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| IALA Guideline |

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OperationAL and technical AccEptance of VTS SYSTEMS

Edition 1.0

Document date

Revisions to this IALA Document are to be noted in the table prior to the issue of a revised document.

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# INTRODUCTION

At present, this document is a collection of information collected and processed during VTS-42, to be brought forward to VTS 43.

It is by no means representing the expected final outcome of the work to eigher opdate G1111 with further information on the acceptance of VTS systems or to make a separate guideline on the subject.

## definition

**Definition of Verification according to ISO:9000-2005 §3.8.4**

Confirmation, through the provision of objective evidence , that specified requirements have been fulfilled

Note 1 to entry: The term “verified” is used to designate the corresponding status.

Note 2 to entry: Confirmation can comprise activities such as

* performing alternative calculations,
* comparing a new design specification (3.7.3) with a similar proven design specification,
* undertaking tests (3.8.3) and demonstrations, and
* reviewing documents prior to issue.

**Definition of Validation according to ISO:9000-2005 §3.8.5**

Confirmation, through the provision of objective evidence (3.8.1), that the requirements (3.1.2) for a specific intended use or application have been fulfilled

Note 1 to entry: The term “validated” is used to designate the corresponding status.

Note 2 to entry: The use conditions for validation can be real or simulated.

## References

|  |  |  |
| --- | --- | --- |
| [1] | IALA Recommendation V-119 | The Implementation of Vessel Traffic Services |
| [2] | IALA Recommendation V-128 | Preparation of Operational and Technical  Performance Requirements for VTS Systems |
| [3] | IALA Guideline 1111 | Preparation of Operational and Technical Performance Requirements for VTS Systems |
| [4] | ISO 15288:2008 | Systems and Software Engineering – System life cycle processes |
| [5] | INCOSE-TP-2003-002-03.2.2 | INCOSE Systems Engineering Handbook. A Guide for System Life Cycle Processes and Activities, Ver. 3.2.2 October 2011. |

# AIMS AND OBJECTIVES

This guideline presents a common source of information to assist Competent Authorities and VTS Authorities in the operational and technical acceptance of VTS systems. Tailoring is required to verify and validate the specific and relevant performance requirements from the generic information included within this document. The Guideline shall not be used as a test procedure without such tailoring.

The aim of this document is not to repeat international standard [4] on verification and validation processes but to address considerations specific to VTS systems, such as:

* Describing the process
* How to verify compliance with individual system requirement (compliance with order)
* How to validate operational and technical performance described in G1111 step by step

# verification and validation process

This section explains the verification and validation process, the planning, the different phases and methods considered by IALA as a reference for the subsequent sections of the document.

This process aims to verify the compliance of the VTS system prior to operation against the tendered system requirements through a structured model.

## Verification and Validation through V-model

This section describes the recommended Verification and Validation processes applied to VTS system using a Generic Project Life-cycle Model called the V-model in System Engineering terms. This is detailed in [4] and [5] and illustrated by Figure 1: V model



Figure 1: V model

## Verification and Validation Planning

Validation activities shall be prepared and reviewed together with the stakeholders with reference to contractual requirements. It may also take into account inputs from Concept Documents, Closed Design Review (CDR), use cases or operational scenarios, etc...

The validation process consists of the following activities:

* Plan Validation
* Create validation plan that includes the strategy for validating the system or product entities throughout the life cycle.
* Specify the sequence of validation activities, pass/fail criteria and corrective actions. Specify resources such as staffing and responsibilities, prerequisites, risk, contingency, approach and overall test environments.
* Schedule and confirm validation enabling systems, tools or resources.
* Provide feedback to requirement and design process.
* Analyzing how to validate stakeholder requirements in detail might trigger a change in requirements due to cost or feasibility
* Release the validation specifications and/or procedures.
* Develop validation specification that demonstrates that the system is fit for its purpose and satisfies the stakeholders’ requirements.
* Perform Validation
* Ensure readiness to conduct validation – system, enabling systems, and trained operators.
* Conduct validation per established procedures to demonstrate conformance to stakeholder requirements. Validation is typically witnessed by customers, representative or assigned QA.
* If anomalies are detected, analyse for corrective actions and detect trends in failure to find threats to the system and evidence of design errors
* Recommend corrective actions and obtain stakeholder acceptance of validation results
* Document validation results (including nonconformities)
* Conclude on the verification documentation with the approving customers

## Process Phases

### Establishment of Acceptance Test Plan (ATP)

The Acceptance Test Plan (ATP) is a collection of tests, analysis, and acceptance criteria that allows the suppliers to demonstrate to the customer that the system met contractual requirements. It shall describe the Validation methods for each requirement and the process phase in which these tests or analysis shall be conducted.

The Contractor, in cooperation with the Customer, may be responsible for the creation of the ATP. The agreed Acceptance Test Plan should be available prior to the commencement of the acceptance testing. The ATP scope shall cover the complete system that forms the overall deliverable.

For each stage of acceptance testing, the Contractor shall issue a test procedure based on the agreed acceptance methods and procedures captured in the ATP. Test procedures should demonstrate compliance to the Customer’s functional and performance requirements.

This validation procedure/specification shall include requirements for any systems, tools, software or resources needed to enable validation of the system under test. It should also include an agreed test script which consist of a list of requirements and corresponding verification tests, with their measurements and expected results, to demonstrate compliance.

At each stage of acceptance testing, test records may include but not limited to:

* Configuration details;
* Date of the test;
* Who performed the test;
* The outcome of the test such as pass/fail, measurements, or findings.

Upon successful completion of the acceptance activities, described in the ATP, the system is considered ready for operational use.

### System Element verification

The purpose of System Element Verification aims to verify the individual function and performance compliance of the different system component. The vendor usually performs this phase before or during implementation. This is typically done in the form of compliance statements, also stating the used validation methods. However, the VTS Authority may want to witness and/or approve part of the process, such as:

* Individual Hardware and Software
* Equipment

### System Integration Verification

The purpose of System Integration Verification aims to verify that all system elements are integrated and performing according to its intended functions. The extent of verification is highly dependent on the system complexity and VTS authority specific requirement.

### Validation Process prior to installation and Factory Acceptance Test (FAT)

The purpose of the Validation process prior to installation is to verify the Functional and Performance of the system in vendor premises. The conduction of this phase is the vendor responsibility and usually prepares for the Factory Acceptance Tests

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* ories.

### System Validation Process on site and Site Acceptance Test (SAT)

The purpose of the Validation Process on site is to provide objective evidence that the services provided by a system when in use comply with stakeholders’ requirements, achieving its intended use in its intended operational environment.

This process performs a comparative assessment and confirms that the stakeholder requirements are correctly fulfilled. Where deviations are identified, these are recorded and guide corrective actions. The VTS authority shall approve the system validation.

The validation process may cover the following validation examples depending on type of system:

* Site Acceptance tests
* Possibly, In-operation test (determining that availability, maintainability criteria etc. are meet)

, but not repeating the tests done at FAT.

Further advise to be added, describe the different purposs of FAT and SAT, include a discussion of acceptance criteria, what to do when something fails. What to do if development is occurring in parallel

Authorityand the Contractor discussed any outstanding issues agree on to be taken ward

## Verification and Validation Methods

The basic verification and validation methods adopted by IALA, applicable to the VTS system or its different elements and relevant in the different phase of the V model, are as follow:

* *Inspection (I):* An examination of the item against applicable documentation to confirm compliance with requirements. Inspection is used to verify properties best determined by examination and observation (e.g. paint color, weight, physical dimensions, etc.).
* *Similarity (S):* Similarity is most appropriate where a design is being modified or is very similar to an existing verified system. When verifying by similarity, a common scenario is to perform an analysis to ensure the design and operational environment is similar enough to claim similarity.
* *Analysis (A):* Use of analytical data or simulations under defined conditions to show theoretical compliance. Analysis (including simulation) is used where verifying to realistic conditions cannot be achieved or is not cost-effective and when such means establish that the appropriate requirement, specification, or derived requirement is met by the proposed solution.
* *Demonstration (D):* A qualitative exhibition of functional performance, usually accomplished with no or minimal instrumentation. Demonstration (a set of verification activities with system stimuli selected by the system developer) may be used to show that the system or subsystem response to stimuli is suitable. Demonstration may also be appropriate when requirements or specifications are given in statistical terms (e.g. mean time to repair, average power consumption, etc.).
* *Test (T):* An action by which the operability, supportability, or performance capability of an item is verified when subjected to controlled conditions that are real or simulated. These verifications often use special test equipment or instrumentation to obtain very accurate quantitative data for analysis.
* *Operational Trial (O):* A period of time by which the system performance and reliability has to be proven according to Operational Procedure and reliability requirement.
* *Certification (C):* Written assurance that the product has been developed and can perform its assigned functions in accordance with legal or industrial standards. The development reviews and verification results form the basis for certification; however, outside authorities, without direction as to how the requirements are to be verified, typically perform certification(e.g. CE certification, UL certification, etc.)

The verification and validation cost generally increase when going down the method list, but also provides increased confidence that the requirement is actually met. The methods therefore involve balancing the most cost-effective mix of adequate testing against minimizing the risk of not meeting a requirement. Inadequate verification postpones problems to the validation phase, where costs for implementing needed changes to remedy the possible non-conformance is typically much larger.

For the validation, it is not sufficient to indicate the validation method. It is also needed to document *how* the stakeholder requirements shall be validated, and which validation activities the customer shall witness. As an example, there is a big difference if a requirement shall be tested with targets of opportunity or if the customer presupposes calibrated and certified targets, as the latter is much more expensive in both cost and schedule.

# Core operational and technical requirement Validation

Shall be revisited to follow that stated in chapter 3

G1111/§1.3 states that it is important to write well-structured, individual requirement statements within the published requirements documentation. This statement combining the relevant operational requirements with the technical requirements shall be the basis for the verification and the validation

1.4.1 Availability and Reliability

Verification of overall system as well as individual components reliability is an integral part of a design following the principles of the V-model. Calculations and analysis done during the design process are important to eliminate weak points and determine maintenance costs of the installed system.

Calculations and Failure Mode Analysis do often pay an important role in the technical acceptance of a VTS system, however, detailed analysis may be very time consuming and it will always result in theoretical figures. The practical and cost effective way of validating Availability and Reliability may therefore be a combination of analysis and ‘In Operation Test’ made during the first months of operation – possible followed by corrective actions.

Methods

1. Verify

*There might be a need to advise more on specific methods*

1.4.2 Recording, Archiving and Replay

Technical acceptance of Recording, Archiving and Replay will typically consist of functional tests in combination with validation of archive capacity.

1.4.3 Design, Installation and Maintenance Considerations

1.4.3.1 Climatic Categories for outdoor installations

1.4.3.2 Wind Considerations

1.4.3.3 Special Considerations

1.4.3.4 Installation Considerations

1.4.3.5 Design and Installation Documentation

1.4.3.6 Design Standards Applicable to VTS Equipment

1.4.3.7 Equipment Approval

# Radar Validation

Radar versus radar service to be re-adressed –

Be sure not to repeat descriptions from G1111

The purpose of this section is to support Competent and VTS authorities in the validation of radar performance and its contribution to the VTS traffic image (situational awareness).

The validation shall focus on Operational Requirements, (e.g. coverage, targets to be detected and target separation) rather than Technical Specifications, (e.g. Transmitted power, pulse characteristics and antenna data) of radar sensor(s).

Prior to Acceptance testing, the radar system must be installed at the site and set up in a state ready for operation and the SAT shall demonstrate that the radar system complies with the tender requirements under operational conditions. This includes inspections, functional checks, measurements, and performance validation.

### Inspections

Move to higher level

Verify that all equipment is installed and connected in accordance with the applicable installation documentation and good workmanship practice, in particular check that:

* there are no visible physical defects
* all units are connected to protective ground
* a lightning protection system has been implemented
* all connectors, waveguides, and cable glands are fastened

### Functional verification

Move general items to higher level

With the radar(s) in operational state, verify that:

* the built in test equipment does not display any error
* interfaces function as intended
* network redundancy (if applicable) is set up correctly
* transceiver redundancy (if applicable) is set up correctly
* the safety switch functions as intended
* the transmitted power is OK
* the reflected power is OK
* receiver sensitivity (e.g. by means of a noise figure) is OK
* transmission blanking sectors have been set up, if required
* site specific setup (position, site specific operational settings etc.) has been completed
* radar video is available and updated within the required rate
* that the video alignment in range and azimuth is correct. The test should be performed on at least two clearly visible point targets at known positions differing in, at least, azimuth.
* that the overall correspondence between the radar video and the underlying charts.
* that, if applicable, “Area Masking” has been set up correctly, e.g. that the Area Masking correspond to the actual land and sea.

### Radar coverage

Validation of the radar coverage may be divided into two parts, one part entails validating the overall coverage of the VTS system while the other part is concerned with validating the range detection performance.

#### Overall coverage

Validation of the radar coverage, ranging from that of individual radar sensors to that of the total VTS system, can be done using several hours of recordings of video and/or tracking information of targets of opportunity. An example of such a recording is shown in Figure 6‑1.



Figure 6‑1: Example of a video recording lasting several hours showing snail tracks of the vessel traffic (find better picture)

Validation of coverage outside normal shipping routes can be done using a test vessel covering additional areas of interest.

#### Range detection performance

The validation of the range detection performance shall determine the detection of targets from minimum to maximum of the radar coverage range. The test should be performed using one or more test vessels with predetermined RCS and must validate the detection ranges at selected bearings (at least two for each radar) in the area of interest.

The planned sailing routes should preferably be radially and with free line of sight, from close to the radar to at least 10% beyond the calculated detection range. At the same time, safety of navigation must be obeyed.

The test must be performed within specified weather conditions for detection of the types of targets used. Theoretical ranges for the controlled target(s) used, and in actual weather conditions, must be determined (using CARPET models).

***Test procedure:***

Illustration to be added

Observe radar (and tracking if applicable) performance from radar display, and:

1. Ask the test target to sail along the pre-planed trajectory. Ask the target to make a manoeuvre for each 1-2 nautical miles in order to evaluate radar echoes as a function of aspect ratio.
2. Observe and record (note, make screen captures or record live) the echo updates for the targets.
3. Continue the test until the target reaches a position that is 10% beyond calculated detection range or until video plots are seen in less than 3 out of 10 scans on the radar display, whichever situation occurs first.
4. Repeat the test when targets are sailing inbound.
5. Repeat steps 1)-4) for other selected bearings.

Acceptance criteria, e.g. for 90% probability of detection is that the target is seen in 9 out of 10 scans. However, allow for disturbances, e.g. loss of detection due to a larger vessel passing between the radar and the test target.

The obtained results can be used to benchmark simulation tools (based on the models used by CARPET) which in turn can be used to predict radar detection performance under different weather conditions.

#### Determination of target RCS

Short introduction to RCS, two possibilities of target choice to be added: uncalibrated vs calibrated

RCS must be known………………

Using uncalibrated targets

Most targets of interest for VTS will have AIS position and identification. This information, together with the target characteristics provided in table 9 of the IALA guideline 1111, can be used to obtain a rough estimate of the vessel RCS which in turn can be used in the validation of the radar detection performance.

However, this method can never lead to precise results as the RCS of such targets may vary drastically depending on the aspect angle as illustrated in *Figure 6‑2*.



*Figure 6‑3: The RCS as a function of the aspect angle for two different vessels. Both vessels are approximately 4000 GRT. Note that the scale is logarithmic and readings range from approximately 1 thousand square meters to 10 million square meters.*

Using calibrated targets

The most accurate results on radar performance are obtained using calibrated targets, however, it is not practical to move e.g. radar reflectors at sea and it is therefore necessary to measure the RCS of vessels used for test against a reference reflector prior to any testing.

The selection of test targets should at least include the smallest type of test vessels mentioned in tender requirements (see tables 9 and 10 in ref [3]). (somewhere, discuss the importance of knowing the relation between RCS and target type)

Using very small targets such as rubber or wooden boats require radars meeting the IALA advanced recommendations. For non-metallic targets, circular polarisation will not work.

The calibration must be performed in calm weather with a low sea state.

A reliable choice of reference reflector is a metallic sphere floating on the sea surface on an air-filled tube (see Figure 6‑3).



Figure 6‑4 Example of a reference target: a metallic sphere on top of an air-filled tube floating on the sea surface.

The RCS, , of such a metallic sphere can be calculated according to

(insert reference)

where is the radius of the sphere. Note that the above equation is independent of the radar frequency and is valid in the regime where the radar wavelength is much smaller that the sphere radius. As an example, the radius of the sphere shown in Figure 6‑3 is 0.35 meters corresponding to an RCS of 0.4 square meters.

It is essential that the sphere is positioned close to the sea surface. If the sphere is elevated significantly, the measurements will be compromised due to lobing, that is interference between the direct echo signal and that reflected off of the sea surface

Note that the response of reference targets is polarisation dependent (typically calibrated in the horizontal plane) and the target calibration plane must match that of the antenna polarisation.

A prerequisite for the calibration is that the radar receiver characteristics are known.

Calibration procedure

The target to be calibrated and the reference reflector must be placed within a short distance from the radar, preferably at 0.5 to 1 nautical mile and in any case at less than 2 nautical miles. Additionally, the test area must be within free line of sight and distant from larger objects.

Illustrate/describe test setup

Request the controlled target(s) to move into the decided test position, carrying the reference target and:

1. Place the reference target with its floating support on the surface of the water.
2. Let the controlled target move 50-100 meters away from the test target, until clear separation is obtained on the radar display
3. Adjust the radar gain to obtain a clean picture of the test spot, with the test and reference targets clearly visible, and stable in the water, both in azimuth and range. Make sure that any automatic gain adjustment is disabled such that the gain will remain constant throughout the calibration procedure
4. Record the intensity of the reference target echo during at least 30 consecutive scans. Calculate the average value and variance of the echo intensity
5. Ask the controlled target to point its stern towards the radar (see Figure 6‑3)
6. Record the intensity of the controlled target echo during at least 30 consecutive scans. Calculate the average value and variance of the target intensity
7. Let the controlled target change its aspect angle in steps of 45 degrees (see Figure 6‑3), and after each change of aspect angle, repeat the measurement in 6). The last measurement is performed with the controlled target seen from astern
8. Let the controlled target move along a circular path centred at the reference target and with a radius of approximately 100 meters, and for each antenna scan, record the intensity of the controlled target echo



Figure 6‑5 Target angle relative to the radar antenna

If the values of the recorded intensities are on a logarithmic scale (in dB), the echo intensities must be transformed into the linear domain before averaging.

In order to determine the correct RCS, the receiver characteristics must be taken into account. (describe better)

When watching the echoes, note that real targets seldom follow the (simplified) mathematical models used by radar performance evaluation tools. This is particularly the case if very small, especially non-metallic, targets are used. Proper judgement of system performance does therefore require vast experience.

#### target separation and positional accuracy

To be developed

#### dynamic capabilities

To be developed

### in operation testing (not sure if this is needed specifically for radar)

# AUTOMATIC IDENTIFICATION SYSTEM

## Introduction

The purpose of this section is to support Competent and VTS authorities in the validating AIS performance, AIS service and its contribution to the VTS traffic image (situational awareness).

The operational requirements to validate are the following:

* Automatically receive information from AIS-equipped vessels, including the ship’s identity, ship type, position, course and speed over ground, navigational status and other safetyrelated information;
* Monitor and track AIS-equipped vessels;
* Exchange data with AIS-equipped vessels;
* Support value added functions over the AIS infrastructure;
* Manage AIS-based Aids to Navigation (including virtual and synthetic AtoN).
* Provision of vessel identification and location information to the VTS traffic image;
* Provision of vessel manoeuvring and voyage related data to the VTS;
* Provision of facilities to enable transmission of information between the VTS and the mariner.

Note that the validation procedure as to be adapted to the contractual requirement and in particular depend from available Physical Equipment (AIS base station; AIS limited base station; AIS receiver; AIS repeater; AIS Aid to Navigation (AtoN)).

## Verification items

The Competent and VTS authorities may verify that the following documents have been issued:

* AIS equipment test sheet issued by the AIS equipment manufacturer.
* AIS equipment compliance certificate issued by the AIS manufacturer including international standard (XXXX) and national or reginal regulation (CE Certificate)
* An MMSI number attribution issued by the appropriate national authority (Radio Communications or Broadcast Authority in most countries). Note that when several AIS base stations cover a large VTS Area, each base station can be given the same virtual MMSI.
* License has been attributed for every AIS base station by the appropriate national authority (Radio Communications or Broadcast Authority in most countries).
* Every AIS base station has a MMSI (Maritime Mobile Service Identity).
* Configuration document stating at the minimum that:

The correct MMSI number has been configure for each AIS equipment

If there is two base stations in and AIS Cell 30NM x 30 NM, one of the AIS base stations within a cell is configured to transmit its Fixed Access TDMA (FATDMA) information on one of the AIS VHF frequencies and the other base station is configured to transmit its FATDMA information on the other AIS VHF frequency.

## Validation items

|  |  |  |  |
| --- | --- | --- | --- |
| G1111 | Scope | Procedure | Expected Result |
| 3.5 Operational Requirement | Check the AIS Coverage: | Check AIS track position report and information on the traffic image.  A cooperative vessel, with a verified AIS | All vessels equipped with an AIS transponder within the expected coverage area are displayed.  Cooperative vessel is tracked in the complete coverage area.  Note that weather condition, AIS network overload or specific consideration may affect the coverage ref to G1111 §3.7 for more information |
| 3.6.1.1 Target Tracking | Check that Vessel Position Report are available for VTSO |  | AIS tracks are display in the traffic image at the correct position  AIS information including the ship’s identity, ship type, position, course and speed over ground, navigational status and other safety related information are available.  The portrayal of the AIS tracks is consistent with the information received from the vessel (label, heading, outline size, …) |
| 3.6.1.2 Aids to Navigation | Check that AIS AtoN Report are available for VTSO AIS |  | AIS AtoNs are display in the traffic image at the correct position.  AIS AtoNs information including identity, type and other transmitted information are available |
| 3.6.1.3 Voyage-Related Data | Check that voyage, ETA and cargo are available to VTSO  Voyage, ETA and cargo are part of the standard AIS transmissions at 6 minutes intervals or on request. | Due to the absence of any commonly agreed procedure to update this data, it may not be present, be outdated or simply incorrect.  Consequently, the verification of this information shall be done with a cooperative vessel for which |  |
| 3.6.2 Information Exchange between VTS and Mariner |  | Coopering Vessel equipped with AIS shall be identified prior to the test |  |
| 3.6.2.1 Text Messaging | Check that VTSO and Mariner can exchange text message | Broadcast a message to all vessels fitted with AIS.  Acknowledge through VHF the good reception of AIS message | Vessel officer confirm the reception of the AIS message on its will appear on the Minimum Keyboard Display (MKD) of the on board AIS system |
|  |  | Send a message to specific vessels fitted with AIS.  Acknowledge through VHF the good reception of AIS message | Vessel officer confirm the reception of the AIS message on its will appear on the Minimum Keyboard Display (MKD) of the on board AIS system |
|  |  | Request to the Vessel Officer to send an AIS message to VTS. (It may be necessary to communicate the VTS MMSI number to the Vessel Officer). | VTSO is notify that an AIS message is received and can read the send message. |
| 3.6.2.2 Binary Messaging | Verify that the relevant “global” or “regional” binary messaging can be exchanged with mariners |  |  |
| 3.6.2.3 Aids to Navigation | AIS base stations, as part of a VTS System, can be configured to broadcast synthetic and/or virtual aids to Navigation (AtoN). |  |  |
| 3.6.3 Assigned Mode | VTS may use the AIS Service capability to change the reporting mode (from autonomous to assigned mode, for example) of selected shipboard AIS units. |  |  |

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# RADIO COMMUNICATIONS

The purpose of this section is to support Competent and VTS authorities in the validating of radio communications, its performance parameters and its contribution to the VTS traffic image (situational awareness) and in supporting safe navigation of the VTS area.

## requirements

In 1111, do not repeat, advise on the most important specifics, such s EMC, keep on high level

The operational requirements to validate are the following:

* Collect position, safety, and general information from shipboard personnel and remote sensing devices ;
* the radio infrastructure guarantee the coverage in line with the area (A1, A2, A3, or A4) ;
* enable voice communications, data services and potentially video applications ;
* the radio communications range should facilitate VTS ship communications before the ship enters a VTS area of responsibility ;
* provide facility to automatically record radio communications and play back.

The functional requirements to validate are the following:

* Shipborne equipment should meet the functional requirements of the relevant IMO performance standards and the ITU‐R Radio Regulations ;
* Shore based equipment should also conform to the appropriate local technical standards ;
* Routine calls using DSC can be initiated by the VTS in order to direct a VHF call to a specific vessel through MMSI based addressing ;
* Distress calls use DSC system
* Power supply :
  + Spare solutions for supplying power (diesel generators, batteries, solar panels, wind turbines)
  + uninterruptible power supplies
* Site selection:
  + electrical power
  + physical security of the site
  + housing and possible re-location with existing infrastructure
  + Optimization of the coverage
* Environmental conditions – Weather elements
  + Electronic devices must be adapted from weather conditions : temperature, humidity and wind
  + wind load on antennas
  + lightning protection
  + maintenance access
  + Build-up of ice should also be a consideration
* Interference
  + Healthy requirements
  + Frequency spectrum must be agreed with the national radio licensing authority
  + Equipment should be installed in accordance with manufactorer's instruction and monitored
* Interfacing / Network
  + Compatibility of equipments with systems
* Development and innovations
  + Network card should be implemented in transmitters
* Back-up radio equipment
  + Radio equipment should be duplicated : availability assessment
* Shore stations
  + Power must be checked on antenna
* Antenna:
  + The resistance of the tower must be taken in consideration in the choice of antenna (wind conditions, weight)
  + orientation of antenna
  + Antenna directivity diagram
* Rack

## Verification items

* Power supply
  + Power supply test sheet issued by the equipment manufacturer
  + Power supply compliance certificate issued by the AIS manufacturer including local standard.
* Site location
  + Avoid channel saturation by subdividing the VTS area
  + Evaluate the impacts on human beings.
* Interference
  + Certificate…
  + Check if there is no neighboorhood station that can interfere the signal
* Interfacing / Network
  + Check the possibility of linking the equipment to the VTS authority network
* Shore stations / Radio signal
  + Check the Frequency band : VHF, MHF…

## Validation items

* Power supply must be available as long as possible : need alternative solutions as as batteries
  + Check the electrical wiring
  + Check the voltage of each power supply in respect of local standards
  + Check the activation time of spare power supply if main power is interrupted
* Environmental conditions – Weather elements - Electronic devices must be adapted from weather conditions
  + temperature, humidity and wind must be checked on site
* Shore stations / Radio signal
  + Measurements
    - Tx frequency
    - Rx frequency
    - Transmitters – ratio directed power / reflected power
    - Transmitters – Demodulation
    - Transmitters – Distorsion
    - Receivers – Sensitivity for squelch on
    - Receivers – Sensitivity for squelch off
    - Receiver – Scope 50 % full scale
    - Receiver – Listening on receiver loud speaker
* Antenna
  + Adaptation measurement for each antenna
* Interference: Frequency spectrum must be agreed with the national radio licensing authority
  + Study by the radio authority to validate the agreement
  + Check the frequency spectrum with tools like spectrum analyzer
* Interference: other tests to measure the efficience of the signal
  + Decoupling measurements between antennas
  + Harmonics measurements
* Development and innovations
  + voip: test:
    - Latency
    - Jitter
    - Quality of Service QoS
* Rack
  + Racks must be located in protected housing where tests must be done:
    - Power supply
    - Ambiant temperature
    - Humidity

# DATA PROCESSING 85

## Introduction

The purpose of this section is to support Competent and VTS authorities in the validation of Data processing, its performance parameters and its contribution to the VTS traffic image (situational awareness).

The validation shall focus on Operational Requirements of a recognized up-to-date traffic image, rather than Technical Specifications, using the principles of target racking and data fusion. Additionally, it introduces the issues of managing various types of information required within and outside the VTS.

the trade-off between a higher target detection probability, a larger initiation delay or a larger false target rate,needs to be taken into account.

It is recommended that the VTS Authority should specify the Operational and associated Validation

Requirements rather than Technical Specifications of Data processing

The operational requirements may be determined by:

* the Tracking and Data Fusion of the VTS system;
* the Tracking and Data Fusion sections consider sensor data from various sources including:

 Radar sensors;

 Adjacent VTS area or other agency tracks;

 AIS and Satellite AIS;

 LRIT;

 Electro-Optical Systems (EOS);

* Extracted plots include the following attributes:

 Time of measurement;

 Measured position (Cartesian or polar) and positional uncertainty;

 Originating sensor

* In addition, the plots attributes include:

 Identity;

 Radial (Doppler) speed;

 Physical extent of the plot;

 Signal strength

* Determination of environmental capabilities and constraints;
* Determination of ; the required probability of target detection and minimum acceptable latency in weather and propagation conditions normal for the VTS area
* Target separation and positional accuracy
* Update rate
* The required positional accuracy of the track and other associated track information (identity, target type, COG, SOG, manoeuvre etc.).

## Verification of Function and Performance Requirements

* It is recommended to base acquisition of sensors and subsequent verification after installation based on measured performance data using real targets.
* Such measurements should be carefully analyzed including the influence from weather and propagation.
* Verification of radars using floating-point targets, such as corner reflectors or Lunenburg reflectors, is subject to large inaccuracies due to sea surface movements and variations in propagation.
* It is suggested to measure the radar cross section of real targets and use those for actual measurements.
* Radar cross section measurement of targets should be made in calm sea conditions, at close range and using stable (not moving) Luneburg reflectors as reference.

## Validation of Function and Performance Requirements

* All individual sensor measurements have limited accuracy and they affected by random errors. In order to obtain a more reliable estimate of a target position and speed vector, measurements need to be processed.
* The traffic image is created by processing the raw data from the available sensors of the VTS network.

## Verification items

The Competent and VTS authorities may verify that the following documents have been issued:

* All sensors test sheet issued by the equipment manufacturer.
* All sensors compliance certificate issued by the manufacturer including international standard (XXXX) and national or regional regulation (CE Certificate)
* The sensors stations must cover the whole VTS Area.
* The calibration certificate must issue for every sensor by the manufacturer.

## Validation items

|  |  |  |  |
| --- | --- | --- | --- |
| G1111 | Scope | Procedure | Expected Result |
| Technical Requirements |  |  |  |
| Tender approval | Check if the tender comply with country law | Review the tender documents and ensure that it comply with law and regulations | the tender match with all documents |
| Contract approval | Check the contact validity | Verify compliance with contractual documents and include all SAT and FAT Procedures | Validated contract |
| Type approval | Check if the type of the sensors is comply with the tender and country law | Review the tender documents and ensure that the sensor comply with documents | All sensors match with the tender documents |
| Qualified Person | Find the trained and Qualified Person | Proceed the FAT & SAT by the Qualified Person | Test done |
| Software/Hardware Version/Model | Check HW/SW Version / Model | Compare with contractual documents |  |
| Specifications | Check technical characteristics of the equipment | Fulfillment of the minimum requirements |  |
| Fall back mode | Check Fall back mode |  |  |
| Availability | Check the redundancy that get the desired Availability | Ensure that the availability not less than the requirement | High Availability |
| Latency | Check latency | measure the time from a sensor first gathering data relating to a target, to the time the corresponding data is presented to the user | Acceptable Latency Level |
| Coverage | Check that the coverage meet the requirements | Check overlapping sensors coverage | Full coverage |
| Bit error rate BER | Check BER | Check that the BER is below the acceptable level | Low BER |
| Signal to Noise ratio SNR | Ensure that the measured SNR give the required quality of service QOS | measurement of the power of a return from a target vs. the local sensor noise around the location of the target | High SNR |
| Sensors correlation | Check the correlation between sensors | Ensure that the correlation is done between Sensors | done |
| Operational Requirements |  |  |  |
| Sensors Sensitivity | Check sensors sensitivity | Measure the minimum received signal from all sensors |  |
| Calibration of all sensors | Check the calibration procedures for all sensor | accurately calibrate various sensors to the common reference system | Calibration certificate issued |
| Reliability | Check Reliability | Check the maintenance Procedures and spare parts list |  |
| The probability of target detection | Check the target detection rate |  | there is a trade-off between a higher target detection probability, a larger initiation delay or a larger false target rate. |
| The probability of false alarm | Check the false alarm rate |  | there is a trade-off between a higher target detection probability, a larger initiation  delay or a larger false target rate. |
| Sensors Accuracy | Check that sensor measurements have accepted accuracy | estimate of a target position and speed vector, measurements |  |
| The time stamping | Check The time stamping | The time stamping of sensor data, accurately reflecting the time of observation and measurement, is essential to enable the correct and accurate traffic image to be established and maintained |  |
| Track Validation | Check the Track Validation | Tracks should be validated against the possibility that they are, or have become, false tracks. Assessment of track quality and erratic track update behaviour may be considered as techniques to provide validation. | operational requirements regarding the detection of small targets may result in an increase in the probability of false tracks. |
| Track Data Output | The output of track data to other VTS sub-systems such as the display of the established traffic image to the VTSO | Track information, which might be required for display to the VTSO, includes:   Current location;   Vessel Identity;   Speed and course over ground;   Track history;   Contributing sensors (and lack of updates i.e. coasting);   Associating plot data;   Destination and ETA;   Passage plan;   Cargo;   Crew and passenger details. |  |

**Notes:**

* **The test result must be recorded and analyzed at the end of acceptance process**
* **If the test process if failed, it is necessary to prepare correction action plan to remove all finding**
* **If the test succeed the certificate of acceptance issued**

Table 17‑1 Specification, verification and validation template for VTS systems

| **Item** | Description | Requirements | G1111 Reference | Compliance Statement *(Contractual agreement - shall this be included?)* | | Verification and Validation of delivered solution | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **SoC** | **Clarification** | **Test method** | **Milestone** | **Procedure** | **Expected results per contractual requirements** | **Result incl. reference to reporting & description of possible corrective actions** |
| 1 | **INTRODUCTION** | **Heading** |  | **N/A** |  |  |  |  |  |  |
| 1.1 | **Scope** | **Heading** |  | **N/A** |  |  |  |  |  |  |
|  | This document covers the technical requirements for the delivery and associated life cycle support of …… | Information |  |  |  |  |  |  |  |  |
| 1.3 | **Core Requirements** | **Heading** |  | **N/A** |  |  |  |  |  |  |
| 1.3 | **Operational Requirements** | **Heading** | **1.3** | **N/A** |  |  |  |  |  |  |
| 1.3.1 | The VTS area, (VTS sub-areas) (and sectors) are delineated …. | Information |  |  |  |  |  |  |  |  |
| 1.3.2 | The of services to be provided include (INS, TOS, NAS) | Information |  |  |  |  |  |  |  |  |
| 1.3.3 | Types and sizes of vessels expected to participate in the VTS include: | Information |  |  |  |  |  |  |  |  |
| 1.3.4 | Navigational Hazards and traffic patterns are described in ….. | Information |  |  |  |  |  |  |  |  |
| 1.3.5 | Human factors including health and safety issues include ….. | Information |  |  |  |  |  |  |  |  |
| 1.3.6 | Tasks to be performed by System users include…. | Information |  |  |  |  |  |  |  |  |
| 1.3.7 | Refer to ……. For operational procedures, staffing level and operating hours of the VTS | Information |  |  |  |  |  |  |  |  |
| 1.3.8 | Co-operation with external stakeholders will include ……. | Information |  |  |  |  |  |  |  |  |
| 1.3.9 | Refer to ….. for information about physical security of the VTS Centre and remote sites *(possible classified documentation)* | Information |  |  |  |  |  |  |  |  |
| 1.3.10 | Refer to ….. for information on Business continuity, availability, reliability and disaster recovery | Information |  |  |  |  |  |  |  |  |
| 1.3.11 | The Legal framework is described by ….. | Information |  |  |  |  |  |  |  |  |
| 1.3 | **Technical Implementation** | **Heading** | **1.3** | **N/A** |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
| 1.4.1 | **Availability and Reliability** | **Heading** | **1.4.1** | **N/A** |  |  |  |  |  |  |
|  | Note that multiple means of communications and multiple sources of sensor information may result in reduced requirements for the availability of each item of equipment individually. | Information |  | N/A |  |  |  |  |  |  |
|  | Overall System Availability shall be XX.X % | Requirement |  |  |  | Analysis during design | FAT |  |  |  |
| Measurement | IOT |  |  |  |
|  | Individual sensor a… | Requirement |  |  |  |  |  |  |  |  |
|  | Individual sensor b… | Requirement |  |  |  |  |  |  |  |  |
|  | Communication …. | Requirement |  |  |  |  |  |  |  |  |
|  | Etc. | Requirement |  |  |  |  |  |  |  |  |
| 1.4.2 | **Recording, Archiving and Replay** | **Heading** | **1.4.2** | **N/A** |  |  |  |  |  |  |
| 1.4.2.1 | Stored and archived data shall include:   * ….. | Requirement |  |  |  |  |  |  |  |  |
| 1.4.2.1 | Storage capacity shall be for a minimum of \_\_ days | Requirement |  |  |  |  |  |  |  |  |
| 1.4.2.1 | Data shall be recorded automatically and be capable of replay without impact to on-going VTS operations. | Requirement |  |  |  |  |  |  |  |  |
|  | Information shall be synchronised of for replay | Requirement |  |  |  |  |  |  |  |  |
| 1.4.3 | Design, Installation & Maintenance | **Heading** | **1.4.3** |  |  |  |  |  |  |  |
| 1.4.3.1 | **Climatic Categories for outdoor installations** | **Heading** |  | **N/A** |  |  |  |  |  |  |
|  | The outdoor installations will be subject to  “Basic”, “Hot”, “Cold” “Severe Cold” /  “Coastal/Ocean”, “hot dry”, “hot humid” climate condition *(delete as appropriate)* | Information | 1.4.3.1 | N/A |  |  |  |  |  |  |
|  |  | Requirement |  |  |  |  |  |  |  |  |
| 1.4.3.2 | **Wind Considerations** | **Heading** | **1.4.3.2** | **N/A** |  |  |  |  |  |  |
|  |  | Information |  |  |  |  |  |  |  |  |
|  |  | Requirement |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
| 1.4.3.3 | **Special Considerations** | **Heading** | **1.4.3.2** | **N/A** |  |  |  |  |  |  |
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To be discuss if it is relevant to have compliance & Verification and Validation in separated rows – or make 2 tables – also should we make separate annexes for each type of subsystem.

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# RADIO COMMUNICATIONS

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# RADIO COMMUNICATIONS

## Introduction

Radio communication equipment is typically integrated into VTS applications to provide the VTSO with a real-time assessment of the situation in the VTS area of responsibility as well as a means to deliver timely services to VTS participants. Information collected and disseminated via this equipment can assist in assembling the traffic image and in supporting safe navigation of the VTS area.

## Purpose and Objectives

The purpose of this section is to support Competent and VTS authorities in the validation of Radio Communication System performance, supporting the design of the Radio Communication System and its contribution to the VTS traffic image (situational awareness).

The objectives of this validation will be to ensure the VTS system fulfills the following radio communication related objectives:

* Conforms to relevant local and international standards;
* Achieves design, installation and maintenance requirements;
* Achieves required radio communications coverage;
* Achieves required recording and playback of data;
* Demonstrates and displays required system malfunctions, warnings, alarms and indications

## Standards and References

Standards and references as per G1111 and customer supplied.

## Design, Installation and Maintenance

To be detailed – using G1111 as basis.

## Radio Communications Coverage

Validation of Radio Communication equipment to guarantee required coverage should be based upon the following:

* Area A1 - Within range of VHF coast stations with continuous DSC (digital selection calling) alerting available (about 20-30 nautical miles);
* Area A2 - Beyond area A1, but within range of MF coastal stations with continuous DSC alerting available (about 100 nautical miles);
* Area A3 - Beyond the first two areas, but within coverage of geostationary maritime communication satellites (in practice this means INMARSAT). This covers the area between roughly 70°N and 70°S
* Area A4 - The remaining sea areas. The most important of these is the sea around the North Pole (the area around the South Pole is mostly land). Geostationary satellites, which are positioned above the equator, cannot reach this far.

## Recording and playback of data

Recording and replay of radio communications should be validated to ensure that all designated radios record data as per recording and replay guidelines in G1111 and customer requirements.

## System Malfunctions, Warnings, Alarms and Indications

From the system verification tables all radio communication system malfunctions, warnings, alarms and indications should be defined.

Where system malfunctions, warnings, alarms and indications can be raised via controlled means or by triggers of opportunity, these should be validated to ensure adequate performance.

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1. G1111 reference Matrix

*Separate annexes may need to be developed for subsystems*

Table 17‑1 provides a specification, validation and verification template for VTS systems following the structure of IALA guideline 1111 providing compliance matrix intended for use at time of proposal as well as verification and validation matrix intended to be filled out during acceptance tests of the delivered solution.

The VTS authority might adapt the table to the individual requirements whereas proponents offering VTS solution not in any way shall modify the tables by editing text, deleting or adding a line. Only the fields marked as SoC (Statement of Compliance) and Clarification shall be completed as part of the proposal work

For compliance statements there are 4 types of fields:

1. Heading: section heading, no responses required
2. Information: informative text to provide further clarification – no responses required
3. Implicit: A requirement which is further subdivided into “children requirements. All children requirements must be complied to, in order to fully comply to an implicit requirement. A “partially comply” can be responded if one or more children requirements are not compliant
4. Requirement: a mandatory requirement associated with a single “shall” statement

Requirements shall be answered with one and only one of the following text:

1. C: “Comply” - the requirement is fully met by the proposed system, with no need for modification (COTS).
2. WC: “Will Comply” the requirement is not currently met by a COTS system baseline SW/HW but will do so after development or modification.
3. WPC: “Will Partially Comply” - the requirement will partially do so after modification. The proponent must explain in detail the required modification(s), how it will improve the system and where it will meet and not meet the requirement.
4. PC: “Partially Comply” - The current COTS baseline does not fully meet the requirement. Clarification is required.
5. NC: “Not Compliant” - The current COTS baseline does not meet the requirement and cannot be migrated to the PC, WPC or WC state in the near future.

Verification and validation shall follow the requirements set by the VTS-authority using the following methods:

* *Inspection (I):* An examination of the item against applicable documentation to confirm compliance with requirements.
* *Similarity (S):* Similarity is most appropriate where a design is being modified or is very similar to an existing verified system.
* *Analysis (A):* Use of analytical data or simulations under defined conditions to show theoretical compliance.
* *Demonstration (D):* A qualitative exhibition of functional performance, usually accomplished with no or minimal instrumentation.
* *Test (T):* An action by which the operability, supportability, or performance capability of an item is verified when subjected to controlled conditions that are real or simulated.
* *Certification (C):* Written assurance that the product has been developed and can perform its assigned functions in accordance with legal or industrial standards. The development reviews and verification results form the basis for certification; however, outside authorities, without direction as to how the requirements are to be verified, typically perform certification(e.g. CE certification, UL certification, etc.)

Where Table 17‑1 also suggest methods and appropriate stage,

* during design,
* as part of Factory Acceptance Test ,
* as part of Site Acceptance T
* or as part of In Operation Test

Table 17‑1 Specification, verification and validation template for VTS systems

| **Item** | Description | Requirements | G1111 Reference | Compliance Statement *(Contractual agreement - shall this be included?)* | | Verification and Validation of delivered solution | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **SoC** | **Clarification** | **Test method** | **Milestone** | **Procedure** | **Expected results per contractual requirements** | **Result incl. reference to reporting & description of possible corrective actions** |
| 1 | **INTRODUCTION** | **Heading** |  | **N/A** |  |  |  |  |  |  |
| 1.1 | **Scope** | **Heading** |  | **N/A** |  |  |  |  |  |  |
|  | This document covers the technical requirements for the delivery and associated life cycle support of …… | Information |  |  |  |  |  |  |  |  |
| 1.3 | **Core Requirements** | **Heading** |  | **N/A** |  |  |  |  |  |  |
| 1.3 | **Operational Requirements** | **Heading** | **1.3** | **N/A** |  |  |  |  |  |  |
| 1.3.1 | The VTS area, (VTS sub-areas) (and sectors) are delineated …. | Information |  |  |  |  |  |  |  |  |
| 1.3.2 | The of services to be provided include (INS, TOS, NAS) | Information |  |  |  |  |  |  |  |  |
| 1.3.3 | Types and sizes of vessels expected to participate in the VTS include: | Information |  |  |  |  |  |  |  |  |
| 1.3.4 | Navigational Hazards and traffic patterns are described in ….. | Information |  |  |  |  |  |  |  |  |
| 1.3.5 | Human factors including health and safety issues include ….. | Information |  |  |  |  |  |  |  |  |
| 1.3.6 | Tasks to be performed by System users include…. | Information |  |  |  |  |  |  |  |  |
| 1.3.7 | Refer to ……. For operational procedures, staffing level and operating hours of the VTS | Information |  |  |  |  |  |  |  |  |
| 1.3.8 | Co-operation with external stakeholders will include ……. | Information |  |  |  |  |  |  |  |  |
| 1.3.9 | Refer to ….. for information about physical security of the VTS Centre and remote sites *(possible classified documentation)* | Information |  |  |  |  |  |  |  |  |
| 1.3.10 | Refer to ….. for information on Business continuity, availability, reliability and disaster recovery | Information |  |  |  |  |  |  |  |  |
| 1.3.11 | The Legal framework is described by ….. | Information |  |  |  |  |  |  |  |  |
| 1.3 | **Technical Implementation** | **Heading** | **1.3** | **N/A** |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
| 1.4.1 | **Availability and Reliability** | **Heading** | **1.4.1** | **N/A** |  |  |  |  |  |  |
|  | Note that multiple means of communications and multiple sources of sensor information may result in reduced requirements for the availability of each item of equipment individually. | Information |  | N/A |  |  |  |  |  |  |
|  | Overall System Availability shall be XX.X % | Requirement |  |  |  | Analysis during design | FAT |  |  |  |
| Measurement | IOT |  |  |  |
|  | Individual sensor a… | Requirement |  |  |  |  |  |  |  |  |
|  | Individual sensor b… | Requirement |  |  |  |  |  |  |  |  |
|  | Communication …. | Requirement |  |  |  |  |  |  |  |  |
|  | Etc. | Requirement |  |  |  |  |  |  |  |  |
| 1.4.2 | **Recording, Archiving and Replay** | **Heading** | **1.4.2** | **N/A** |  |  |  |  |  |  |
| 1.4.2.1 | Stored and archived data shall include:   * ….. | Requirement |  |  |  |  |  |  |  |  |
| 1.4.2.1 | Storage capacity shall be for a minimum of \_\_ days | Requirement |  |  |  |  |  |  |  |  |
| 1.4.2.1 | Data shall be recorded automatically and be capable of replay without impact to on-going VTS operations. | Requirement |  |  |  |  |  |  |  |  |
|  | Information shall be synchronised of for replay | Requirement |  |  |  |  |  |  |  |  |
| 1.4.3 | Design, Installation & Maintenance | **Heading** | **1.4.3** |  |  |  |  |  |  |  |
| 1.4.3.1 | **Climatic Categories for outdoor installations** | **Heading** |  | **N/A** |  |  |  |  |  |  |
|  | The outdoor installations will be subject to  “Basic”, “Hot”, “Cold” “Severe Cold” /  “Coastal/Ocean”, “hot dry”, “hot humid” climate condition *(delete as appropriate)* | Information | 1.4.3.1 | N/A |  |  |  |  |  |  |
|  |  | Requirement |  |  |  |  |  |  |  |  |
| 1.4.3.2 | **Wind Considerations** | **Heading** | **1.4.3.2** | **N/A** |  |  |  |  |  |  |
|  |  | Information |  |  |  |  |  |  |  |  |
|  |  | Requirement |  |  |  |  |  |  |  |  |
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| 1.4.3.3 | **Special Considerations** | **Heading** | **1.4.3.2** | **N/A** |  |  |  |  |  |  |
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To be discuss if it is relevant to have compliance & Verification and Validation in separated rows – or make 2 tables – also should we make separate annexes for each type of subsystem.

## (Example Heading level 2)

Body text



1. Geographical range

Where:

Rg is the geographical range (nautical miles) (alternatively NM)

ho is the elevation of observer’s eye (metres) (alternatively m)

Hm is the elevation of the mark (metres) (alternatively m)

### (Example heading level 3)

Body text.

1. Theory of Special Relativity

Where:

E is the kinetic energy (Joules) (alternatively J)

m is the mass (kilograms) (alternatively Kg)

c is the speed of light (metres/second) (alternatively m/s)

#### (Example heading level 4)

Body text.

# OVERVIEW (Example Heading level 1)[[1]](#footnote-1)

Body text. Bullets have only one sentence. Anything further needs to appear in the relevant 'bullet text' style.

* Bullet 1:
* Bullet 1:
* Bullet 1.

## TABLES

Body text

1. Example of a table with the significant information in the first column

|  |  |
| --- | --- |
| Table heading | Table text |
| Table heading | Table text |
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| Table heading | Table text |

1. Example of a table with the significant information in the first row[[2]](#footnote-2)

|  |  |  |
| --- | --- | --- |
| **Table heading** | Table heading | Table heading |
| Table text | Table text | Table text |
| Table text | Table text | Table text |
| Table text | Table text | Table text |
| Table text | Table text | Table text |

1. Example of a table with coloured rows

|  |  |  |
| --- | --- | --- |
| Table heading | Table heading | Table heading |
| Table text | Table text | Table text |
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**Note:** Colours for text and cell shading need to be selected from the permitted palette (see ANNEX C)

# FIGURES



1. Example figure



1. Another example figure

# DEFINITIONS

The definition of terms used in this Guideline can be found in the International Dictionary of Marine Aids to Navigation (IALA Dictionary) at <http://www.iala-aism.org/wiki/dictionary.Acronyms>

# ACRONYMS

IMO International Maritime Organization (Acronym style)

# REFERENCES

1. Abcd
2. Efgh
4. EXAMPLE OF AN ANNEX - LANDSCAPE

Body text

1. example of ANNEX heading level 1

Body text

* 1. example of annex heading level 2

Body text

* + 1. Example of annex heading level 3

Body text

* + - 1. Example of Annex heading level 4

Body text

1. Example table

| No | Title/Topic | IMO References | Requirements | Possible Audit Questions | Remarks |
| --- | --- | --- | --- | --- | --- |
| 1 | Table text | Table text | Table text | Table text | Table text |
| Table text | Table text |
| Table text | Table text |

1. EXAMPLE OF AN APPENDIX TITLE
2. APPENDIX HEADING 1

Body text

* 1. APPENDIX HEADING 2

Body text

* + 1. APPENDIX HEADING 3

Body text

* + - 1. Appendix Heading 4

Body text

1. (EXAMPLE ANNEX TITLE)
2. Introduction (Example Annex Heading 1)

Body text.

* 1. Example of ANNEX HEADING Level 2

Body text

* + 1. Example of annex heading level 3

Body text

* + - 1. Example of Annex heading level 4

Body text

1. PERMITTED COLOUR PALETTE



The IALA colour palette is divided in 3 palettes of different level of hierarchy that has to be respected.

Corporate colours

IALA’s corporate colour palette is directly inspired from the colours in our logotype:

- dark blue

- white

- yellow

- gradient blue

**Primary and secondary colours**

The primary colours are to be applied in complement

with the corporate colours.

This second level of colours gives rhythm and helps

to segment our publications.

The secondary colours are used to highlight

information, titles in a minor proportion only.

**Note: Corporate colours are not shown**

Recommendations

Model Courses

Guidelines

1. Example footnote [↑](#footnote-ref-1)
2. Example of footnote [↑](#footnote-ref-2)