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| IALA Guideline |

G1111

Establishing Functional and Performance Requirements for VTS Systems

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|  May 2015 | First issue (edition 1.0) of Guideline 1111 on “Preparation of Operational and Technical Performance Requirements for VTS systems”. Originated from IALA Recommendation V-128, edition 3. Annex from former Recommendation changed to Guideline and revised to include additional considerations, new technologies and emerging technologies. Additionally, consistency has been improved and duplications were removed.  | Council 60 |
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| June 2022 | Edition 2.0 - Due to the comprehensive content of G1111 (115 pages), the document was split into one guideline and nine sub-guidelines and reviewed to describe the establishment of the functional requirements better. Title changed to “Establishing Functional & Performance Requirements for VTS systems” | Council xx |
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# INTRODUCTION

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

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

*This Guideline is associated with Recommendation R0128 Operational and Technical Performance of VTS Systems, a normative provision of IALA Standard S1040 Vessel Traffic Services (VTS) [1]. To demonstrate compliance with the Recommendation, the provisions of this Guideline should be taken into account.*

## Purpose

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

## G1111 guideline series

The G1111 series of guideline documents present system design, sensors, communications, processing, and acceptance, without inferring priority. New sub-guidelines can be introduced to the *G1111* series in future. The guideline documents are numbered and titled as follows:

* G1111 Establishing Functional & Performance Requirements for VTS Systems
* G1111-1 Producing Requirements for the Core VTS System
* G1111-2 Producing Requirements for Voice Communications
* G1111-3 Producing Requirements for RADAR
* G1111-4 Producing Requirements for AIS and VDES
* G1111-5 Producing Requirements for Environment Monitoring Systems
* G1111-6 Producing Requirements for Electro Optical Systems
* G1111-7 Producing Requirements for Radio Direction Finders
* G1111-8 Producing Requirements for Long Range Sensors
* G1111-9 Framework for Acceptance of VTS Systems

# Establishing the FUNCTIONAL AND PERFORMANCE Requirements for a VTS System

IALA Guideline *G1150* [2] advises on the planning and implementation of a VTS related to the definition of operational, functional, performance and acceptance requirements of a VTS system. These requirements should be:

* derived from a business case and feasibility study in the initiating phase; and
* defined in the planning phase of the overall VTS project before the procurement of the VTS system.

The VTS provider should establish operational, functional and performance requirements and acceptance plan for a VTS system at the same time as they establish their procurement plan. These requirements should form the basis for the entire system lifecycle, its definition and its acceptance following implementation.

The *G1111* Guideline Series provide generic guidance for all potential equipment and sensors that may be used in designing a VTS system. The guidance is not prescriptive, and the capabilities required may vary between VTS, VTS area and VTS sectors or even specific parts of a VTS area or sector. VTS capability should be linked to risk assessment which will identify the degree of mitigation expected of a VTS and its contribution, together with other mitigation measures, to address a specific hazard or hazards. The extent of risk mitigation provided through the implementation of a offered will be determined by a number of factors that include the equipment fit, equipment capability, local geography and operator authorization/training. This guideline focuses to provide an overview of the key areas for consideration related to the establishment of a VTS system.

IALA guidelines *G1111-1* to *G1111-8* provide a specific guidance on initiating and planning functional and performance requirements and implementing VTS systems and VTS equipment, based on operational requirements.

Acceptance steps are typically conducted on the proposed or implemented VTS system to control the compliance to the requirements. These acceptance steps are discussed in *G1111-9* *Framework for Acceptance of VTS Systems*.

## Project planning

IALA Guideline *G1150 Establishing, Planning and Implementing VTS* recommends a project management approach to ensure that major deliverables, assumptions and constraints are clearly documented when planning and implementing a VTS. This will assist in defining the scope of the VTS, its goals and objectives that need to be met. Project management is considered as a discipline with the purpose to achieve specific goals and objectives by planning, organizing, motivating, and controlling resources.

Relevant international guidance prepared and published by appropriate international organizations regarding project management should be considered, or, where there are national requirements for project management, these should be used.

### ISO 21502:2020 Guidance on project management

This is an international standard issued by the International Organization for Standardization (ISO).

In summary, the standard:

* Provides high-level description of concepts and processes that are considered to form good practice in project management.
* Can be used by any type of organization, including public, private or community organizations, and for any type of project, irrespective of complexity, size, or duration.

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### Project management steps

Project management is undertaken in different steps in order to improve control and quality. Guideline *G1150* provides an overview of the five project management phases and the key areas for consideration as they relate to VTS:

* Initiating
* Planning
* Implementing
* Controlling
* Closing.

It is noted that before completing each stage to define functional and performance requirements, these results could be re-evaluated by risk assessment and cost benefit analysis. The core practice in the planning phase is finalising the requirements. This involves combining the relevant operational requirements with the functional and performance 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 phase, several possible technical solutions may be identified to achieve the defined 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 need to be considered when preparing procurement plan.



1. Project management steps in establishing VTS systems

## Operational requirements

The operational requirements needed to derive the functional and performance requirements should include:

* delineating the VTS area and, if appropriate, VTS sub-areas or sectors;
* types and sizes of ships required or expected to participate in the VTS;
* navigational hazards and traffic patterns;
* human/machine interface and human factors including health and safety issues;
* tasks to be performed by VTS operators or supervisors;
* Operational procedures, staffing level and operating hours of the VTS;
* information sharing and co-operation with external stakeholders; and
* legal framework.

## Security requirements

 The security requirements needed to derive the functional and performance requirements should include:

* physical security of the VTS Centre and remote sites;
* cyber security; and
* business continuity, availability, reliability and disaster recovery.

## Deriving functional and performance requirements

The functional and performance requirements for a VTS system should be derived from the operational requirements. This may be an iterative process, which can be aligned with the phases of Guideline *G1150*.

In order to define functional and performance requirements, the operational requirements may be grouped into:

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

The grouping of operational requirements facilitates the creation of functional and performance requirements, for example divided into:

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

Deriving system concepts may involve various mathematical, functional and simulation models to visualize 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; and
* lifecycle costs.

The models could assist in establishing the relationship between the system concepts, associated functional and performance 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 functional and performance requirements may come from:

* environmental considerations;
* legal obligations;
* ergonomic issues;
* safety (other than navigational safety);
* security requirements e.g., physical security, personnel security, cyber security incl. software updates during operation; and
* operational business rules or operational procedures.

# Implementation considerations

VTS system implementations may require consideration of the following:

* VTS System function and performance:
* Off the shelf solution or customized solution;
* Sensor and radio coverage, including overlapping coverage;
* Equipment redundancy;
* Communications routes;
* External Interfaces;
* Electromagnetic issues (EMI/EMC); and
* Audit Tracking;
* VTS system sustainability:
* Lifecycle planning, including environmental impact and sustainability in the choice of materials, power consumptions etc.; and
* Maintenance of the VTS system and sensors.
* Environmental constraints and impact such as wind, influence from sea, precipitation and possibly ice
* Locational and infrastructure design:
* VTS Centre location(s);
* available land and suitability of sensor sites;
* existing infrastructure such as power and data lines;
* selection of installation sites with due respect to neighbours; and
* security and site access.
* Rules and regulations
* Business Rules; and
* Applicable regulations and required licenses (transmission, building etc.).
* Organization and staffing
* Administrative functions; and
* Authorization levels.

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 of a VTS system should carefully consider issues such as:

* network requirements (bandwidth, latency etc.);
* redundant data paths;
* data integrity;
* security requirements e.g., physical security, cyber security;
* data storage; and
* reporting and maintenance facilities.

In addition, the system 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 the potential risks (e.g., design and performance).

## Availability and reliability

The VTS provider should define an overall availability and reliability target for the VTS system including the elements to be considered based on the risk assessment results. The relationship between downtime and availability figures is given by Table 1.

1. Relationship between downtime and availability

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| Availability |
| Annual downtime | 87,6 hours  | 24 hours | 8 hours | 4 hours |
| Corresponding Availability | 99% | 99.7% | 99.9% | 99.95% |

The VTS provider can decide whether individual sub-systems are critical or non-critical. 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 providers should plan for sufficient spare parts and service arrangements, or business continuation plans in order to meet the availability criteria.

The VTS system availability may be improved by the following redundancy measures:

* by duplicating hardware and/or externally hosting VTS services:
* In duplicated hardware cases, parameter hand-over from active to stand-by equipment should be considered; and
* 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; and
* 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 relevant data can be consistently recalled.

The data type, resolution and period of time for which data is required to be stored should be derived from operational procedures. A minimum of thirty (30) days' storage capacity is recommended. Consideration including data security, can be given to providing this as online storage. Archiving of older data may be considered for traffic statistics, risks evaluation, strategic planning etc.

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 provider and other authorized parties.

Stored and archived data should include:

* VTS traffic image;
* sensor data;
* voice communication; and
* other relevant information.

It may also include (within legal limitations):

* internal VTS personnel conversations inside the VTS centre; and
* VTS personnel activities.
* technical and maintenance purposes e.g. logging, failure tracking, long term failure statistics and analysis, system performance monitoring and improvement;

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

## Other considerations

### Environmental considerations

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

### 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; and
* potential equalization 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. Specific light arrangements may also be disturbing to both vessel traffic, the public and to animals. It is therefore recommended to consult local authorities for specific requirements or restrictions in the area.

### Site and equipment access

As part of the design of a VTS system locations, the VTS provider 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, renewable sources should be used if possible.

### Safety and security precautions

For each location, the VTS provider should determine safety and security requirements in accordance with local legislation.

Safety requirements should, at least, consider but are not limited to:

* safety procedures, such as instructions to personnel performing maintenance;
* personnel protection equipment for working at heights;
* lone working on remote sites should be avoided;
* safety switches to isolate equipment and to stop rotating antennas;
* precautions regarding electromagnetic radiation, rotating machinery and electrical shock, railings on masts etc.; and
* protection of the general public.

Security requirements should, at least, consider:

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

### Equipment preservation and monitoring

The VTS provider should also consider the following:

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

### Marking and identification

VTS equipment should be marked with manufacturer name, type and serial number.

Legislation may require additional marking or identification, signposts etc.

### Documentation

The VTS provider 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;
* test procedures, test certificates; and
* “As built” documentation comprising drawings, equipment configurations, software versions, 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 provider to ensure compliance to local, regional and international standards. The VTS Provider 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 providers 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 following definitions apply within this document and in all the G1111 series of guideline documents:

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| *VTS system* | – | within the G1111 guidelines, the VTS system is the VTS software, hardware, communications and sensors. This excludes personnel and procedures. |
| *VTS equipment* | – | within the G1111 guidelines, VTS equipment refers to the individual items of software, hardware, communications and sensors, which make up the VTS system. |
| *VTS user* | - | within the G1111 guidelines, VTS user is defined as someone with either an operational, technical, or administrative need to use or access the VTS system. |

The other 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.

# Abbreviations

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 Marine 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

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 Electronics Engineers

IETF Internet Engineering Task Force

IHO International Hydrographic Organization

IMD Indian Meteorological Department

IMO International Maritime Organization

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

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, Authorization 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

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 Service or Vessel Traffic Services (dependent on context)

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. IALA. Recommendation R0128 (V-128) Operational and Technical Performance of VTS Systems.
2. IALA. Guideline G1150 Establishing, Planning and Implementing a VTS