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| IALA Guideline |

G1111

Establishing Functional and Performance Requirements for VTS Systems

Edition 1.0

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

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| Date | Page / Section Revised | Requirement for Revision |
| January 2020 | Edition 1.0  This document originated from Guideline G1111 which has been subdivided into 13 sub-guidelines, including this document. There has been no significant revision of content, only document structure.  (Note - G1111 originated from annex of Recommendation V-128 Ed 3 in May 2015) |  |
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# INTRODUCTION

This Guideline presents a common source of information to assist competent authorities and VTS authorities in the preparation and establishment of operational and technical performance requirements of standards and specifications for VTS systems. Tailoring is required to capture the specific and relevant performance requirements from the generic information included within this document. The Guideline shall not be used as a specification without such tailoring.

References and definitions applicable to the separate sections are included in the sections where appropriate.

## G1111 guideline series

This Guideline is one of the G1111 series of guideline documents. The purpose of the G1111 series is to assist the VTS authority in preparing the definition, specification, establishment, operation and upgrades of a VTS system. The documents address the relationship between the operational requirements and VTS system performance (technical) requirements and how these reflect into system design and sub system requirements.

The G1111 series of guideline documents present system design, sensors, communications, processing, and acceptance, without inferring priority. The guideline documents are numbered and titled as follows (common title suffix of “Preparation of Operational and Technical Performance Requirements of VTS Systems” omitted below for brevity):

* + - G.1111 Establishing Functional and Performance Requirements for VTS systems
    - G.1111-1 Producing Functional and Performance Requirements for the Core VTS system
    - G.1111-2 Producing Functional and Performance Requirements for Voice Communications
    - G.1111-3 Producing Functional and Performance Requirements for RADAR systems
    - G.1111-4 Producing Functional and Performance Requirements for AIS and VDES systems
    - G.1111-5 Producing Functional and Performance Requirements for Environment Monitoring systems
    - G.1111-6 Producing Functional and Performance Requirements for Electro Optical systems
    - G.1111-7 Producing Functional and Performance Requirements for Radio Direction Finder systems
    - G.1111-8 Producing Functional and Performance Requirements for Long Range Sensor systems
    - G.1111-9 Producing Acceptance Requirements for VTS Systems

## Definitions of VTS terms

For absence of doubt, the following definitions apply within this document and in all the G1111 series of guideline documents:

* VTS equipment - individual items of hardware and software which make up the VTS System.
* VTS system – the hardware, software, and their behaviour as a coherent entity. This excludes personnel and procedures.

Within the G1111 series of guideline documents, reference is made to three different levels of equipment capabilities: Basic, Standard and Advanced. In the specification of VTS, the authority should determine the required performance for situational awareness, and associate this to the level of capabilities described in the G1111 series of guideline documents. This process should also consider the relationship between capabilities and system cost. The required performance is likely to vary in different parts of the VTS area.

# Establishing the Requirements for a VTS System

The Operational requirements should form the basis for the entire system lifecycle, its definition and its verification and validation following implementation.

IALA Recommendation V119 [5] (Implementation of Vessel Traffic Services) describes how the operational requirements are produced from the needs analysis process which are used to derive the technical requirements.

## Operational Requirements

The operational requirements needed to derive the system concept and technical requirements could include:

* delineating the VTS area and, if appropriate, VTS sub-areas or sectors;
* type of services to be provided (INS, TOS, NAS);
* types and sizes of vessels which are required or expected to participate in the VTS;
* navigational hazards and traffic patterns;
* human factors including health and safety issues;
* tasks to be performed by System users.

Operational procedures, staffing level and operating hours of the VTS, including:

* information sharing and co-operation with external stakeholders;
* physical security of the VTS Centre and remote sites;
* cyber security;
* business continuity, availability, reliability and disaster recovery;
* legal framework.

## Deriving the System Level Technical Requirements

The technical requirements should be derived from the operational requirements. This may be an iterative process, which can be aligned with the phases of IALA Recommendation V119 ‘On the Implementation of Vessel Traffic Services’ as illustrated by Figure 1.

In order to define technical requirements, the operational requirements may be grouped into:

* communications;
* situational awareness;
* recording and playback;
* reliability and Availability.

The grouping of operational requirements facilitates the creation of technical requirements, for example divided into:

* voice and data communication;
* the VTS centre, sites, sensors and processing;
* recording and replay including post situational analysis;
* redundancy and resilience.

The provisional system concept and the associated technical requirements are input to the provisional risk assessment and cost assessment. Depending on the outcome the system concept and requirements may need to be reassessed prior to the Formal Risk Assessment and Cost Benefit Analysis phases.



1. Deriving implementation from operational requirements

Deriving system concepts may involve various mathematical, functional and simulation models to visualise different characteristics of the system. Models to consider might include:

* radio communications coverage;
* sensor coverage;
* communications network infrastructure;
* data architecture and interfaces;
* reliability and availability including any redundancy options;
* lifecycle costs.

The models could assist in establishing the relationship between the system concepts, associated technical requirements and the operational requirements. Feasibility studies (site surveys, equipment trials etc.) may also be appropriate to reduce technical risks which may otherwise not be apparent until implementation.

Additional technical requirements may come from:

* environmental considerations;
* legal obligations;
* ergonomic issues
* safety (other than navigational safety);
* security requirements;

After completion of the system concept and associated technical requirements, the result should be input to the Formal Risk Assessment and Cost Benefit Analysis.

Completion of the Cost Benefit Analysis leads to the decision to proceed with implementation.

The first activity in the implementation phase is finalising the requirements. This involves combining the relevant operational requirements with the technical requirements, without unintentionally restricting flexibility in the implementation.

It is important to write well-structured, individual requirement statements within the published requirements documentation.

Note that, for the implementation, several possible technical solutions may be identified to achieve the operational requirements and each of these solutions may have different strengths and weaknesses. Scoring systems to address the most critical aspects of the operational requirements may be appropriate.

# Technical Implementation considerations

Implementation of a VTS system requires consideration of:

* VTS Centre location(s);
* available land and suitability of sensor sites;
* sensor and radio coverage;
* overlapping coverage and equipment redundancy;
* existing infrastructure such as power and data lines;
* communications routes;
* environmental constraints and impact;
* operating conditions such as wind, influence from sea, precipitation and possibly ice;
* electromagnetic issues (EMI/EMC),
* applicable regulations and required licenses (transmission, building etc.);
* selection of installation sites with due respect to neighbours;
* security and site access.

Any VTS system should, as a minimum, be equipped with a means to build a VTS traffic image as well as providing reliable communications.

The system architecture should carefully consider issues such as:

* bandwidth requirements;
* redundant data paths;
* data integrity;
* cyber security;
* data storage;
* reporting and maintenance facilities.

In addition, the architecture should have built in flexibility for future upgrades and have the capability to be maintained without impacting routine VTS operations.

During the development of the system architecture, comprehensive site surveys could be performed, including but not limited to the above considerations. Involvement of relevant stakeholders in the site survey early in the process adds value and ensures awareness of design and performance issues.

## Availability and Reliability

The VTS Authority should define an overall availability and Reliability target for the VTS System based on the Risk assessment results. The relationship between downtime and availability figures is given by Table 1.

1. Relationship between downtime and availability

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Availability | | | | |
| Annual downtime | 3.65 days | 24 hours | 8 hours | 4 hours |
| Corresponding Availability | 99% | 99.7% | 99.9% | 99.95% |

The VTS Authority can decide whether individual sub-systems are critical or non-critaical. Non-critical sub-systems may be excluded from the overall System availability requirement.

Note that multiple means of communications and overlapping sensor coverage will increase overall availability. Such a solution may result in reduced requirements for the availability of each item of equipment individually.

Scheduled maintenance activities may be included in availability figures.

Also note that required spare parts should be readily available, to ensure the shortest time to repair. Therefore, VTS authorities should plan for sufficient spare parts and service arrangements in order to meet the availability criteria.

The VTS System availability can be improved by the following redundancy measures:

* by duplicating and/or virtualising VTS Equipment;

In such cases, parameter hand-over from active to stand-by equipment should be considered.

* between sensors and radio base stations, where overlap can provide redundancy, possibly with reduced performance;
* between various types of sensors and voice communications, where overlap can provide redundancy, possibly with reduced performance;
* by adding graceful degradation capabilities to individual VTS Equipment.

## Recording, Archiving and Replay

Within legal limitations, provision should be made for secure storage, retrieval and presentation of VTS data so the VTS Traffic Image can be consistently reproduced.

The data type, resolution and period of time for which data is required to be stored should be derived from operational procedures. thirty ()Consideration can be given to providing this as online storage.

The time period should allow for the full retrieval of data post-incident/accident, in compliance with national requirements and those of the incident/accident investigation procedures of the VTS Authority and other authorised parties.

Stored and archived data should include:

* Sensor data recordings;
* voice communication;
* other relevant information.

It may also include (within legal limitations):

* internal VTSO conversation recordings inside VTS Centre;
* VTSO actions recording.

The data should be recorded automatically and be capable of replay without impact to on-going VTS operations. Synchronisation of information is recommended for replay.

## Design, Installation and MaintenanceEnvironmental Considerations

The VTS authority should specify the local environmental conditions for VTS system performance, design and outdoor installations















## Other Considerations

### Equipment Shelters

A shelter can provide a protective environment with characteristics that depend on the location and design of the shelter. In situations where contained equipment is reliant on the environment created by the shelter, the shelter facilities (e.g. cooling or heating) may become critical to the achieved availability of the equipment.

### Lightning Protection

Lightning protection is often subject to national or local legislation taking into account local conditions, severity, earth conductivity, power grid constraints etc. The guidance from country to country differs depending on lightning strike frequency and severity. As a consequence, requirements for the number and type of lightning arrestors, the number of earthing points and the minimum cross section of lightning conductors vary to suit local conditions.

The general principles include:

* lightning arresters should be higher than other equipment and be designed to protect the entire installation.

They should have separate down conductor(s) on the exterior of buildings and the down conductors should not be connected to metal parts of buildings such as steel reinforcements, handrails and antenna masts;

* safety grounding of equipment should be kept separate from lightning protection;
* potential equalisation should be achieved in earth and never at the top of the equipment.

### Warning Lights

High structures may require warning lights for air traffic, such as radar towers. It is recommended to consult local aviation authorities for specific requirements.

### Site and Equipment Access

As part of the design of a VTS System locations, the VTS Authority should analyse the need for site access for installation and maintenance. Fencing and other protective means against illegal intrusion will also be needed in many cases.

### Electrical Power

The VTS System requires a reliable source of electrical power, which could include a backup power source such as an Uninterruptable Power Supply (UPS).

Where a new or replacement source of electrical power is necessary, diesel generators should be avoided and renewable sources should be used if possible.

### Safety and Security Precautions

For each location, the VTS Authority should determine safety and security requirements.

Safety requirements should, at least, consider:

* personnel protection equipment for working at heights;
* safety switches to isolate equipment and to stop rotating antennas;
* precautions regarding electromagnetic radiation, rotating machinery and electrical shock, railings on masts etc.;
* protection of the general public.

Security requirements should, at least, consider:

* access restrictions;
* alarm International Ship and Port Security code requirements.

### Equipment Preservation and Monitoring

The VTS Authority should also consider the following:

* fire detection and (remote) alarms;
* automated fire extinguishers;
* remote monitoring of site status (power, fuel, temperature, meteorological data etc.);
* remote monitoring of equipment status.

### Marking and Identification

VTS Equipment should be marked with manufacturer name, type and serial number. In addition, build state records for equipment, including software, should be included with delivered equipment.

Legislation may require additional marking or identification, signposts etc.

Privacy regulations may require the posting of signs to notify the public that they are under surveillance.

### Documentation

The VTS Authority should specify deliverable documentation to accompany the VTS equipment. As a minimum, documentation should include:

* operating instructions;
* maintenance instructions (preventive and corrective) inclusive of procedures and spare parts catalogue;
* safety information (e.g. regarding radiation, electrical safety and rotating machinery);
* certificates and permissions as required by law (e.g. CE marking, permission to radiate, permit to build and acoustic noise certificate);
* test procedures, test certificates, 'As built' documentation, etc.











### Equipment Standards and Approvals

Legal requirements for equipment standards and approval (or statements of conformity) vary from country to country. It is the responsibility of the VTS Authority to ensure compliance to local, regional and international standards. The VTS Authority should state any applicable standards as part of the acquisition process.

Typical standards and approvals may include the following (Note. This is not a complete list and VTS Authorities should ensure that all appropriate standards and approvals for their VTS area have been considered):

* Electrical Safety
* Mechanical Safety
* Radiation Safety
* Electromagnetic Compatibility
* Radio Spectrum licensing
* Hazardous / Chemical Substances

# DEFINITIONS

The definitions 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> and were checked as correct at the time of going to print. Where conflict arises, the IALA Dictionary should be considered as the authoritative source of definitions used in IALA documents.

# ACRONYMS

º Degree

 Plus or minus

> Greater than

≤ Less than or equal to

≥ Greater than or equal to

% percent

µs microsecond

AIS Automatic Identification System

AREPS Advanced Refractive Effects Prediction System

ASL Above Sea Level

AtoN Aid(s) to Navigation

BITE Built In Test Equipment

BoM Bureau of Meteorology (Australia)

C Celsius

CARPET Computer Aided Radar Performance Evaluation Tool

CCTV Closed-Circuit Television

CE Conformité Européenne

CHC Canadian Hurricane Centre

Circ. Circular (IMO)

COG Course over Ground

COSPAS Cosmicheskaya Sistema Poiska Avariynyh Sudov (Russian; Space System for the Search of Vessels in Distress

COSPAS/SARSAT Search and Rescue Satellite-Aided Tracking

CPA Closest Point of Approach

CPHC Central Pacific Hurricane Centre

CS Coastal Surveillance

CW Continuous Wave

dB decibel

dB(A) A-weighted decibel

dBi decibel isotropic

DF Direction Finder

DSC Digital Selective Calling

DSF Decision Support Function

DST Decision Support Tool

D-GNSS Differential GNSS

EC European Commission

ECC Electronic Communications Committee

ECDIS Electronic Chart Display and Information System

ECS Electronic Chart System

EIA Electronics Industry Association

ELT Emergency Location Transmitter

EMC Electromagnetic Compatibility

EMF ElectroMagnetic Force (EU Directive)

EMI Electromagnetic Interference

ENC Electronic Navigation Chart

EO Electro-Optical

EOS Electro-Optical Sensor

EPIRB Emergency Position Indicating Radio Beacon

ERC European Research Council

ETA Estimated Time of Arrival

ETSI European Telecommunications Standards Institute

EU European Union

FAT Factory Acceptance Test

FATDMA Fixed-Access Time-Division Multiple Access

FCA Functional Configuration Audit

FMCW Frequency Modulated Continuous Wave

FMS Fiji Meteorological Service

FoV Field of View

GHz gigahertz

GIT Georgia Institute of Technology

GMDSS Global Maritime Distress and Safety System

GNSS Global Navigation Satellite System

GPS Global Positioning System

h/hr hour

HDF Hierarchical Data Format

HF High Frequency (3–30 MHz radio frequency range (band))

HMI Human / Machine Interface

hPa hectoPascal

hydro/meteo hydrological/meteorological

IALA International Association of Marine Aids to Navigation and Lighthouse Authorities

ICNIRP International Commission on Non-Ionizing Radiation Protection

ID Identification

IDC International Data Centre (for LRIT)

IEC International Electro-Technical Commission

IEEE The Institute of Electrical and Electronic Engineers

IETF Internet Engineering Task Force

IHO International Hydrographic Organization

IMD Indian Meteorological Department

IMO International Maritime Organization

INS Information Service

IOC Intergovernmental Oceanographic Commission

IP Ingress Protection

IP Internet Protocol

IR InfraRed

ISO International Organization for Standardization

IT Information Technology

ITU International Telecommunication Union

ITU-R International Telecommunication Union-Radiocommunication

JMA Japan Meteorological Agency

JTWC Joint Typhoon Warning Center

Ka-band 26.4 – 40 GHz (radar band)

kg kilogram

kHz kilohertz

km/h kilometres per hour

KPI Key Performance Indicator(s)

Ku-band 12.0 – 18.0 GHz (radar band)

kW kilowatt

LRIT Long Range Identification and Tracking

LVD Low Voltage Directive (EU)

m metre

m/s metres per second

m2 square metre

m3 cubic metre

MF Medium Frequency (300 kHz and 3000 kHz radio frequency range (band))

MFR Météo France

MHz MegaHertz

MIL-STD Military Standard (US)

MKD Minimum Keyboard and Display

mm/hr millimetre per hour

MMSI Maritime Mobile Service Identity

MPA Marine Protected Area(s)

MPEG Moving Pictures Expert Group

MSC Maritime Safety Committee (IMO)

MSI Maritime Safety Information

MTBF Mean Time Between Failure

MTI Moving Target Indication

N The radio refractivity index

N/A Not applicable

NAS Navigational Assistance Service

NAVTEX Navigational Telex

NHC National Hurricane Centre

NIMA National Imagery and Mapping Agency

NM nautical mile

NTIA National Telecommunications and Information Administration

OFTA Office of the Telecommunications Authority

OJ Official Journal of the European Union

PC Personal Computer

PCA Physical Configuration Audit

PD Probability of Detection

PFA Probability of False Alarm

PRF Pulse Repetition Frequency

PSLR Peak Side Lobe Ratio

PSS Practical Salinity Scale

PSSA Particularly Sensitive Sea Area(s)

PTZ Pan, Tilt, Zoom

QoS Quality of Service

RACON Radar beacon

RADAR Radio Detection and Ranging

RCS Radar Cross Section

REACH Registration, Evaluation, Authorisation and Restriction of Chemical substances

RF Radio Frequency

RDF Radio Direction Finder

RH Relative Humidity

RMS Root Mean Squared

RoHS Reduction of Hazardous Substances

R&TTE Radio and Telecommunications Terminal Equipment

SAIS Satellite AIS

SAR Search and Rescue

SARSAT Satellite-based Synthetic Aperture Radar

SART Search and Rescue Transponder

SAT Site Acceptance Test

S-band 2.0 – 4.0 GHz (Note: military designation is F-band)

SLA Service-Level Agreement

SN Safety of Navigation (IMO)

SOG Speed over Ground

SOLAS Safety of Life at Sea

SPA Special Protected Area(s)

SS Sea State

STC Sensitivity-Time Control

STD./std. Standard

S-57 Transfer Standard for Digital Hydrographic Data (IHO)

S-100 Geospatial Information Registry (IHO)

S-101 IHO ENC Product Specification (under development in 2015)

TCPA Time to Closest Point of Approach

TDMA Time-Division Multiple Access

TOS Traffic Organization Service

UPS Uninterruptable Power Supply

US United States (of America)

UV Ultra Violet (light)

VDL VHF Data Link

VHF Very High Frequency

VoIP Voice over Internet Protocol

VTMIS Vessel Traffic Management and Information System

VTS Vessel Traffic Services

VTSO Vessel Traffic Services Operator

W watt

WGS84 World Geodetic System 1984 (Reference coordinate system used by GPS)

WMO World Meteorological Organization

X-band 8.0 – 12.0 GHz (Note: military designation is I-band)

XML Extensible Mark-up Language

# references

1. Convention on Safety of Life At Sea (SOLAS 1974) (as amended).
2. IMO Resolution A.857(20) - Guidelines for Vessel Traffic Services (1997).
3. IALA Vessel Traffic Services Manual.
4. IALA Recommendation V-103 - On Standards for Training and Certification of VTS Personnel.
5. IALA Recommendation V-119 – The Implementation of Vessel Traffic Services.
6. MIL-STD-810G - Environmental Engineering Considerations and Laboratory Tests.