REPORT ON

RF Exposure Assessment
Raymarine plc. Fixed Mount VHF Radio Model Number RAY218 & RAY55

Report No WS615608/01 Issue 1 **February 2007**

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REPORT ON RF Exposure Assessment Raymarine plc. Fixed Mount VHF Radio
Model Number RAY218 & RAY55

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PREPARED FOR

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ATTESTATION

The wireless device described within this report has been shown to be capable of compliance with the basic restrictions related to human exposure to electromagnetic fields (10 MHz - 300 MHz) - General public.
The calculations shown in this report were made in accordance the procedures specified in the applied test specification(s).

All reported calculations were carried out on a sample of equipment to demonstrate compliance with the applied test specification(s) the sample tested was found to comply with the requirements of the applied rules.

PREPARED BY

A Miller
Principal Engineer

APPROVED BY

M Jenkins
Authorised Signatory

DATED 16th February 2007

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Section **Page No**

SECTION 1

REPORT SUMMARY

SUMMARY Based upon the supplied data for Model Number RAY218 & RAY55 and point of investigation '**R**' being 1.410 m (**141.0 cm**)
GENERAL PUBLIC LIMITS The calculations have shown that they **meet** the General Public Exposure Levels described in the FCC 47 CFR § 1.1310 Guidelines **OCCUPATIONAL LIMITS** The calculations have shown that they **meet** the Occupational Exposure Levels described in the FCC 47CFR § 1.1310 Guidelines

1.1 STATUS

APPLICANT	Raymarine plc.
MANUFACTURING DESCRIPTION	Fixed Mount VHF Radio
MODEL NUMBER	RAY218 & RAY55

1.2 TEST SPECIFICATIONS

1. OET Bulletin 65 Edition 97-01 August 1997 - Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields

1.3 REFERENCES

2. National Council on Radiation Protection and Measurements (NRPC) - Report No. 86(1986) "Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields".

3. FCC Guidelines for Evaluating exposure to RF Emissions - 47 CFR § 1.1310; 47 CFR § 1.1307(b) & 47 CFR § 80.83.

4. EN 50383:2002 - Basic standard for the calculation and measurement of electromagnetic field strength and SAR related to human exposure from radio base stations and fixed terminal stations for wireless telecommunication systems (110 MHz - 40 GHz).

5. IEEE Std C95.1-2005: IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3KHz to 300GHz.

1.4 SUMMARY

The equipment subject to the RF exposure assessment is a Fixed Mount VHF Radio model number RAY218 & RAY55**.** The RF exposure assessment is based upon the following criteria:-

- The Fixed Mount VHF Radio operates in the frequency range of 156.025 MHz to 157.425 MHz, the numeric gain of the Fixed Mount VHF Radio is 1.995 gain.
- The length of the Fixed Mount VHF Radio is assumed as 40.64 centimetres (cm).
- The Fixed Mount VHF radio power is 25.0 Watt maximum.
- The point of investigation is calculated to be 141.0 cm with an assumed maximum antenna gain of 3 dBi.

1.5 REQUIRED MINIMUM SEPARARTION DISTANCES

Power Density Field 'S'

The minimum separation distance based upon occupational limit level for the Power Density field 'S' is:

$$S = \frac{PG_{(\theta,\phi)}}{4\pi r^2}$$ Transposed to find '*r*' = $$r = \sqrt{\frac{PG_{(\theta,\phi)}}{4\pi S}}$$

P = 25000.0 *mW; G* = 1.995*; S = 1.000 mW/cm*^{2}
Therefore 'r' = 63.004 *cm*

The minimum separation distance based upon general public limit level for the Power Density field 'S' is:

$$S = \frac{PG_{(\theta,\phi)}}{4\pi r^2}$$ Transposed to find '*r*' = $$r = \sqrt{\frac{PG_{(\theta,\phi)}}{4\pi S}}$$

P = 25000.0 *mW; G* = 1.995*; S = 0.200 mW/cm*^{2}
Therefore 'r' = 140.880 *cm*

1.5 REQUIRED MINIMUM DISTANCES - CONTINUED

Electric Field 'E'

The minimum separation distance based upon occupational limit level for the electric field 'E' is:

$$E = \frac{\sqrt{30PG}_{(\theta,\phi)}}{r} \qquad \text{Transposed to find 'r' =} \qquad r = \frac{\sqrt{30PG}_{(\theta,\phi)}}{E}$$

P = 25 *W; G = ; E = 61.400 V/m*
Therefore 'r' = 0.6300 *m*

The minimum separation distance based upon general public limit level for the electric field 'E' is:

$$E = \frac{\sqrt{30PG}_{(\theta,\phi)}}{r} \qquad \text{Transposed to find 'r' =} \qquad r = \frac{\sqrt{30PG}_{(\theta,\phi)}}{E}$$

P = 25 *W; G* = 1.995*; E = 27.500 V/m*
Therefore 'r' = 1.4067 *m*

Magnetic Field 'H'

The minimum separation distance based upon occupational limit level for the Magnetic field 'H' is:

$$H = \frac{E}{\eta_o} \qquad \text{Transposed to find 'r' =} \qquad r = \frac{\sqrt{30PG}}{\eta_o H}$$

P = 25 *W; G = ; H = 0.163 A/m; η_0 = free space wave impedance = 120 π (377)* Ω
Therefore 'r' = 0.0199 *m*

The minimum separation distance based upon general public limit level for the Magnetic field 'H' is:

$$H = \frac{E}{\eta_o} \qquad \text{Transposed to find 'r' =} \qquad r = \frac{\sqrt{30PG}}{\eta_o H}$$

P = 25 *W; G = ; H = 0.073 A/m; η_0 = free space wave impedance = 120 π (377)* Ω
Therefore 'r' = 0.0444 *m*

SECTION 2

TEST DETAILS

2.1 RATIONALE FOR ASSESSMENT OF THE RF EXPOSURE

The aim of the assessment report is to evaluate the compliance boundary for a set of given input power(s) according to the basic restrictions (directly or indirectly via compliance with reference levels) related to human exposure to radio frequency electromagnetic fields.

The chosen assessment method to establish the compliance boundary in the far-field region is the reference method as defined in BS EN50383:2002 Clause 5.2; E-filed or H-field calculation. The method of calculation used is defined in BS EN50383:2002; Clause 8.2.2, 8.2.3 and 8.2.4.

The calculated values have been compared with limits provided in the ICNIRP guidelines. Calculations can be made in three separate regions, based on distance from the antenna. These are called:-

- far-field region,
- radiating near-field region,
- reactive near-field region.

The theory that defines these regions is given in EN50383:2002 Annex A.

Far-field region
As shown in EN50383 Annex A, the far-field calculations are accurate when the distance, r, from an antenna of length D to a point of investigation is greater than

$$r = \frac{2D^2}{\lambda}$$

Where, r is the distance from the antenna to the point of investigation.

Radiating near-field region
The radiating near-field region of an antenna of length D as shown in EN50383 Annex A, this region is defined by

$$\frac{\lambda}{4} < r > \frac{2D^2}{\lambda}$$

Reactive near-field region
The reactive near-field region of an antenna as shown in EN50383 Annex A, this region is defined by

$$r \leq \frac{\lambda}{4}$$

Where, r is the distance from the antenna to the point of investigation.

Recommend λ/4 as the boundary between the radiated near-field and reactive near-field for RF exposure compliance assessment.

2.2 DEFINED LIMITS

Normative Reference: ICNIRP Advice on Limiting Exposure to Electromagnetic Fields (0-300GHz). Table A4, Reference Levels for General Public Exposure to Time Varying Electric & Magnetic Fields. Vol 15 No.2. 2004.

Reference levels for general public exposure to time-varying electric and magnetic fields (unperturbed rms values)

At 156.025 MHz

E-Field (Vm^{-1}) = 61.400

H-Field (Am^{-1}) = 0.163

Power density (mW/cm^2) = 1.000

Reference levels for occupational exposure to time-varying electric and magnetic fields (unperturbed rms values)

At 156.025MHz

E-Field (Vm^{-1}) = 27.500

H-Field (Am^{-1}) = 0.073

Power density (mW/cm^2) = 0.200

2.3 ESTABLISHING WAVELENGTH AND 1/4 WAVELENGTH

Frequency (MHz)	$\lambda = \frac{3x10^8}{f}$		$\frac{\lambda}{4}$	
	m	cm	m	cm
157.425	1.9057	190.57	0.4764	47.64
156.725	1.9142	191.42	0.4785	47.85
156.025	1.9228	192.28	0.4807	48.07

2.4 FAR FIELD CALCULATIONS

The following calculations are based on: dBi gain antenna

P = 25 (Power (Watts)) or 25000.0 (Power milliwatts)
G = 1.995 (Numeric Gain)
r = (Distance (meters)) or 141.0 (Distance (centimetres))

The power flux:

$$S = \frac{PG_{(\theta,\phi)}}{4\pi r^2} \qquad S = \text{mW/cm}^2$$

The electric field strength

$$E = \frac{\sqrt{30PG}_{(\theta,\phi)}}{r} \qquad E = \text{Eeff V/m}$$

The magnetic field strength

$$H = \frac{E}{\eta_o} \qquad H = \text{A/m}$$

The calculations **meet** the General Public Exposure Levels described in the ICNIRP Guidelines
The calculations **meet** the Occupational Exposure Levels described in the ICNIRP Guidelines

2.5 FIELD REPRESENTATIONS

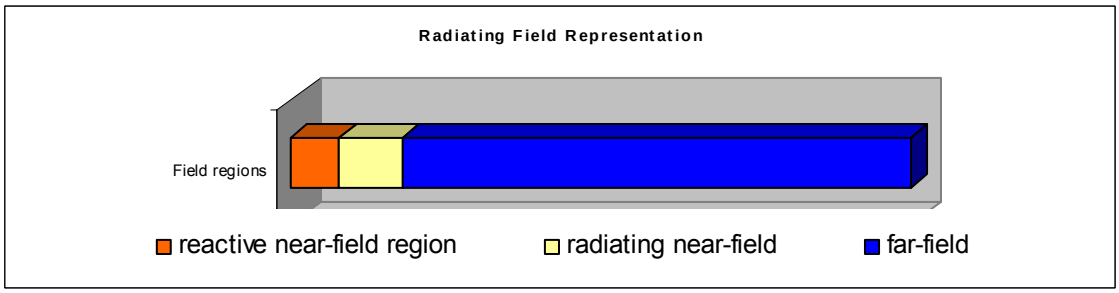

Figure 1 - This graph shows the radiating field representation and is not to scale

Worst case frequency 156.025 MHz
The Reactive near-field region (from antenna) is less than.....: 47.642 cm
The Radiating near-field region is greater than.....: 47.642 cm
The Radiating near-field region is less than.....: 62.948 cm
The Far-field region is greater than.....: 62.948 cm

SECTION 3

FIGURES

3.1 FIELD REPRESENTATIONS

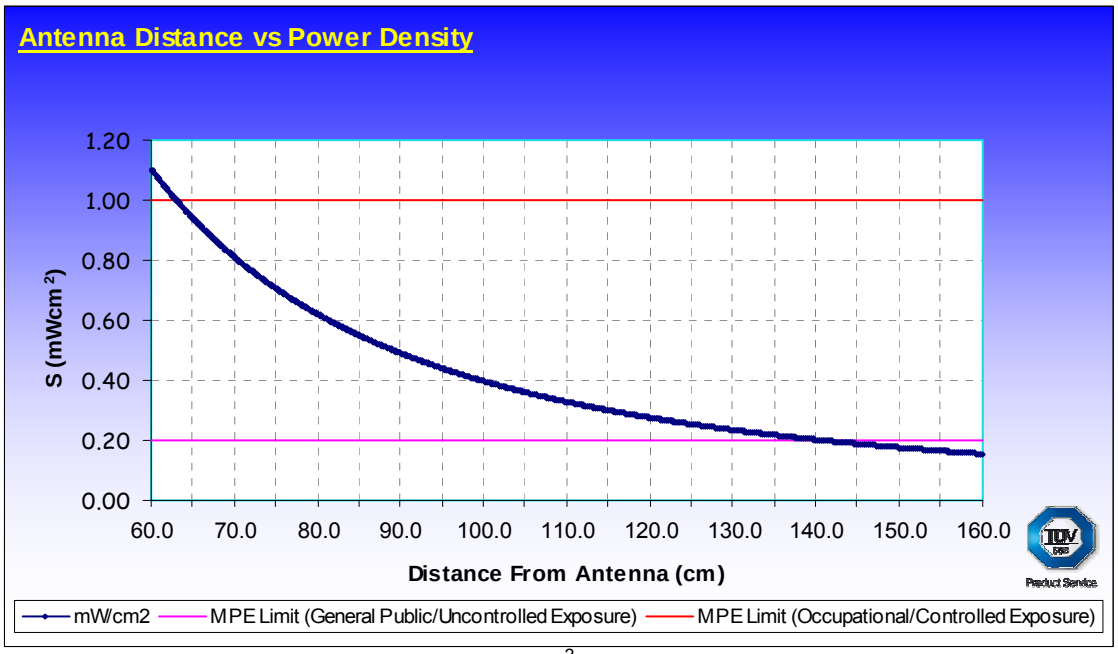

Figure 2 - This graph shows the S field (mW/cm^2) strength value with regards to distance from the Antenna (cm)

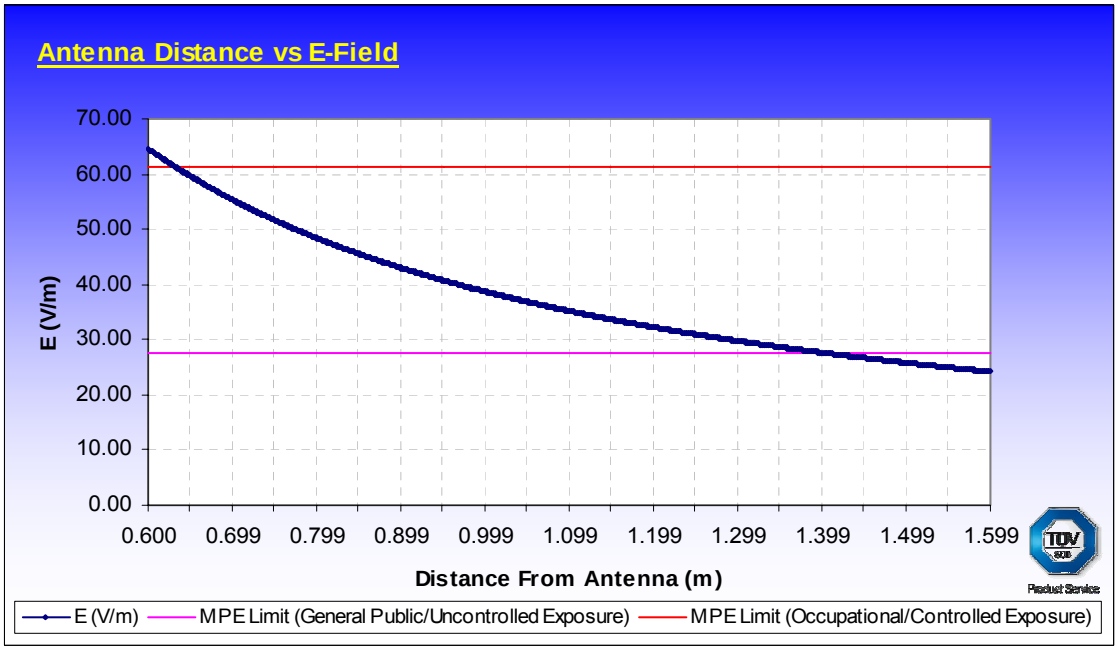

Figure 3 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (m).

3.1 FIGURES

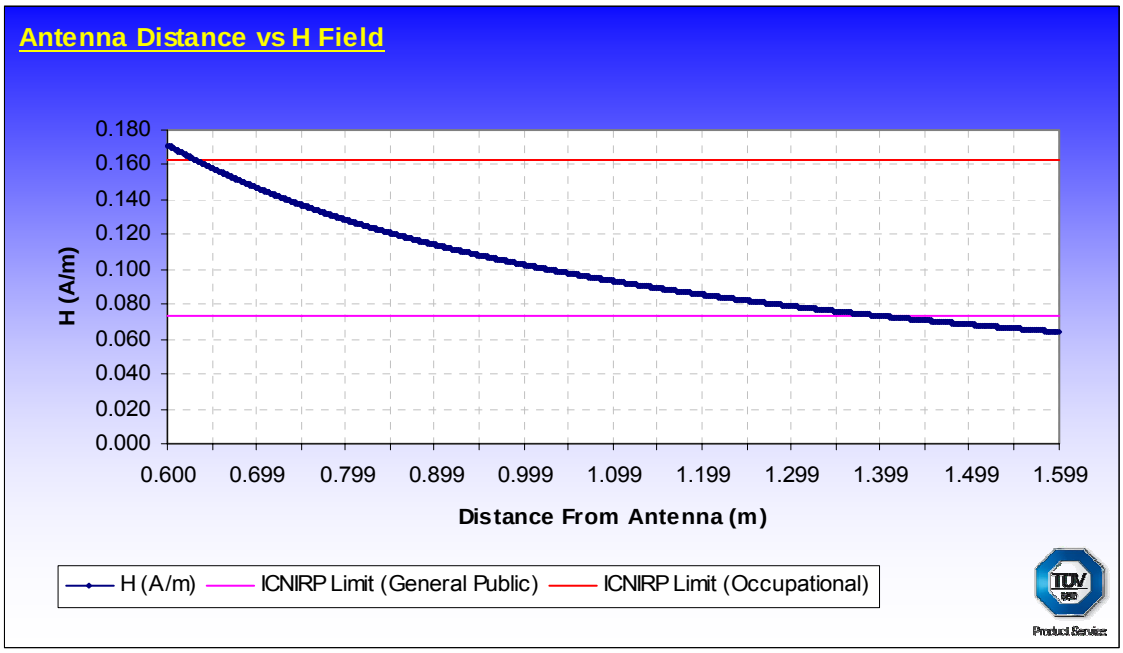

Figure 4 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (m).

SECTION 4

DISCLAIMERS AND COPYRIGHT

4.1 DISCLAIMERS AND COPYRIGHT

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