Part 80 - VHF Transceivers and Marine Radars

Andy Leimer
Equipment Authorization Branch

Federal Communications Commission
Office of Engineering and Technology
Laboratory Division
TCBs have been able to review these applications and may continue to do so.

The US Coast Guard regularly reviews Granted applications and contacts the FCC if there are issues – this may result in an Audit.

Presentation intended to clarify Maritime issues and review process.
The Global Maritime Distress and Safety System (GMDSS) is an international system which uses terrestrial and satellite technology and ship-board radio-systems to ensure rapid, automated, alerting of shore based communication and rescue authorities, in addition to ships in the immediate vicinity, in the event of a marine distress.

GMDSS is the general “umbrella” that cover many Maritime radio services.
Scope B3 – Maritime Services
GMDSS Overview (Cont.)
Scope B3 – Maritime Services
GMDSS – Radio Communications

- MF (including DSC) – 2 MHz Band
- HF (including DSC and telex) – 4, 6, 12, 16, 18, 22, and 25 MHz Bands
- VHF (including DSC) – 156 to 162 MHz
Scope B3 – Maritime Services
GMDSS Geographic Configuration

- Applies to cargo vessels >300 gross tons & passenger ships carrying more than 12 passengers when traveling on international waters or in the open sea.
- Depends on the sea area of which the ship will trade:
  
  [link](http://www.navcen.uscg.gov/marcomms/gmdss/area.htm)

  - **Sea area A1** is within VHF range of a coast station
  - **Sea area A2** is within MF range of a coast station
  - **Sea area A3** is within Inmarsat Satellite System coverage
  - **Sea area A4** is world-wide and within HF range of a coast station (Including the Polar Regions)
Digital Selective Calling (DSC) Overview

Replacement for the radiotelephone and radiotelegraph (Morse) alarm signal

Information transmitted:
- the priority of the call - DISTRESS, URGENCY, SAFETY or ROUTINE;
- the address - ie: all ships or a single ship/station
- the identification of the ship in distress
- the position of the ship in distress
- the nature of the distress

MF/HF DSC Distress and Safety Channels:
- 2187.5, 4207.5, 6312.0, 8414.5, 12577.0, and 16804.5 kHz

VHF DSC Distress and Safety Channel:
- Marine channel 70 (156.525 MHz)

DSC Classifications:
http://www.navcen.uscg.gov/marcomms/gmdss/dsc.htm
Scope B3 – Maritime Services

MF & HF Channel Information

- Duplex Channels - single sideband radiotelephone channels used for communications between coast and ship stations
- Simplex Channels - single sideband radiotelephone channels for worldwide use by ships of all categories, for communications with coast stations or other ships
- Frequency Plan - Appendix 16 of the International Telecommunications Union (ITU) Radio Regulations, including revisions made by the 1987 Mobile World Administrative Radio Conference (Mob-87)

http://www.navcen.uscg.gov/marcomms/high_frequency/default.htm
Scope B3 – Maritime Services
VHF Channel Information

- 156 to 162 MHz – channelized radio service (assigned channel frequencies)
  - A Channels: ship frequencies
  - B Channels: shore frequencies

http://www.navcen.uscg.gov/marcomms/vhf.htm

- Channels 2, 4, 60, and 62 cannot be used for transmission in US waters
  - User’s Manual must make this clear

- R&O (FCC 04-3) redesignates Channels 75 and 76 for communications related to port operations, and establish requirements for equipment to operate on the channels with reduced carrier power

## Scope B3 – Maritime Services

### VHF User’s Manual - Frequency Table

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<tr>
<td>9</td>
<td>RX only</td>
</tr>
<tr>
<td>10</td>
<td>RX only</td>
</tr>
</tbody>
</table>

*“Low power only. “Momentary high power. “DSC operation only.

**NOTE:** Simplex channels, 3, 21, 23, 61, 64, 81, 82 and 83 CANNOT be lawfully used by the general public in U.S.A. waters.
Scope B3 – Maritime Services

VHF Applicable Rules

- GMDSS – Part 80 Subpart W
- GMDSS Equipment must meet the requirements of 80.1101(c)(2)
- Non-Compulsory or voluntary equipment must meet the requirements of 80.225(a)

**WARNING:** DSC is permitted in VHF handheld radios but it must also meet 80.225(a). Paragraph 80.225(a) requires that DSC equipment installed in coast or ship stations must meet either the requirements of ITU-R M.493 or RTCM Paper 56-95/SC101-STD. Contact the FCC.

- DSC typically not in handhelds since the requirements are hard to meet
Section 80.1101(b)…must be tested in accordance with the applicable testing standards listed

Section 80.1101(c)(2) – lists applicable standards

- IMO Resolution A.803(19) Performance Standards for Shipborne VHF Radio Installations Capable of Voice Communication and Digital Selective Calling
- ITU-R Recommendation M.541-8 Operational Procedures for the use of Digital Selective-Calling Equipment in the Maritime Mobile Service
Scope B3 – Maritime Services

VHF Applicable Standards

- **RTCM Paper 56-95/SC101-STD**
  - RTCM Recommended Minimum Standards for DSC Equipment Providing Minimum Distress and Safety Capability, Version 1.0 – defines minimum functions for DSC transceivers used in the US
  - Paper Only ($10)

- **ITU-R M.541-9**
  - Operational procedures for the use of digital selective-calling equipment in the maritime mobile service

- **ITU-R M.493-11**
  - Digital selective-calling system for use in the maritime mobile service

- **ITU Radiocommunication Sector – standards, updates & news Subscription Services (Electronic or paper)**

May 2005

TCB Workshop
Scope B3 – Maritime Services
VHF Technical Parameters

- DC Voltage & Current into Final Device 2.1033(C)(8)
- RF Output Power 2.1046 (Typically conducted power)
- Modulation Characteristics (Audio Roll-off) 2.1047 & 80.213
- Modulation Characteristics (Audio Frequency Response) 2.1047
- Modulation Characteristics (Modulation Limiting) 2.1047
- Occupied Bandwidth 2.1049(c)(1) & 80.211
- Spurious & Harmonic Emission at Antenna Terminal 2.1051
- Field Strength of Spurious & Harmonic Radiation 2.1053
- Frequency Stability (Temperature) 2.1055 & 80.209
- Frequency Stability (Voltage) 2.1055 & 80.209
- Receiver radiated spurious emissions 80.217(b)
- DC Voltage & Current into Final Device 2.1033(C)(8)
Scope B3 – Maritime Services
VHF Equipment Authorization

Equipment Class
- GVH: Part 80 VHF Transmitter (GMDSS) Base Station
- TNB (Base Station) or TNF (Handheld): Part 80 VHF transmitters without GMDSS/DSC

For devices with DSC (Base Station)
- CS “Transmitter meets technical requirements for ship stations”.
- GM “This unit meets requirements for GMDSS as contained in Subpart W of Part 80”.
- Handhelds - no Note Code required

Modulations
- VHF Marine: 16K0F3E and/or 16K0G3E
- DSC: 16K0G2B (Requires separate line item)
Scope B3 – Maritime Services
VHF Equipment Authorization (Cont.)

Modulation Characteristics (Audio Roll-off) 2.1047 & 80.213
- FCC limits:
  - 3 kHz - 15 kHz: -40 log (F/3) dB
  - >20kHz : At least -28 dB

Modulation Characteristics (Audio Frequency Response) 2.1047
- FCC limits: 300 - 3000 Hz: 6dB/octave roll-off (+1/-3 dB)

Modulation Characteristics (Modulation Limiting) 2.1047
- FCC limits: +/-5 kHz deviation
Scope B3 – Maritime Services
VHF Equipment Authorization (Cont.)

- Occupied Bandwidth 2.1049(c)(1) & 80.211
  - a) -25dB (50 - 100% of assigned frequency)
  - b) -35dB (100 - 250% of assigned frequency)
  - c) 43 + 10log (RF output power in Watts) dB or 80dB, whichever is lesser attenuation for more than 250% of assigned frequency

- Spurious & Harmonic Emission at Antenna Terminal 2.1051
  - FCC limits: 43 + 10log (RF output power in Watts) dB

- Field Strength of Spurious & Harmonic Radiation 2.1053
  - FCC limit = 43 + 10log P(Watts) dB
  - P(dBm) = -30 + 10 log P(Watts) therefore Limit = -13 dBm
  - X axis is dBm
Scope B3 – Maritime Services
VHF Equipment Authorization (Cont.)

- Frequency Stability (Temperature) 2.1055 & 80.209
  - From -20 °C to +50 °C at intervals of 10°C
  - FCC limits: +/-0.0005%

- Frequency Stability (Voltage) 2.1055 & 80.209
  - 85% to 115% of the nominal voltage
  - FCC limits: +/-0.0005%

- Typically test a low and high channel
- If the device has a switchable high/low power setting test at both high and low power. If the power is variable test at high power setting only.
- US Coast Guard approval letter or MRA approval not required for VHF radios
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Modulation Characteristics (Audio Roll-off)
Scope B3 – Maritime Services

Modulation Characteristics (Audio Frequency Response)

![Graph showing modulation characteristics](image-url)
Scope B3 – Maritime Services
MODULATION CHARACTERISTICS (MODULATION LIMITING)
Scope B3 – Maritime Services
F3E (Channel 16) Occupied BW
Scope B3 – Maritime Services
DSC (G2B Modulation, Channel 70) Occupied BW
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VHF Handheld PTT RF Exposure

- Categorically excluded: Section 1.1307(b)(2)
- Option 1 (Portables): Occupational Limits
  - Submit Occupational training material
  - Special exemption from the July 02 Exclusion List
  - SAR Report is not required
- Option 2 (Portables): General Population Limits
  - SAR Report required
- If Portable power > 7 Watts contact the FCC before proceeding for both Occupational and General Population limits
Scope B3 – Maritime Services
VHF Handheld PTT RF Exposure (Cont.)

If applicant chooses to submit SAR - TCBs cannot review the application
  – Submitted to the FCC
  – No standard SAR procedures for 150 MHz devices

RF exposure training instructions and labeling information is required for portables and mobiles
  – To determine mobile separation distance an MPE exhibit is required if separation distance not equal to 20 cm
Scope B3 – Maritime Services
VHF Base Station RF Exposure

- Categorically excluded: Section 1.1307(b)(2)
- RF exposure training instructions and labeling information is required since these are mobiles
- To determine mobile separation distance an MPE exhibit is required

For further details on RF Exposure Requirements for all Part 80 VHF devices, refer to February 05 TCB Workshop notes and March 04 KDB procedures
Scope B3 – Maritime Services
VHF Example Grant

<table>
<thead>
<tr>
<th>Grant Notes</th>
<th>FCC Rule Parts</th>
<th>Frequency Range (MHz)</th>
<th>Output Watts</th>
<th>Frequency Tolerance</th>
<th>Emission Designator</th>
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<tr>
<td>CS GM</td>
<td>80.1101(c)(4)</td>
<td>156.025 - 157.425</td>
<td>1</td>
<td>7 PPM</td>
<td>16K0G3E</td>
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<td>80.1101(c)(4)</td>
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<tr>
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<td>156.025 - 157.425</td>
<td>25</td>
<td>7 PPM</td>
<td>16K0G2B</td>
</tr>
</tbody>
</table>

Power listed is conducted. This device must not exceed a maximum transmitting duty factor of 50%. All qualified end-users of this device must have the knowledge to control their exposure conditions and/or duration, and the exposure conditions and/or duration of their passengers and bystanders, to comply with the General Population/Controlled MPE limit and requirements. Users must be provided with the training information, antenna installation and transmitter operating conditions for satisfying RF exposure compliance. The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 60cm from all persons and must not exceed an antenna gain of 0 dBi.
“Includes integral DSC modem in conformity with ITU-R M.493.8”

CS: Transmitter meets technical requirements only for use at ship stations.
GM: This unit meets requirements for GMDSS use as contained in Subpart W of Part 80.
Scope B3 – Maritime Services

Radars – Frequency Bands

- 2450–2500 MHz
- 2900–3100 MHz
- 5460–5650 MHz
- 9300–9500 MHz
- 14.00–14.05 GHz

This presentation focuses on the 9300-9500 MHz band since the majority of new devices only use this band.
Scope B3 – Maritime Services
Radars – Applicable Rules

- R.F. Power Output
  - Sections 2.1046(a), 80.215 – “mean power”
  - Duty Cycle = P.R.F. x Pulse Width
  - Peak Power = Average Power/Duty Cycle
  - Note: high peak power & low average power

- Modulation Characteristics
  - Section 2.1047
  - P0N (Pulsed CW Radars)
  - Pulse widths (typically selectable for range)
  - PRF

- Occupied Bandwidth
  - Sections 2.1049(c)(1), 80.209(b), 80.211(f)
Scope B3 – Maritime Services
Radars – Applicable Rules (Cont.)

- Spurious Emissions at Antenna Port
  - Sections 2.1051, 80.211(f)

- Radiated Spurious Emissions
  - Sections 2.1053, 80.211(f)

- Frequency Stability – temperature & voltage variation
  - Sections 2.1055, 80.209(b)
  - $1.5/T$ where $T =$ Pulse Duration (microseconds)
  - Example for 9300-9500 MHz Band – frequency must be within
    - Upper Limit = 9500 – 1.5/T
    - Lower Limit = 9300 + 1.5/T
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Radars – International standards

- Section 80.273 *Technical requirements for radar equipment – list of applicable standards*

- RTCM Paper 133–87–SC 103–33
  - RTCM Recommended Performance Specification for a General Purpose Navigational Radar Set for Oceangoing Ships of 500 Gross Tons and Upwards for New Radar Installations

- RTCM Special Committee No. 65 Final Report
  - Performance Specification for a General Purpose Navigational Radar Set for Oceangoing Ships of 1,600 Tons Gross Tonnage and Upwards for New Radar Installations

- International Standards are under review
Scope B3 – Maritime Services
Radars – Typical Measurement Procedure

The average power, pulse widths, pulse rise and decay times, and the interval between successive output pulses are measured (1/2 Voltage PW).

The pulse repetition frequency (PRF) is then calculated from the reciprocal of the interval.

The duty cycle is calculated from the product of the PRF and the pulse width.

The average power is corrected for attenuation.

The peak power is calculated by dividing the average power by the duty cycle.

The spurious and harmonic radiation characteristics, the occupied bandwidth and the receiver radiation are measured.
Scope B3 – Maritime Services
Radars – Equipment Authorization

- Equipment Class – MRD (Marine Radar)
- Can list entire band on Grant but must have operational frequencies and frequencies parameters (Hopping, etc.) in the Operational Description
- Modulation P0N (Not PON)
- Necessary BW is typically several MHz
- Measure all PW and OBW – preferable to include plots in the Test Report
- Conducted spurious radiation
- Case radiated measurements
  - Antenna terminated
- No RF Exposure requirements
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Radars – Measured PW
Scope B3 – Maritime Services
Radars – OBW RW #1
Scope B3 – Maritime Services
Radars – OBW PW#2
## Scope B3 – Maritime Services

### Radars – Grant Example

- **Equipment Class** – MRD
- **List entire 9300-9500 MHz band**
- **Output Power** – manufacturers rated peak power
- **Frequency Tolerance** – leave blank (must comply)
- **No RF Exposure Conditional Requirements Necessary**

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Notes: Marine Radar RA41C
Questions and Answers

Thanks!