



IALA GUIDELINE

G1111-2 PRODUCING REQUIREMENTS FOR VOICE COMMUNICATIONS

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1. INTRODUCTION

Radio communication equipment is typically integrated into VTS applications to provide the vessel traffic service operator (VTSO) with a real-time means of disseminating information from the traffic image to VTS participants to support safe navigation of the VTS area.

The intent of this Guideline is

- To be a common source of information on VTS voice communication systems.
- To provide detailed information about functional and performance requirements regarding voice communication in VTS systems

1.1. THE IALA G1111 GUIDELINE SERIES

This sub-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, 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 requirements affect 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:

- G1111 Establishing Functional & Performance Requirements for VTS Systems and Equipment
- 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
- 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 and Equipment

A VTS system primarily comprises three elements: an IT platform, software functionality and a suite of communication devices and sensors. The Communication devices and sensors are each covered by the new sub-Guidelines *G1111-2* to *G1111-8*.

2. OPERATIONAL CONSIDERATIONS

2.1. OPERATIONAL OVERVIEW

Communication is an essential part of a VTS system. It is the means by which a VTSO can provide essential navigation advice to visiting vessels for the purpose of improving navigational safety and efficiency. Therefore, a VTS provider should ensure that the VTS communication system enables VTSOs to easily call the correct vessel and correctly

identify an incoming caller over clear voice communication channels. The VTS provider should clearly identify the area over which voice communication is required and the operating ranges for the types/ sizes of vessel that will be participating in the VTS. In addition, the VTS provider should specify the required voice communication channels, the operational functionality that will be used, and the sites where it is possible to install equipment.

As specified in ITU *R M.689-2* [1], the use of Digital Selective Calling (DSC) may be included within the voice communication system as a means of improving efficiency.

The VTS provider can use IALA Guideline *G1150 Establishing, Planning and Implementing a VTS* [2] and could apply this process to the defined VTS Area to determine the precise functional requirements for the VTS design and procurement, including the voice communication requirements.

A VTS is typically implemented in three situations, as follows:

- Ports and Port Approaches
- Coastal VTS (such as a managed Traffic Separation Scheme)
- Inland VTS

2.2. PORT AND PORT APPROACHES

The port approach area is usually within the 12NM zone but may extend beyond. Due to the nature of a port approach and the activities that take place, it is likely that a high volume of VHF communication takes place in the port approach area. The VTS Provider might consider that some operations, such as bunkering, may be assigned a specific channel in order to keep other channels clear for navigation and VTS-related communication.

The port area typically consists of confined waters. Traffic includes sea-going vessels, allied services vessels and, possibly, inland waterway vessels and leisure craft. Due to the VTS workload a port may be divided into sectors with a separate VTSSO responsible for each defined sector. A radio plan should define specific radio channels for use in each of the sectors.

The required VHF range is usually very limited, but might be obstructed or subject to reflections, even if only temporarily, by cranes, moored or passing vessels, cargo and buildings. For this reason, special attention should be given to VHF antenna siting.

2.3. COASTAL VTS

A coastal VTS may be established to manage vessel traffic through a traffic separation scheme or when in transit passage through an international strait, to assist vessels in navigating specific obstacles (such as bridges) or to guide vessels safely through marine protected areas. In such cases, VTSSOs will be in communication with all visiting vessels to ensure that they are aware of the prevailing regulations and to ensure that they have provided the necessary pre-arrival information. A radio plan should be published according to legislation to simplify communication with vessels approaching from different directions by allocating a specific channel to a vessel based on their direction of approach. However, different approaches (e.g., based upon workload) may occur.

Coastal VTS that are in busy areas with a high volume of voice communication are recommended to consider the use of MMSI based calling using channel 70 (DSC) to increase communications efficiency.

2.4. INLAND WATERWAY

Inland waterways, such as rivers and canals, are confined waters that may be used by a large variety of vessels, ranging from sea-going vessels to recreational vessels. Locks, bridges, and waterway intersections may be present that might require special attention from VTSOs. VHF communication with locks, bridges may be outside VTS responsibility.

The inland waterways VTSO will be required to manage all types of vessel that use the waterway, from commercial ships to leisure vessels. Due to the confined nature of inland waterways, fast and correct identification of calling vessels is essential. Systems such as the ATIS system (used on European Inland Waterways) transmit the vessel identity digitally within the VHF voice call in order to provide easy access to vessel identity information for the VTSO. Such systems could be considered for use on other inland waterway systems.

2.5. COVERAGE

Typically voice communication for VTS operations can be achieved using the Maritime VHF band for voice and DSC, and many VTS systems are only implemented for GMDSS Sea Area A1.

However, VTS providers may choose to implement extended coverage based on the sea areas defined by the GMDSS:

- Sea Area A1: the area within the radiotelephone coverage of at least one VHF coast station in which continuous DSC (Digital Selective Calling) alerting is available;
- Sea Area A2: the area, excluding Sea Area A1, within the radiotelephone coverage of at least one MF coast station in which continuous DSC (Digital Selective Calling) alerting is available;
- Sea Area A3: the area, excluding Sea Areas A1 and A2, within the coverage of an Inmarsat geostationary satellite in which continuous alerting is available; and out of scope of this document
- Sea Area A4: an area outside sea areas A1, A2 and A3 and out of scope of this document

2.5.1. VERY HIGH FREQUENCY (VHF)

The Maritime Mobile VHF Band, as per the ITU-R, comprises a number of channels within the frequency range of 156.025 MHz to 162.025 MHz. These are mainly used for voice communication except channel 70 (DSC) and the channels allocated specifically for AIS. The VTS authority may require VHF Channels to be designated / licensed by the national radio authority for specific types of operations (e.g., Coast Station Radio License). Specific channels are determined to provide safety watch, DSC and VTS information.

The VHF equipment should comply with national and international regulations, particularly with the Master Plan of shore-based facilities for GMDSS [3]. The use of 25 KHz simplex and duplex channels can be used in accordance with the appropriate ITU-R and national regulations. Additionally, 12.5 KHz channels are also allowed under Appendix 18 of the Radio Regulations in accordance with ITU-Radio Regulations

As it evolves, e-Navigation will enable greater use of data communication between ship and shore. Such data communication between ship and shore or ship to ship can be implemented within the VHF Marine Band in accordance with ITU-R *M.1842-1* [4]. However, it should be noted that certain duplex channels in the maritime VHF band will be converted to the VHF Data Exchange System (VDES) data service and will therefore no longer be available for voice communication.

2.5.2. MEDIUM AND HIGH FREQUENCY (MF AND HF)

MF and HF may be used on a regional basis where medium and long range communication is required. The VTS provider may require specific channels to be designated by the national radio authority for specific types of operations. The equipment should comply with national and international regulations.

2.6. EMERGENCY SITUATIONS

The Global Maritime Distress and Safety System (GMDSS) is a worldwide system for automated emergency signal communication for ships at sea developed by the United Nations' International Maritime Organization (IMO) as part of the SOLAS Convention.

GMDSS comprises several communication systems that are intended to enable any participating vessel to call for assistance when in distress. As identified in section 4.5 above, it includes VHF, HF and MF voice communication frequencies as well as DSC frequencies across these bands.

3. PRODUCING FUNCTIONAL AND PERFORMANCE REQUIREMENTS

3.1. FUNCTIONAL AND PERFORMANCE REQUIREMENT OVERVIEW

Operational requirements outline the user needs. Technical, functional and performance requirements define the equipment used, what the equipment can do and how it needs to perform. VTS providers should avoid being too prescriptive regarding the technical requirements of the voice communication system to enable innovative solutions to be offered.

In general, radio equipment that is designed and programmed for use on board a ship should not be used in a VTS. This is because a radio for shipboard use must ensure duplex channels can be selected and used for communications with shore stations such as a VTS – the ship transmit frequency aligns with the shore station receive frequency.

e.g., Channel 28 is a duplex channel, with one defined channel for transmit and one for receive. The definition of these are opposite for a vessel and a coast station radio. Coast station transmit is 162 Mhz and the coast station receive is 157.400 Mhz. This means that the ship radio must be programmed such that the ship transmit is 157.4 Mhz and ship receive is 162 Mhz.

If however, the VTS provider used shipboard radios as a coast station radio then coast station transmit is now 157.4 Mhz but ship board receive is 162Mhz, which results in the transmission not being received.

VTS Radio Communication equipment should be designed and configured for coast station operation.

Functional requirements are the operational facilities provided by the communication equipment and their user interface. Voice communication functionality will probably be implemented in software and therefore the user interface and facilities may vary from one supplier to another, even if using the same physical hardware. Therefore, functional requirements should be about coverage, the number of (simplex/duplex) channels required for each VTS-centre, availability per VTS working position, recording facilities etc.

Performance requirements relate to the operational capability of the communications equipment and its ability to deliver the performance that is defined within the operational requirements. Achieving defined performance requirements may require one or more coastal radio sites and where multiple sites are necessary, additional functional requirements may need to be specified in order-e.g., to achieve best signal.

3.2. FUNCTIONAL REQUIREMENTS

VTS centres require a means of clear and “easy to use” voice communication for interacting with ships. Within the VHF band, the VTS centre might require the availability of a number of additional radio channels depending upon the number of ship movements and the size of the VTS area. The functionality requested should reflect its intended operational use, so a clear definition is essential. e.g., a VTS provider should confirm whether specific voice channels are to be continuously monitored or whether a particular receiver might scan a number of channels to search for calls.

Built-in test equipment (BITE) features should include monitoring of functions and performance.

3.2.1. USER INTERFACE

VTS providers should give careful consideration to ensure that the user interface of the voice communication system eases the operator workload and does not cause complications. Sometimes mistakes in voice communication are a factor in maritime accidents and so the voice communication system needs to present the VTSS with an unambiguous status display to enable accurate and efficient communication.

The user interface should provide easy identification of incoming calls and provide a simple means of channel selection.

It is common for modern voice communication systems to use a touch screen display for presenting the status of all radio equipment and to enable channel and radio selection. The status display should clearly present the current operational status of each item of radio equipment with clear indication of incoming calls and when a ship is transmitting. The operator display should also be able to provide facilities for handling the transmission and reception of DSC messages.

The voice communication system operator display could include:

- Channel selection facilities
- Radio Station selection facilities
- Push-to-talk functionality
- Squelch control
- Visual transmit indication
- Visual receive indication
- Signal strength indication (where available)
- Capability of displaying DSC messages
- Capability to send DSC messages
- Capability to display ATIS code or similar (where applicable)
- System status information (e.g., warnings, alarms)
- Replay facilities

The voice communication user interface may be implemented using some or all of the following components and should allow easy switching between connected devices:

- Graphical presentation (typically a touch screen display).
- Microphone
- Loudspeaker

- Hand switch (PTT)
- Foot switch (PTT)
- Headset

3.2.2. CALL MANAGEMENT (MULTIPLE RADIO COAST STATIONS)

Where a VTS System comprises multiple radio coast station sites, calls to and from vessels may be received by more than one coastal radio site such that the status display shows reception of a single call at multiple sites which presents a challenge to the VTSO who needs to focus on the optimum signal. Call management techniques can help mitigate this and other effects, some examples are provided in the sub-sections below.

3.2.2.1. Automatic selection of best audio quality.

When a ship is transmitting and the signal is received at multiple radio stations sites, the status display will appear to show multiple incoming calls. However, the signal strength will vary depending on the distance of each radio station from the ship and lower signal strength might lead to lower quality audio. In order to ensure that the operator receives the best quality audio, the voice communication system should monitor the received signal strength at each site and automatically route the best quality audio signal to the VTSO.

3.2.2.2. Adjacent Station Channel Muting.

When the VTSO transmits from a coastal site there is a highly probability that the transmitted signal will be received by the VHF receivers at an adjacent VHF site as well as by the ship. This is especially true when omnidirectional aerials are used. To the VTSO, this will appear to be another incoming call at the adjacent station but in reality it is the result of its own transmission. Adjacent station channel muting will mute the receivers at the adjacent station on the channel used for transmission to avoid this potential confusion.

3.2.2.3. Duplex channel retransmission

Where continuous monitoring of a duplex channel is required, communication from a ship to a VTS Centre will not be heard by other ships, whereas communication from the VTS centre to ships will be heard. Hearing only half of the conversation will not enable mariners to fully understand the situation. This can be overcome by instantaneous retransmission of the incoming call on the other part of the duplex channel, being used by the VTS operator, so it is received by all other ships.

3.2.3. NOISE SUPPRESSION

Clear voice communication is essential to VTS operations and so the user interface of the voice communication system should include functionality for suppressing low level background noise (typically known as squelch).

3.2.4. DIGITAL SELECTIVE CALLING (DSC)

DSC provides additional facilities that can improve the effectiveness of VHF voice communication. DSC initiated calls (using commands transmitted on VHF Channel 70) can be addressed to a ship by using its MMSI. This means that the VTSO can be certain that the call can only be answered by the correct vessel. In addition, a DSC call can make the radio equipment on the bridge of a ship produce an audible alarm. In certain situations, this can be useful for alerting an unresponsive crew.

Other DSC facilities, including receipt of GMDSS DSC emergency calls can be managed through an effective DSC interface.

3.2.5. RECORDING AND REPLAY

The voice communication system shall record all conversations time synchronized with the traffic image recording for a number of days specified by the VTS authority or national administration.

The replay of a recorded conversation by a VTSO shall be possible at any time, without interrupting the recording. A clear indication should be given that a replay is active.

3.3. PERFORMANCE REQUIREMENTS

The selection of antenna parameters (height, gain, polarization etc) for a given installation is vital to the resulting VHF performance. VTS providers are, however, advised to avoid specifying detailed antenna characteristics, in favour of specifying performance requirements such as:

- Coverage area and range performance
- Overlapping and redundant coverage

The identified performance requirements will allow the supplier some flexibility in trying to achieve the optimum solution within any constraints imposed such as budget and site location options.

VHF radio communication is *generally* dependent upon the line-of-sight between the VTS VHF antenna site and the ship VHF antenna.

VHF coverage area should be determined based on the maximum range required for communication with the smallest size of participating vessel. Large vessels such as very large crude carriers (VLCC) normally have their communication antenna on a mast on the roof of the bridge. In such cases, the antenna may be at a height of 30m or more above sea level whereas a pilot vessel may have communication antenna at heights of less than 10m above sea level and therefore communication would normally be possible with the VLCC at a greater range than for a pilot vessel.

Due to the curvature of the earth and properties of VHF propagation, the actual range for VHF transmission is slightly further than “line of sight” and is determined by the height of the antenna’s (sending and receiving antenna). The formula below can be used for a calculation of the antenna range, or vice versa calculating which antenna height should be used to achieve a certain reach.

$$S(h_1, h_2) = 3,57 * (\sqrt{h_1} + \sqrt{h_2}) \quad (1)$$

where:

S = maximum line of sight in kilometres

h_1 = antenna height station 1 in metres

h_2 = antenna height station 2 in metres

3.4. INSTALLATION CONSIDERATIONS

3.4.1. SITE CONSIDERATIONS

Appropriate and available sites for the installation of voice communication equipment need to be specified. A voice communication site will need facilities for the installation of antenna equipment in an elevated position. This may be achieved through the provision of a communications tower or a multi sensor tower that also hosts other equipment. It should be noted that where multiple antenna installations are required at a single location, there must be appropriate vertical separation between antennas. The site should also provide space to house rack mounted equipment, preferably in a temperature-controlled environment.

The following should also be taken in account when establishing coastal radio sites:

- Lightning protection
- Wind load on structures housing the aerials

- Capacity of radio tower
- Ice build up
- Maintenance considerations
- Legal access for example if maintenance staff need to drive over private land

Externally installed electronic equipment should be in an appropriate environmental enclosure. IEC requirements should be applied as far as relevant. In addition the siting and installation of radio communication equipment should make provision for accessibility, maintenance, and repair. Also, provisions regarding logging and monitoring should be taken into account.

Consideration should be given to the power output of the radio system at the antenna instead of the power output at the radio equipment.

Care must also be taken that proper separation is maintained when co-locating antenna sites.

Sites for radio communication equipment should be selected based upon optimizing the coverage of the VTS area and the ability to provide the required services e.g., telecommunication links and access. Considerations include availability of electrical power, physical security of the site, housing, and possible co-location with existing infrastructure.

In areas with ATEX restrictions, requirements to reduce transmit power (both ships as well as VHF sites) may apply.

3.4.2. ANTENNA ARRANGEMENTS

A typical marine VHF antenna is designed with vertical polarization. This means that the best performance from the antenna will be achieved when the antenna is mounted perfectly vertical. Any angle beyond vertical will lessen the performance of the antenna.

It should be noted that multiple radio transmitters can be combined to operate through the same antenna. The result of this action is that the output power of connected radio equipment will be reduced. For example, the use of two radios transmitting through a single antenna will result in a 50% reduction in output power. However, it should be noted that achieving the required range performance is primarily a function of height above sea level.

Antennae can be configured as transmit/receive or as single function antenna. A single function (receive) antenna can be split to the receive connection on all voice communication base station equipment. Where there are multiple radios on a single site, a single function (receive) antenna should be installed at the highest location so that it has the best chance to receive weaker signals from small vessels at long range. Transmit antenna would then be installed at lower positions on the tower (to maintain the appropriate vertical separation). Whilst they will be lower and potentially suffer a loss of range performance, a single transmitter transmitting through a single antenna will transmit at its full power output.

Local legislation or regulations considering antenna height and transmission power, as well as practical considerations such as availability of sites for installation will lead to an overall antenna layout design. Use of omnidirectional antennae or directional antennae may be part of this process.

VHF range on inland waterways is often limited by obstructions along the banks of a meandering river. Local legislations may restrict antenna height and transmission power.

3.4.3. INTERFERENCE

Radio communications equipment complies with applicable international standards and regulations. The avoidance of interference is essential; therefore equipment should be installed in accordance with manufacturer's instructions and monitored to ensure that instances of interference are investigated and rectified.

Special attention should be given during the design stage to ensure electromagnetic compatibility (EMC) of radio communication equipment used. Frequency spectrum (i.e., VHF working channels), used for VTS radio communication, must be agreed with the national radio licensing authority.

3.4.4. VTS CENTRE LAYOUT

Special attention should be given to equipment in a situation with multiple VTSOs in a same room. Voice communication from one VTSO may disturb the work of another. Assessing the acoustic properties of the proposed VTS Centre may be appropriate and assist in the design of acoustic barriers or directional speakers to enable multiple operators to work side by side undisturbed.

3.4.5. NETWORKING

VTS systems with multisite VHF requirements should be aware that network latency is something to be considered as voice communications are sensitive to delays, resulting in delays in conversation which is inconvenient both for VTSO and for the mariner.

Modern VHF systems are typically implemented using of Voice over Internet Protocol (VoIP) technology enabling the voice communication to use the same network as other elements of the VTS system. This allows for a more efficient use of infrastructure, more flexibility and optimized system design

VoIP is a common implementation for transporting voice over a network. Within VoIP several implementations have been defined including, RTP H.323, ED-137 (Air Traffic) and SIP(Telephony). Interface standards will thus be dependent on the requirements of the VTS provider and/or the implementation from the supplier regarding the equipment being installed.

3.4.6. REDUNDANCY ARRANGEMENTS

Modern voice communication systems can provide facilities that enable remote channel selection for individual receivers and transmitters. Therefore, redundancy can be provided by including an extra receiver and an extra transmitter at radio sites and using them, when required, to replace a device that has failed.

4. DEFINITIONS

The definitions of terms used in this Guideline can be found in the *International Dictionary of Marine Aids to Navigation* (IALA 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. VTS definitions are as follows:

VTS System	–	within the <i>G1111</i> guidelines, the VTS System is the VTS software, hardware, communications and sensors. This excludes personnel and procedures.
VTS Equipment	–	within the <i>G1111</i> guidelines, VTS Equipment refers to the individual items of software, hardware, communications and sensors, which make up the VTS System.
VTS User	-	within the <i>G1111</i> guidelines, VTS User is defined as someone with either an operational, technical, or administrative need to use or access the VTS System.

Specific terms in this document are defined as follows:

ATIS	Automatic Transmitter Identification System in use in certain European inland waters. At the end of transmission an ATIS code is transmitted as identification, resulting in displaying the ships call sign on the VHF UI.
ATEX	ATmosphères EXplosibles; A European Guideline for areas with danger for explosions under atmospheric circumstances



Simplex	Communication is done via one frequency. Both transmitter and receiver use the same frequency.
Duplex	Communication is done via 2 different frequencies enabling bi-directional communication.
Directional antenna	A directional antenna is an antenna which radiates or receives greater power in specific directions
Omni-directional antenna	An omnidirectional antenna is a class of antenna's which radiates power equally in all directions.
Antenna Gain	A relative measure of an antenna's ability to direct or concentrate radio frequency energy in a particular pattern or direction. This measurement is typically measured in dBi (Decibels relative to an isotropic radiator) or in dBd (Decibels relative to a dipole radiator). However, in most marine VHF antenna specifications it is simply stated as dB gain.
RTP	Realtime Transport Protocol; is a network protocol for delivering audio and video over IP networks.
SIP	Session Initiation Protocol; is a signalling protocol that enables the Voice Over Internet Protocol (VoIP)
ITU	International Telecommunication Union.
VDES	VHF Data Exchange System; a radio communication system that operates between ships, shore stations and satellites on Automatic Identification System (AIS), Application Specific Messages (ASM) and VHF Data Exchange (VDE) frequencies in the Marine Mobile VHF band.
PTT	Push To Talk ; A push-to-talk switch or button is used to switch users to transmit mode.
EMC	Electromagnetic compatibility (EMC); the ability of electrical equipment and systems to function acceptably in their electromagnetic environment

5. REFERENCES

- [1] ITU. ITU R M.689-2 - International maritime VHF radiotelephone system with automatic facilities based on DSC signalling format.
- [2] IALA. Guideline G1150 Establishing, Planning and Implementing a VTS
- [3] IMO. Master Plan of shore-based facilities for GMDSS (IMO information related to shore-based facilities for the Global Maritime Distress and Safety System)
- [4] ITU. ITU R M.1842-1 - Characteristics of VHF radio systems and equipment for the exchange of data and electronic mail in the maritime mobile service.