# 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.

## Definitions and References

### Definitions

For general terms used throughout this section, please, refer to references.

### References

1. Convention on Safety of Life at Sea (SOLAS) Chapter IV (Radio Communications).
2. Convention on Safety of Life at Sea (SOLAS) Chapter V (Safety of Navigation) – Regulation 12.
3. Convention on Safety of Life at Sea (SOLAS) Chapter V (Safety of Navigation) – Regulation 19.
4. IMO Resolution A.686(17) - Code on Alarms and Indicators (and MSC.39(63) Adoption of amendments to the Code on Alarms and Indicators.
5. IMO Resolution A.694(17) - General Requirements for Shipborne Radio Equipment forming Part of the Global Maritime Distress and Safety System (GMDSS) and for Electronic Navigational Aids.
6. IALA World Maritime Radio Communications Plan.
7. IEC 60945 - Maritime navigation and radio communication equipment and systems - General requirements, methods of testing and required test results.
8. IEC 61162 - Digital Interfaces for Navigation Equipment within a Ship.
9. ETSI EN301 929-2 v1.2.1 - Electromagnetic compatibility and radio spectrum matters (ERM): VHF transmitters and receivers as Coast Stations for GMDSS and other applications in the maritime mobile service.
10. ITU-R M.493-11 - Digital selective-calling system for use in the maritime mobile service.
11. ITU-R M.541-9 - Operational procedures for the use of Digital Selective Calling equipment in the Maritime Mobile Service.
12. ITU-R M.689-2 - International maritime VHF radiotelephone system with automatic facilities based on DSC signalling format.
13. ITU-R M.1082-1 - International maritime MF/HF radiotelephone system with automatic facilities based on DSC signalling format.
14. ITU-R M.1084-5 – Interim solutions for improved efficiency in the use of the band 156-174 MHz by stations in the maritime mobile service.
15. 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.
16. IMO Resolution A.801(19) – Provision of Radio Services for the GMDSS.

## Characteristics of Radio Communication Equipment

Radio communications links are used to collect position, safety, and general information from shipboard personnel and remote sensing devices. These links are also the primary means through which services are delivered to VTS participants.

### Coverage

Radio communication equipment is adapted to guarantee the coverage of the GMDSS [16]:

* 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°North and 70°South.

* 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.

### VTS Radio Communication

VTS radio communication comprises both voice and data services and potentially video applications using equipment consistent with the GMDSS Sea Areas indicated above.

#### Very High Frequency (VHF)

The Maritime VHF band comprises a number of channels within the frequency range of 156 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. The use of simplex, duplex and semi-duplex channels as well as 25 kHz 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-R M.1084 [14].

VTS Centres require a means of clear and easy to use voice communication for interacting with ships. Within the VHF band, the VTS Centre will require the availability of a number of radio channels relative to the number of ship movements and the size of the VTS area. In addition to distress calling, DSC provides a means of direct calling to vessels through the use of the MMSI and other routine call functions.

As it evolves, e-Navigation will rely more and more on 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 [15]. Following the introduction of this regulation, it is anticipated that a digital infrastructure over Maritime VHF will become available.

#### 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 Authority 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. Also, MF is used for the distribution of DGNSS correction signals.

#### Satellite Communications

Exceptionally, communication via satellite may be required, depending on geographic terrain, shoreline of country and service provided by the VTS.

## Operational Requirements

### Radio Communications Coverage

The VTS Authority should ensure that the VTS radio infrastructure provides adequate coverage for the VTS area.

VHF radio reception is generally dependent upon the line-of-sight distance between VTS receive site and the ship antenna heights. As a minimum requirement, the radio communications range should facilitate VTS ship communications before the ship enters a VTS area of responsibility.

### Recording and Playback of Data

The VTS Authority should have the facility to automatically record radio communications and play back these recordings in synchronisation with the recorded traffic situation.

## Functional Requirements

Shipborne equipment should meet the functional requirements of the relevant IMO performance standards and the ITU-R Radio Regulations (see Section 8.2). Shore based equipment should also conform to the appropriate local technical standards.

### Digital Selective Calling

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. DSC is a standard feature of the GMDSS.

The use of DSC makes more efficient use of the available bandwidth. In addition, DSC is also used for distress calling. Further details are provided in ITU-R M.541-9 [11] and ITU-R M.689-2 [12].

### Malfunctions, Warnings, Alarms and Indications

Please refer to the relevant requirements of IMO Resolution A.686(17) [4].

## Specific Design, Installation and Maintenance Considerations

The radio communication systems should be specified taking the considerations in Section 1 into account. This should also consider lightning protection, wind load on antennas and maintenance access. The build-up of ice in some climates should also be a consideration.

### Durability and Resistance to Environmental Conditions

Externally installed electronic equipment should be in an appropriate environmental enclosure. IEC requirements should be applied as far as relevant.

### Interference

Radio communications equipment complies with applicable international standards and regulations - see IEC 60945 [7], which covers the general requirements for navigation and radio equipment and includes interference. 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.

### Power Supply

IEC requirements should be applied as far as relevant. In remote locations, authorities should consider the use of renewable power sources (e.g. solar panels or wind turbines, in combination with batteries) as an alternative to diesel generators. In addition, uninterruptible power supplies could be considered as a backup to the primary power supply.

### Site Selection and Installation

Operational requirements will determine where radio communication transceivers and antennas are to be located and how many are required.

Consideration should be given to the power output of the radio system at the antenna instead of the power output at the radio equipment. Note that, where multiple transceivers are combined and/or filtered through to a single antenna, the effective radiated power could be reduced significantly.

Care must also be taken that proper separation is maintained when co-locating antenna sites (see also section 8.6.2).

To avoid channel saturation, consideration should be given to subdividing the VTS area into communications sectors based upon channel use with adjacent sectors using separate channels.

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.

### Maintenance

In addition to the requirements of IMO Resolution A.694(17) [4], the siting and installation of radio communication equipment should make provision for accessibility, maintenance and repair.

### Interfacing

Although there are internationally agreed interface standards for interfacing electronic equipment on board ships (IEC-61162-1 and IEC-61162-3 [8]), VTS radio communication interfaces ashore are mostly vendor-specific. An exception is VoIP, which is standardised by industry and the Internet Engineering Task Force (IETF). Interface standards will thus be dependent on the requirements of the VTS Authority and the equipment being installed.

However, work within the IALA e-NAV committee and other organisations aim for open systems architecture with associated international standards, which may be adopted as developed.

### Back-Up and Fall-Back Arrangements

Backup facilities can be provided by duplicated radio communication equipment based on an availability assessment.

Fall-back arrangements, via a business continuity plan, should be considered such as handing over operations to another VTS.

Built-in test features should include monitoring of functions and performance.

### Development and Innovations

VTS authorities are currently making use of Internet Protocol (IP) technology such as VoIP solutions on radio sites and internal communications. This allows for a more efficient use of infrastructure, more flexibility and optimised system design. VoIP technology (especially when applied for VTS radio communications) is very sensitive to delays in the IP network. Excessive delays may cause significant degradation of VHF communication quality. Additional challenges include the need to use the IP packet 'Quality of Service' functionality by the IP network to minimize negative effects such as latency and jitter.