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| IALA Guideline |

DraFT G1111-7

Producing Requirements for radio direction finders

Functionality and performance specifications

Working paper, output from VTS 51

Edition 1.0

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

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|  | Edition 1.0  This document originates from IALA Guideline G1111 (ed 2015), which has been redeveloped as the G1111 series of guidelines concerning establishing functional & performance requirements for VTS Systems. Document revisions include document structure realignment and verification of currency and accuracy of the content. |  |
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# INTRODUCTION

This Guideline presents a common source of information to assist VTS authorities in the understanding of radio direction finders, supporting the design of a radio direction finding service and its contribution to the VTS traffic image (situational awareness) as well as guidance of how the VTS Authority should specify the associated functional and performance requirements.

The guideline considers the potential application of RDF within a VTS area (e.g. inland waterways, Harbours, Coastal regions and offshore).

This includes considerations relative to environmental conditions such as weather, sea conditions, geographical constraints, and obstructions, posing challenges to the detection and coverage of RDF sensors.

Specific maritime security requirements possibly identified by the International Ship and Port Security code and other requirements from allied services may introduce additional challenges.

## The IALA 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:

* 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

# DEFINITIONS

## General Terms

For general terms used throughout this section refer to ~~IEEE Std 686-1997 IEEE Standard Radar Definitions~~ ***(replace with appropriate references for series topic).***

## Specific Terms

Specific terms are defined as follows:

**Specific Term in bold –** details in normal text. Include items specifically relative to the series topic.

## Specific IALA Definitions

**Specific Term in bold –** details in normal text. Include items specifically related to the series topic where IALA has additional clarifying details to common definition (if common definition exists. If no common definition exists, use the IALA definition on its own.)

# References

1. Include references that are specific to the series topic.

# Abbreviations

Please refer to IALA G.1111 Establishing Functional and Performance Requirements for VTS systems for an extensive list of abbreviations and acronyms covering the entire G1111 series

*(If the above isn’t the consensus, then the text below is suggested for template purposes)*

**Specific acronym in bold –** full name in normal text. Include acronyms specific to the series topic.

# Operational Overview

This guideline considers application of RDF to VTS areas of responsibility. These areas may vary in the types of risks, vessels and their interactions, the required sensor ranges and the types of services.

Radio Direction Finders (RDF) are a sensor system that supports VTS and SAR operation by indicating the direction/bearing to a VHF transmitting station. Since a RDF only indicates the bearing of the transmitting station relative to the RDF sensor location, two or more appropriately located RDFs are needed to estimate the position of the transmitting station.

The necessary Functional and Performance requirements may differ throughout the geographical area of VTS responsibility. As such, setting the Functional and Performance Requirement should be conducted precisely for each unique area to make sure the navigational risks are mitigated and VTS Operators can provide services smoothly.

VTS authorities should consider the need for an RDF system based on the type of traffic in the VTS area, such as

the presence of non-SOLAS class vessels and recreational vessels that do not carry an AIS transponder (assuming

the VTS is able to receive AIS data). The VTS Authority should assess the requirement for a RDF system based on

a risk assessment of these and other relevant factors.

When a RDF system is assessed as being necessary, the VTS authorities should, at least, consider the following:

* the required RDF coverage area, based on:
* possible RDF location(s);
* waterway structure and navigational hazards;
* the types of ships to be detected;
* expected meteorological conditions.
* the declared VTS level of capability and possible responsibilities for SAR;
* the required bearing accuracy;
* the required frequency range of the RDF equipment (this may e.g. include frequencies used for SAR);
* the number of simultaneously monitored VHF channels;
* other influencing factors, such as obstructions in the line of sight and the presence of potential reflective surfaces, which may reduce the performance of an RDF system.

## Areas of Coverage

These areas vary in the types of risk, the vessels and their interactions, the required sensor ranges and, possibly, the types of service. There may be several different operational areas depending on the VTS area of interest.

RDF functional and performance requirements will differ in these operational areas, so identifying the appropriate requirements should be a careful process, balancing cost and, sometimes opposing, performance requirements (e.g. probability of detection versus precision of bearing accuracy).

The recommended method for determination of RDF coverage and range performance is a combination of site

inspections and RDF system performance calculations. Figure 15 provides an example of such a calculation.

(insert Figure 15 here)

The evaluation should include:

* calculation of VHF Radio Range based on RDF antenna height and minimal VHF antenna height on the target

of interest;

* calculation of all applicable losses (target’s VHF transceiver power, required RDF sensitivity, losses in VHF

cable etc.);

* evaluation of the effects from propagation conditions and obstructions; and
* influence of meteorological conditions.

The calculations may be supplemented by comparison and/or validation test.

Inland waterways, like rivers and canals, are confined waters that are used by a large variety of vessels, ranging from sea-going vessels (e.g. a river section as part of the port approach), river-trade, allied services vessels, ferries and even recreational vessels. Traffic separation may be as low as a few metres. This requires a high precision of bearing accuracy.

Port area…..

Port approach……

Coastal area……

Offshore…..

## Bearing Accuracy

One of the most important performance parameters of the Radio Direction Finder system is the bearing accuracy.

Besides the technical characteristics of the RDF equipment, many other factors may significantly reduce the

bearing accuracy in real conditions. Therefore, the following aspects should be taken into account when

assessing bearing accuracy:

* the specified RDF equipment bearing accuracy - typically specified for 'near to ideal' conditions;
* the environment of the RDF antenna;

Multipath signal propagation, caused by reflections from surrounding objects, can significantly deteriorate the bearing accuracy.

* .the received signal strength. Low received signal levels may significantly reduce the bearing accuracy. Major factors affecting received signal strength are:
  + distance to the target;
  + RDF receiver(s) sensitivity, antenna gain and feed losses;
  + weather conditions;
  + output power and duration of transmitted signal.
* the delay between signal detection and output for presentation should be no more than 3 seconds.

The main cause of this delay is the internal processing of the received signal within the RDF system to achieve declared accuracy.

In order to achieve the best possible performance, proper calibration is essential and will mitigate against the

adverse effects of some of the factors listed above.

The recommended bearing accuracy for different levels of capability is provided in Table 20.

***Table 20: Recommended Standard Deviation of the RDF Bearing Accuracy***

|  |  |  |
| --- | --- | --- |
| **Level of Capability** | | |
| Basic | Standard | Advanced |
| ≤ 5˚ | ≤ 3˚ | ≤ 2˚ |

## Frequency Range

Since the main purpose of RDF is detection of VHF communication devices, the frequency range of RDF should, at

least, correspond to the frequencies used for marine VHF communications. Additionally, support for standard

SAR frequencies (121.5 MHz, 243 MHz and 406 MHz) may be required if the VTS Authority has a responsibility for SAR operations.

## Number of Simultaneously Monitored VHF Channels

RDF may support simultaneous or almost simultaneous reception on multiple VHF frequencies. This can be

achieved using one or several VHF receivers (typically 4-8).

The single-receiver RDF can be switched to any VHF channel at any time. This can be done manually or

automatically (when the RDF receiver scans a pre-defined list of VHF channels).

There may also be a need to monitor several VHF channels at the same time. For example, SAR channels and VHF

channel 16 may be required to be monitored simultaneously, while all other VHF working channels are monitored

selectively. In such a situation, the use of a multiple-receiver RDF is required.

# Producing Functional and Performance requirements

Producing functional and performance requirements for VTS RDF is an interactive task involving iterations, including evaluation of achievable performance versus overall system cost.

The requirements should be based on Business Case, Feasibility study (on risk, operational feasibility, legality, technical capability, budget, and time) as described in IALA Guideline G1150. This included that the feasibility study on risk should specify the risks within interested area and the way to handle or mitigate the risks.

## VHF Channel Management

There are two types of RDF systems available on the market:

* RDF systems with a single-channel receiver;
* RDF systems with a multi-channel receiver.

RDF systems with a multi-channel receiver may simultaneously receive and process multiple frequencies. Which

RDF system is appropriate for the VTS Authority should be determined from the operational requirements.

Single-channel receiver RDF systems should, as a minimum, include:

* remotely controlled selection of VHF channel;
* automatic channel scan function from a pre-defined list of working channels;
* if relevant, prioritization of SAR channels in scanning mode.

Multi-channel receiver RDF systems should, as a minimum, include:

* remotely controlled selection of VHF channels for each receiver;
* automatic channel scan function from a pre-defined list of working channels for one or more receivers;
* simultaneous output of detected bearings for all receivers.

## SAR Functionality

Where VTS authorities have SAR responsibilities, additional functionality of RDF equipment may be required, such

as:

* detection of devices transmitting on SAR frequencies;
* automatic filtering of Emergency Location Transponder (ELT) tones of Man-Overboard EPIRB devices;
* receiving and decoding of COSPAS/SARSAT signals.

## Man Overboard EPIRB Detection Capabilities

This capability ensures detection of specific standardized ELT codes transmitted by EPIRB devices. It minimizes the probability of false alarms, caused by spurious transmissions on SAR frequencies.

## COSPAS/SARSAT Detection and Decoding

This capability ensures reception and decoding of digital data transmitted by COSPAS/SARSAT radio beacons. Received data contains the identification number and the measured geographic coordinates of the radio beacon, which can be used for SAR planning.

# design, installation and maintenance considerations

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

RDF antenna installation requires careful consideration, especially with regard to the site. The following aspects should be considered:

* the RDF antenna should be placed on a very stable support to avoid any rotation or torque as this directly affects RDF bearing accuracy;
* the antenna height should be sufficient for detection of VHF transmissions from the targets of interest across the coverage area;
* the presence of objects and geographic features that might cause reflections or the blocking of signals;
* rotating or moving objects (like radar antennas and PTZ CCTV) should be a safe distance from the RDF antenna (refer to the manufacturer’s instructions).

## Lightning Protection

Typically, a RDF antenna is placed on the very top of a mast, so special attention should be paid to lightning

protection of the structure. It should provide adequate lightning protection without causing reflections and/or

obstruction of the incoming VHF signals.

## Calibration

Calibration should be performed according to the manufacturer’s instructions and should be revisited if there are

significant changes to the equipment and/or environment.

## Built-In Test and Diagnostics

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