 6.2.4.5.

All positional errors are functions of some of the variables j, k, p_{jk} and q_{jk}. The test technique is to consider the pairs of data points j,p_{jk} and k,q_{jk} where, for each of the n values of k, there are n sets of j,p_{jk} and, for each of the n values of j, there are n sets of k,q_{jk}.

The j,p_{jk} set defines any horizontal position errors and the k,q_{jk} set defines any vertical position errors.

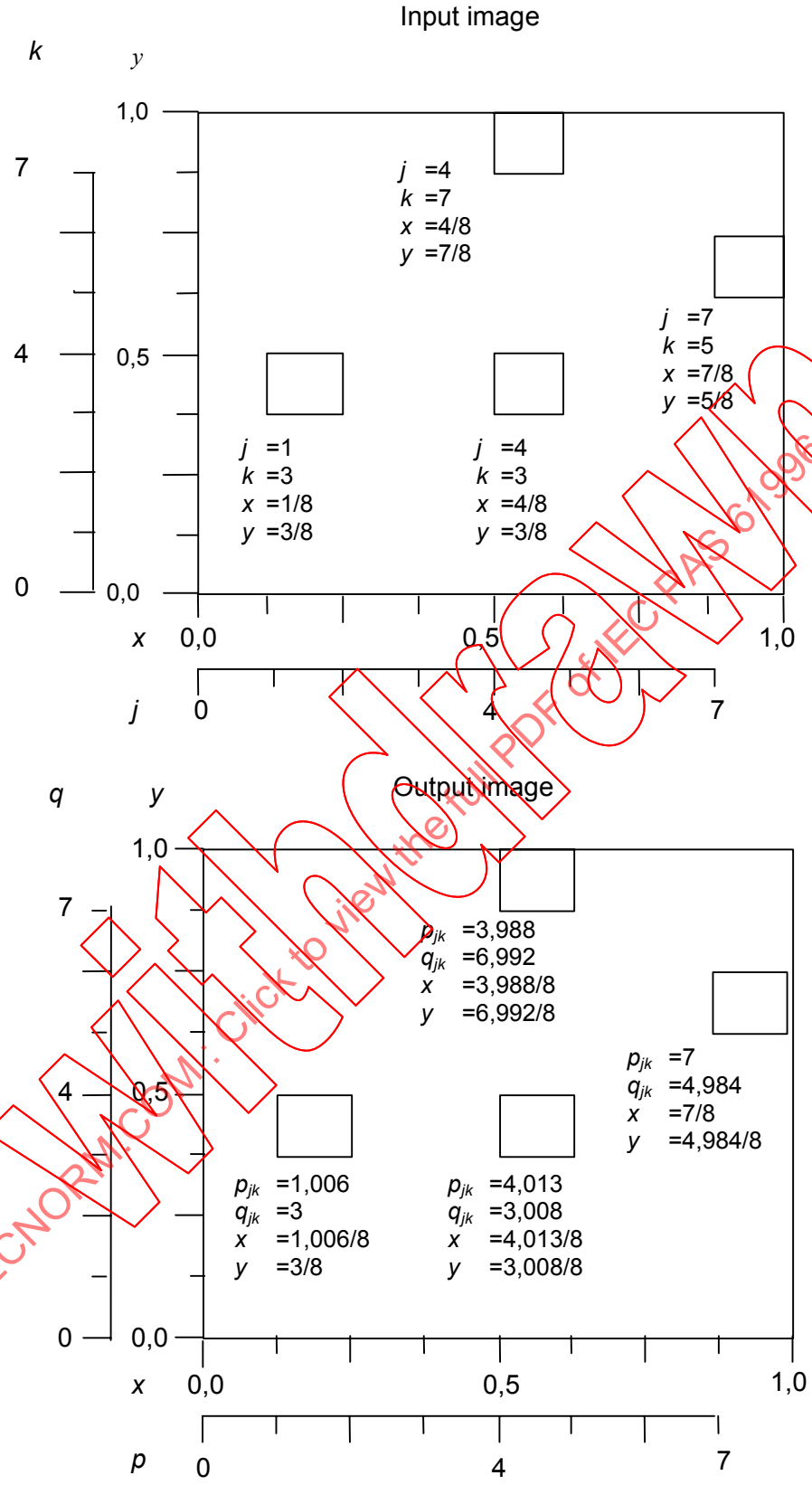

Figure 2 – Comparison of images

6.2.4.6.1 Horizontal position errors

6.2.4.6.1.1 Test method

For each of the n values of k, there will a row of rectangles on the input image each of whose left-hand edges are defined by the n possible values of j. For convenience and consistency of notation, *set* $i = j$, $x = j/n$ and $y = p_{jk}/n$.

If there are no positional errors then $y_i = x_i$ for all i, in terms of a linear equation $y_i = mx + c$, where $m = 1$ and $c = 0$. That will not be the case if there are horizontal positional errors. In that case there will be a best-fit line, of form $y = mx + c$, that has some of the data points lying off the line. The test technique is to set limits on the values of m and c (to limit linear offsets and scalings) and also on the amount by which data points can be displaced from the line (to limit non-linearities).

The possible errors are that the image can be scaled by some constant ($m \neq 1$), offset by some constant ($c \neq 0$) or displaced by different amounts at different parts of the image.

Where $y = mx + \mathrm{c}$ is the best-fit line, there will be n values of y_i that have a horizontal error:

$$X\varepsilon_i = \left| mx_i + c - x_i \right|$$

The X linearity test metric TM_x is the mean value of all $X\varepsilon_i$ where $0 \leq i = j \leq n - 1$

$$TM_x = n^{-1} \sum_{i=0}^{n-1} X\varepsilon_i$$

6.2.4.6.1.2 Required result

It is required that $0{,}99 \leq m + c \leq 1{,}01$ and that $-0{,}01 \leq c \leq 0{,}01$ for each of the n rows of rectangles indexed by k.

It is required that $TM_x \leq 0{,}002$ for each of the n rows of rectangles indexed by k.

In addition, because it would be undesirable to have any discontinuities within the image, it is required that $\left| (mx_i + c - y_i) - (mx_{i+1} + c - y_{i+1}) \right| \leq 0{,}005$ for all values of i, $0 \leq i = j \leq n - 2$.

NOTE For clarity the discontinuity expression is not simplified.

6.2.4.6.2 Vertical position errors

6.2.4.6.2.1 Test method

For each of the n values of j, there will be a row of rectangles on the input image each of whose bottom edges are defined by the n possible values of k. For convenience and consistency of notation, set $i = k$, $x = k/n$ and $y = q_{jk}/n$.

Hereafter, the analysis and method of test is the same as that used for horizontal errors.

If there are no positional errors then $y_i = x_i$ for all i, in terms of a linear equation $y_i = mx + c$, where $m = 1$ and $c = 0$. That will not be the case if there are vertical positional errors. In that case there will be a best-fit line, of form $y = mx + c$, that has some of the data points lying off the line. The test technique is to set limits on the values of m and c (to limit linear offsets and scalings) and also on the amount by which data points can displaced from the line (to limit non-linearities).

The possible errors are that the image can be scaled by some constant $(m \neq 1)$, offset by some constant $(c \neq 0)$ or displaced by different amounts at different parts of the image $(m_i \neq m_{i+1}$ or $c_i \neq c_{i+1}$ for all $i)$.

Where $y = mx + c$ is the best-fit line, there will be n values of y_i that have a vertical error;

$$Y\varepsilon_i = \left| mx_i + c - y_i \right|$$

The Y linearity test metric TM_y is the mean value of all $Y\varepsilon_i$ where $0 \leq i = k \leq n - 1$.

$$TM_y = n^{-1} \sum_{i=0}^{n-1} Y\varepsilon_i$$

6.2.4.6.2.2 Required result

It is required that $0{,}99 \leq m + c \leq 1{,}01$ and that $-0{,}01 \leq c \leq 0{,}01$ for each of the n columns of rectangles indexed by j.

It is required that $TM_y \leq 0{,}002$ for each of the n columns of rectangles indexed by j.

In addition, because it would be undesirable to have any discontinuities within the image, it is required that $\left| (mx_i + c - y_i) - (mx_{i+1} + c - y_{i+1}) \right| \leq 0{,}005$ for all values of i, $0 \leq i = k \leq n - 2$

NOTE For clarity, the discontinuity expression is not simplified.

6.2.4.7 Subjective evaluation

6.2.4.7.1 Test method

A series of images, from a radar complying with any part of the IEC 60936 series, and consistent with 4.6.7, including ones having small groups of isolated pixels, shall be recorded. These shall be played back alongside the original images. A competent person shall be called upon to compare the original and the recorded images.

6.2.4.7.2 Result required

It is required that, in the professional opinion of the competent person, the original and the recorded images are identical with regard to all operational respects.

6.2.5 AIS

(See 4.6.)

6.2.5.1 Test method

Present the AIS IEC 61162 message type “VDM - AIS VHF data link message” in a single AIS frame, simulating 90 % load on the VDL.

Record the data for 30 min. During the recording, generate an ALR sentence by causing one of the conditions described in IEC 61993-2, 6.10.2.2, Table 2.

During the recording, generate a TXT sentence by causing one of the conditions described in IEC 61993-2, 6.10.3.3, Table 3.

Replay the data.

6.2.5.2 Required results

Verify that all VDM messages were recorded and time correlated with sensor and audio data.

Verify that the TXT and ALR messages were recorded.

In the case of “VDO - AIS VHF data link own-vessel report” messages being recorded, verify that these are additional to the recording of date/time, position, heading and speed according to the requirements of 4.6.1 to 4.6.4.

6.2.6 Other items

(See 4.6.9 to 4.6.17.)

6.2.6.1 Test method

The test method and result required is identical in all the items in 6.2.6.

Present the data, item by item, conforming to the format specified in 4.3.6 to the port designated for the specific item. The data shall be presented at a rate greater than once per second and changed at a rate less than once per second. Record the data for 30 min. Replay the data.

6.2.6.2 Result required

It is required that all the changed data are accurately reproduced at a rate of at least once per second.

6.2.7 Interfaces

(See 4.3.6.)

The manufacturer shall demonstrate that all interfaces meet the requirements of 4.3.6.

Annex A
(informative)

IEC 61162 sentence formats

Table A.1 – References in this standard

Parameter to be recorded	Clause(s)	Sentence format $--***	Notes
Date and time	4.6.1	ZDA	
Ship's position and datum used	4.6.2	GNS and DTM	
Speed (water and/or ground)	4.6.3	VBW	
Heading (true)	4.6.4	HDT	
Heading (magnetic)	4.6.4	HDG	
AIS – VHF data-link message	4.6.8	VDM	
AIS – VHF data-link own-vessel message	4.6.8	VDO	
Depth (echo sounder)	4.6.10	DPT	
Alarms	4.6.11	ALR	
Rudder order/response manual	4.6.12	RSA	Note 1
Rudder order/response automatic	4.6.12	HTC and HTD	
Engine order/response	4.6.13	RPM and XDR	Notes 1 and 2
Hull openings, watertight doors	4.6.14 & 4.6.15	XDR	Note 2
Accelerations and hull stress	4.6.16	XDR, ALR	Note 2
Wind speed and direction	4.6.17	MWV	
VDR alarm output		$VRALR	Note 3

NOTE 1 The current specifications for RSA and RPM do not have fields for 'order', only 'response'.

NOTE 2 The table of transducer types in the current specification for XDR does not specifically include these uses.

NOTE 3 There is no requirement for the S-VDR to send alarm messages. If, as an option, such messages are sent, then the appropriate sentence format is ALR.