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Report On

RF Exposure Assessment of the
Garmin International Inc
VHF 200i Marine VHF with DSC and ATIS

FCC ID: IPH-GARVHF12
IC ID: 1792A-GARVHF12 D

Document 75904785 Report 01 Issue 6

August 2009



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REPORT ON

RF Exposure Assessment of the
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10 August 2009

This report has been up-issued to Issue 6 to amend the IC ID



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SECTION 1

REPORT SUMMARY

RF Exposure Assessment of the
Garmin International Inc
VHF 200i Marine VHF with DSC and ATIS



1.1 INTRODUCTION

The information contained in this report is intended to show verification of the RF Exposure Assessment of the Garmin International Inc VHF 200i Marine VHF with DSC and ATIS to the requirements of the applied test specifications.

Objective	To perform RF Exposure Assessment to determine the Equipment Under Test's (EUT's) compliance of the applied rules
Applicant	Garmin International Inc
Manufacturer	Garmin International Inc
Manufacturing Description	VHF 200i Marine VHF with DSC and ATIS
Model Number(s)	VHF 200i
Declared Variant(s)	VHF 100i; VHF 200; VHF 100
Serial Number(s)	Not Supplied
Hardware Version	Not Supplied
Software Version	Not Supplied

Test Specification/Issue/Date

1. EN50385:2002 Product standard to demonstrate the compliances of radio base stations and fixed terminal stations for wireless telecommunication systems with the basic restrictions or the reference levels related to human exposure to radio frequency electromagnetic fields (110MHz – 40GHz) – General public
2. OET Bulletin 65 Edition 97-01 August 1997 - Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields
3. RSS-102 Issue 2 November 2005 Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
4. Radiocommunications (Electromagnetic Radiation – Human Exposure) Standard 2003

Related Document(s)

5. Council Recommendation 1999/519/EC of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (Official Journal L 197 of 30 July 1999).
6. FCC Guidelines for Evaluating exposure to RF Emissions - 47 CFR § 1.1310; 47 CFR § 1.1307(b) & 47 CFR § 80.83.
7. Health Canada's Safety Code 6: Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 KHz to 300 GHz.
8. ARPANSA, 'Radiation Protection Standard – Maximum Exposure Levels to Radiofrequency Fields – 3KHz to 300GHz'
9. ICNIRP 1998, 'Guidelines for limiting exposure to time-varying electric magnetic, and electromagnetic fields (up to 300GHz). Guidelines of the International Commission on Non-Ionizing Radiation Protection', Health Physics, vol.74, no.4, pp.494-522.



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10. National Council on Radiation Protection and Measurements (NRP) - Report No. 86(1986) "Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields".
11. 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).
12. IEEE Std C95.1-2005: IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3KHz to 300GHz.
13. Australian Standard 2772.2 – 1988, 'Radiofrequency Radiation Part 2 – Principles and Methods of Measurement – 300KHz to 10GHz'



1.2 BRIEF SUMMARY OF RESULTS

1.2.1 General Public Exposure Levels

Table show the worst Case Gain of 9dBi

Antenna Gain (Numeric)	Average Output Power (mW)	Field	Calculated RF Exposure at 1.5 m (150 cm)	General Public Exposure Limit	
7.943	1250	S	0.351 Wm-2	2.00	ICNIRP
		S	0.035 mW/cm2	0.20	FCC 47 CFR § 1.1310
		S	0.351 Wm-2	2.00	Canada's RF Safety Code 6
		S	0.351 Wm-2	2.00 Wm-2	ARPANSA
		E	11.506 V/m	28.00	ICNIRP
		E	11.506 V/m	27.50	FCC 47 CFR § 1.1310
		E	11.506 V/m	28.00	Canada's RF Safety Code 6
		E	11.506 V/m	27.40 V/m	ARPANSA
		H	0.031 A/m	0.073	ICNIRP
		H	0.031 A/m	0.07	FCC 47 CFR § 1.1310
		H	0.031 A/m	0.073	Canada's RF Safety Code 6
		H	0.031 A/m	0.073 A/m	ARPANSA

The calculations have shown that they **meet** the General Public Exposure Levels described in the ICNIRP Guidelines, FCC 47 CFR § 1.1310 Guidelines, Health Canada's RF exposure guideline Safety Code 6 and the Australian ARPANSA limits at **150.0 cm**, the point of investigation.



1.2.2 Occupational Exposure Levels

Table show the worst Case Gain of 9dBi

Antenna Gain (Numeric)	Average Output Power (mW)	Field	Calculated RF Exposure at 1.410 m (141.0cm)	Occupational Exposure Limit	Application
7.943	1250	S	0.351 Wm-2	10.00 Wm-2	ICNIRP
		S	0.035 mW/cm2	1.00 mW/cm2	FCC 47 CFR § 1.1310
		S	0.351 Wm-2	10.00 Wm-2	Canada's RF Safety Code 6
		S	0.351 Wm-2	10.00 Wm-2	ARPANSA
		E	11.506 V/m	61.00 V/m	ICNIRP
		E	11.506 V/m	27.50 V/m	FCC 47 CFR § 1.1310
		E	11.506 V/m	60.00 V/m	Canada's RF Safety Code 6
		E	11.506 V/m	61.40 V/m	ARPANSA
		H	0.031 A/m	0.16 A/m	ICNIRP
		H	0.031 A/m	0.16 A/m	FCC 47 CFR § 1.1310
		H	0.031 A/m	0.16 A/m	Canada's RF Safety Code 6
		H	0.031 A/m	0.163 A/m	ARPANSA

The calculations have shown that they **meet** the Occupational Exposure Levels described in the ICNIRP Guidelines, FCC 47 CFR § 1.1310 Guidelines, Health Canada's RF exposure guideline Safety Code 6 and the Australian ARPANSA limits at **150.0 cm**, the point of investigation.



1.3 PRODUCT INFORMATION

1.3.1 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)

1.3.2 Technical Description

The Equipment under Test was a Garmin International Inc Remote mount marine VHF radio with optional AIS functionality. A full technical description can be found in the manufacturer's documentation.

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 the relevant information supplied or measured of a sample of VHF 200i Marine VHF with DSC and ATIS to demonstrate compliance with the applied test specification(s) the sample assessed was found to comply with the requirements of the applied rules.

1.4 SUMMARY

The RF exposure assessment is based upon the following criteria:

The VHF 200i Marine VHF with DSC and ATIS operates in the frequency range of 156.025 – 157.425 MHz

The antenna gains used for the calculation were 0 dBi, 3 dBi, 6 dBi, and 9 dBi. However no dedicated antenna is supplied with the product.

The VHF 200i Marine VHF with DSC and ATIS radio power is a maximum 25000 milliwatts. However when the duty cycle is taken into consideration the average power is a maximum of 1250 milliwatts.

The point of investigation is 150.000 cm (1.5 m).

A duty cycle of 5% has been used for this assessment, however in practice the applicant declares that the duty cycle should be: 5% Transmit / 5% Receive / 90% Standby.



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SECTION 2

TEST DETAILS

RF Exposure Assessment of the
Garmin International Inc
VHF 200i Marine VHF with DSC and ATIS



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-field 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 $\lambda/4$ as the boundary between the radiated near-field and reactive near-field for RF exposure compliance assessment.



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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. The defined limits are in accordance with 47 CFR § 1.1310 Radiofrequency radiation exposure limits.

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

At 156.025 MHz

Power density (Wm-2)	= 2.00	ICNIRP
Power density (mWcm ²)	= 0.20	FCC 47 CFR § 1.1310
Power density (Wm-2)	= 2.00	Canada's RF Safety Code 6
Power density (Wm-2)	= 2.00	Australian Radiation Protection Series Publication No. 3
E-Field (Vm-1)	= 28.00	ICNIRP
E-Field (Vm-1)	= 27.50	FCC 47 CFR § 1.1310
E-Field (Vm-1)	= 28.00	Canada's RF Safety Code 6
E-Field (Vm-1)	= 27.40	Australian Radiation Protection Series Publication No. 3
H-Field (Am-1)	= 0.073	ICNIRP
H-Field (Am-1)	= 0.07	FCC 47 CFR § 1.1310
H-Field (Am-1)	= 0.073	Canada's RF Safety Code 6
H-Field (Am-1)	= 0.073	Australian Radiation Protection Series Publication No. 3

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

At 156.025 MHz

Power density (Wm-2)	= 10.00	ICNIRP
Power density (mWcm ²)	= 1.00	FCC 47 CFR § 1.1310
Power density (Wm-2)	= 10.00	Canada's RF Safety Code 6
Power density (Wm-2)	= 10.00	Australian Radiation Protection Series Publication No. 3
E-Field (Vm-1)	= 61.00	ICNIRP
E-Field (Vm-1)	= 27.50	FCC 47 CFR § 1.1310
E-Field (Vm-1)	= 60.00	Canada's RF Safety Code 6
E-Field (Vm-1)	= 61.40	Australian Radiation Protection Series Publication No. 3
H-Field (Am-1)	= 0.16	ICNIRP
H-Field (Am-1)	= 0.16	FCC 47 CFR § 1.1310
H-Field (Am-1)	= 0.16	Canada's RF Safety Code 6
H-Field (Am-1)	= 0.16	Australian Radiation Protection Series Publication No. 3

2.3 ESTABLISHING WAVELENGTH AND 1/4 WAVELENGTH

Frequency (MHz)	$\lambda = \frac{3 \times 10^8}{f}$		$\frac{\lambda}{4}$	
	m	cm	m	cm
156.025	1.9228	192.28	0.4807	48.07
156.725	1.9142	191.42	0.4785	47.85
157.425	1.9057	190.57	0.4764	47.64



2.4 FAR FIELD CALCULATIONS

0dBi Unity Gain

The following calculations are based on:

$$\begin{aligned} P &= 1.25 \text{ (Power (Watts)) or } 1250 \text{ (Power milliwatts)} \\ G &= 1.000 \text{ (Numeric Gain)} \\ r &= 150.0 \text{ (Distance (centimetres)) or } 1.5 \text{ (Distance (meters))} \end{aligned}$$

The power flux:

$$S = \frac{PG(\theta, \phi)}{4\pi r^2} \quad \begin{aligned} S &= 0.044 \text{ W/m}^2 \\ S &= 0.004 \text{ mW/cm}^2 \end{aligned}$$

The electric field strength:

$$E = \frac{\sqrt{30PG(\theta, \phi)}}{r} \quad E = 4.082 \text{ V/m}$$

The magnetic field strength:

$$H = \frac{E}{\eta_0} \quad H = 0.011 \text{ A/m}$$

3dBi Gain

The following calculations are based on:

$$\begin{aligned} P &= 1.25 \text{ (Power (Watts)) or } 1250 \text{ (Power milliwatts)} \\ G &= 1.995 \text{ (Numeric Gain)} \\ r &= 150.0 \text{ (Distance (centimetres)) or } 1.5 \text{ (Distance (meters))} \end{aligned}$$

The power flux:

$$S = \frac{PG(\theta, \phi)}{4\pi r^2} \quad \begin{aligned} S &= 0.088 \text{ W/m}^2 \\ S &= 0.009 \text{ mW/cm}^2 \end{aligned}$$

The electric field strength:

$$E = \frac{\sqrt{30PG(\theta, \phi)}}{r} \quad E = 5.767 \text{ V/m}$$

The magnetic field strength:

$$H = \frac{E}{\eta_0} \quad H = 0.015 \text{ A/m}$$



6dBi Gain

The following calculations are based on:

$$\begin{aligned}
 P &= 1.25 \text{ (Power (Watts)) or } 1250 \text{ (Power milliwatts)} \\
 G &= 3.981 \text{ (Numeric Gain)} \\
 r &= 150.0 \text{ (Distance (centimetres)) or } 1.5 \text{ (Distance (meters))}
 \end{aligned}$$

The power flux:

$$S = \frac{PG(\theta, \phi)}{4\pi r^2} \qquad S = 0.176 \text{ W/m}^2$$

$$S = 0.018 \text{ mW/cm}^2$$

The electric field strength:

$$E = \frac{\sqrt{30PG(\theta, \phi)}}{r} \qquad E = 8.146 \text{ V/m}$$

The magnetic field strength:

$$H = \frac{E}{\eta_0} \qquad H = 0.022 \text{ A/m}$$

9dBi Gain

The following calculations are based on:

$$\begin{aligned}
 P &= 1.25 \text{ (Power (Watts)) or } 1250 \text{ (Power milliwatts)} \\
 G &= 7.943 \text{ (Numeric Gain)} \\
 r &= 150.0 \text{ (Distance (centimetres)) or } 1.5 \text{ (Distance (meters))}
 \end{aligned}$$

The power flux:

$$S = \frac{PG(\theta, \phi)}{4\pi r^2} \qquad S = 0.351 \text{ W/m}^2$$

$$S = 0.035 \text{ mW/cm}^2$$

The electric field strength:

$$E = \frac{\sqrt{30PG(\theta, \phi)}}{r} \qquad E = 11.506 \text{ V/m}$$

The magnetic field strength:

$$H = \frac{E}{\eta_0} \qquad H = 0.031 \text{ A/m}$$



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The calculations meet the General Public Exposure Levels described in the ICNIRP Guidelines.
 The calculations meet the General Public Exposure Levels described in the FCC 47CFR§1.1310.
 The calculations meet the General Public Exposure Levels described in the Canada's RF Safety Code 6.
 The calculations meet the General Public Exposure Levels described in the Australian Radiation Protection Series Publication No. 3.

The calculations meet the Occupational Exposure Levels described in the ICNIRP Guidelines.
 The calculations meet the Occupational Exposure Levels described in the FCC 47CFR§1.1310
 The calculations meet the Occupational Exposure Levels described in the Canada's RF Safety Code 6
 The calculations meet the Occupational Exposure Levels described in the Australian Radiation Protection Series Publication No. 3.

2.5 FIELD REPRESENTATIONS

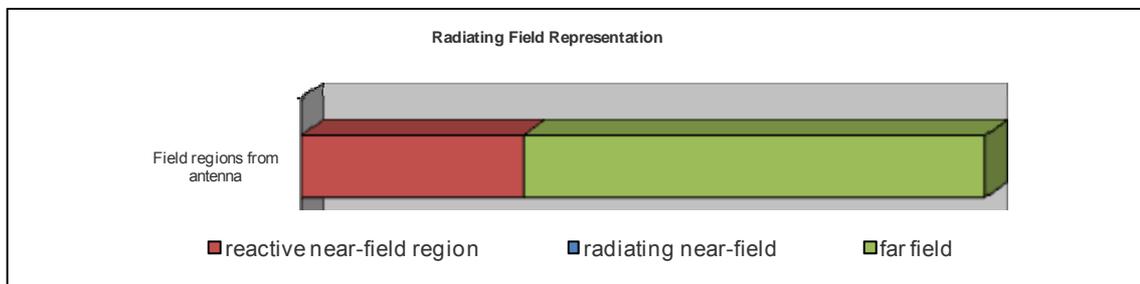


Figure 1 - This graph shows the radiating field representation and is not to scale

Worst case frequency 156.025 MHz
 The Reactive near-field region (from antenna) is less than : 0.481 m (48.069 cm)
 The Radiating near-field region is greater than : 0.481 m (48.069 cm)
 The Radiating near-field region is less than : 0.00 m (0.00 cm)
 The Far-field region is greater than : 0.00 m (0.00 cm)



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SECTION 3

FIGURES



3.1 FIELD REPRESENTATIONS – ICNIRP

0dBi Unity Gain

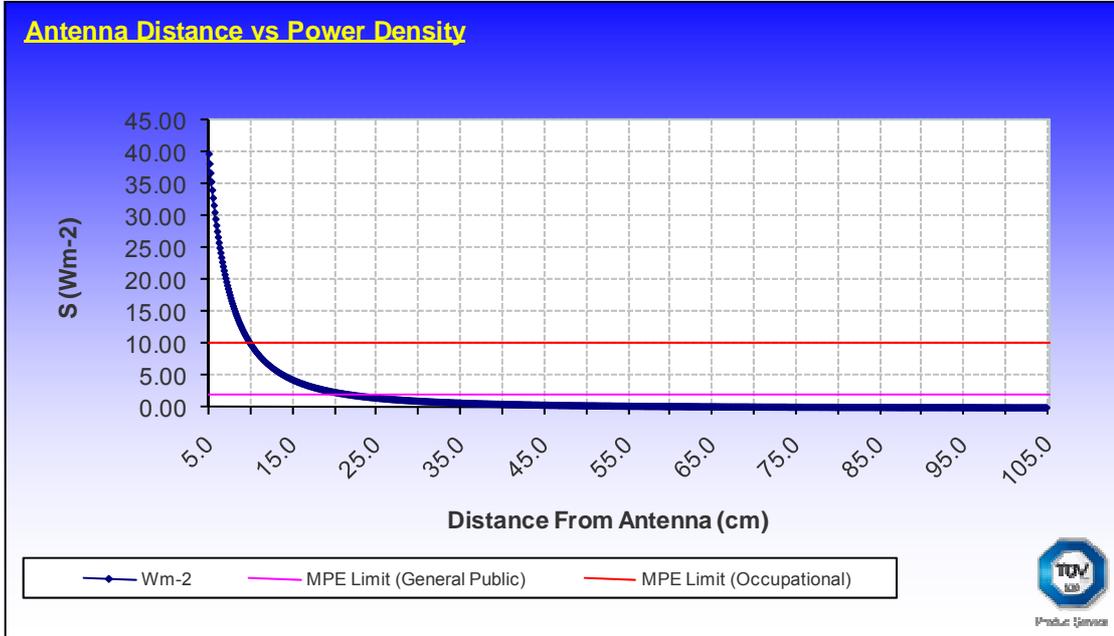


Figure 2 - This graph shows the S field (W/cm^2) strength value with regards to distance from the Antenna (cm)

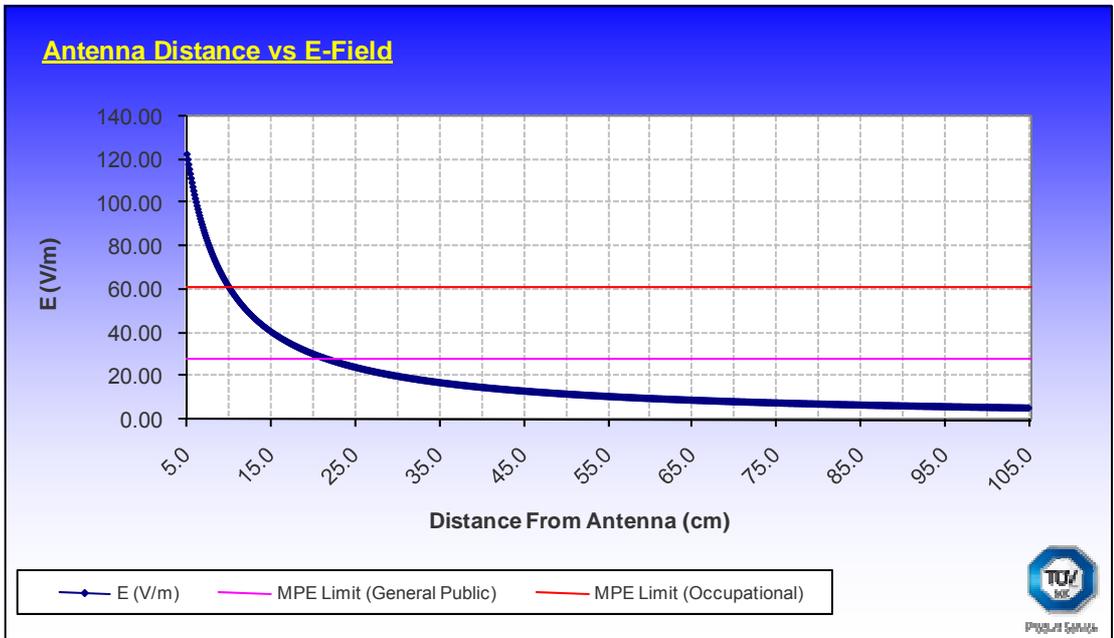


Figure 3 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm)

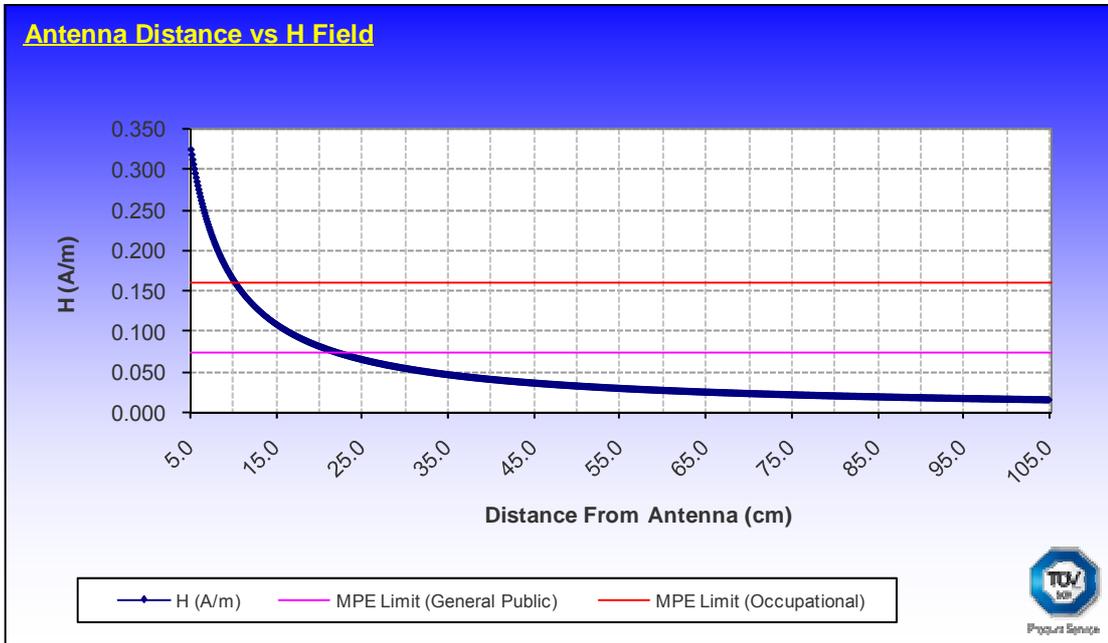


Figure 4 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm)

3dBi Gain

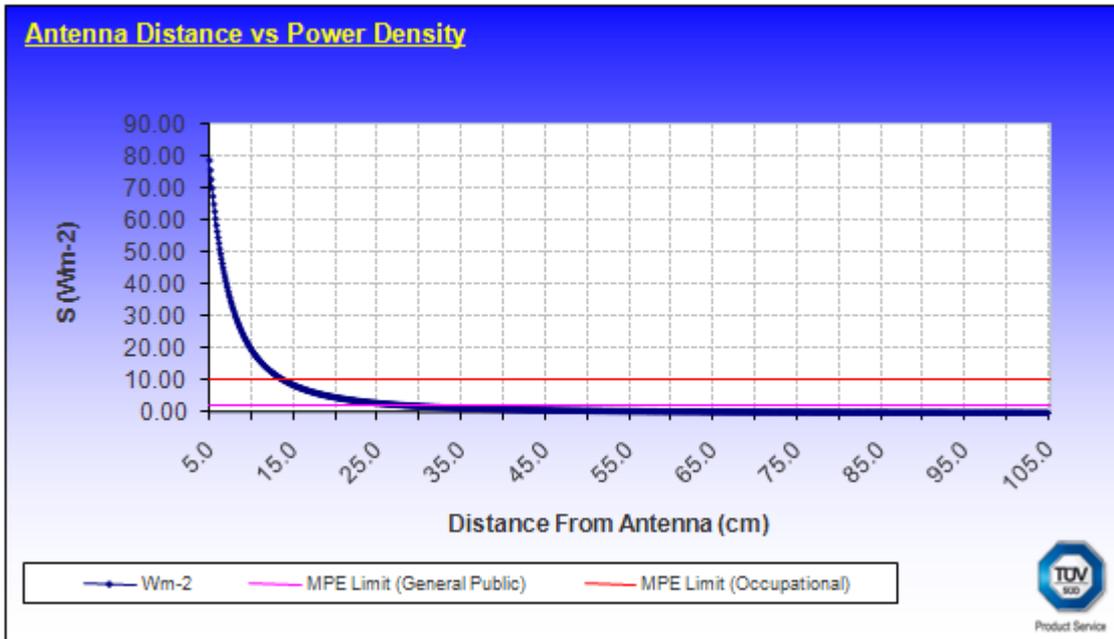


Figure 5 - This graph shows the S field (W/cm²) strength value with regards to distance from the Antenna (cm)

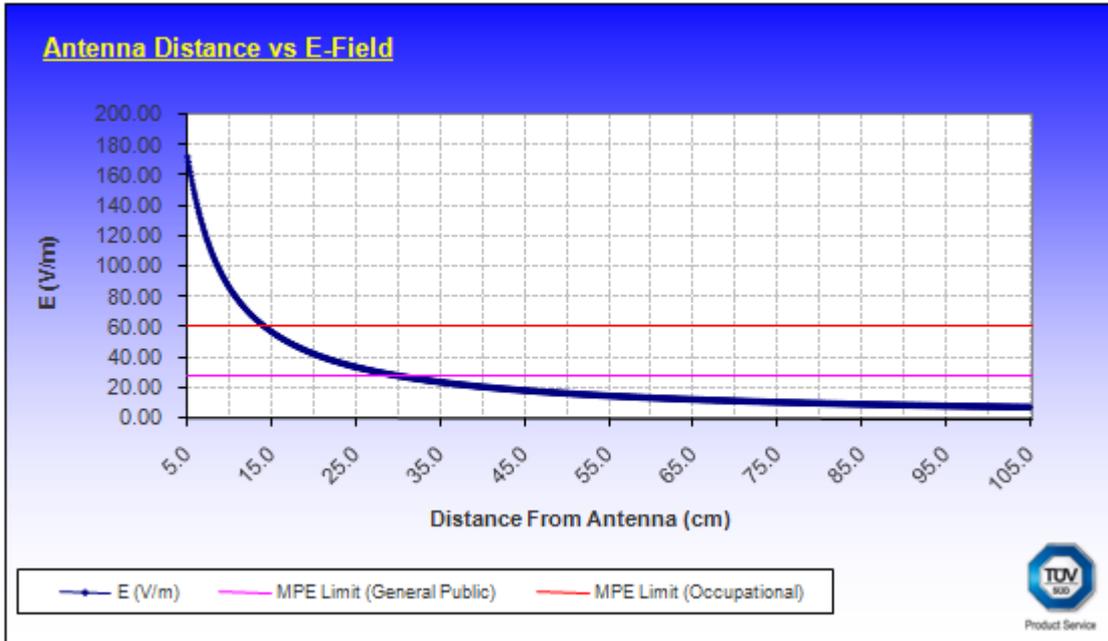


Figure 6 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm)

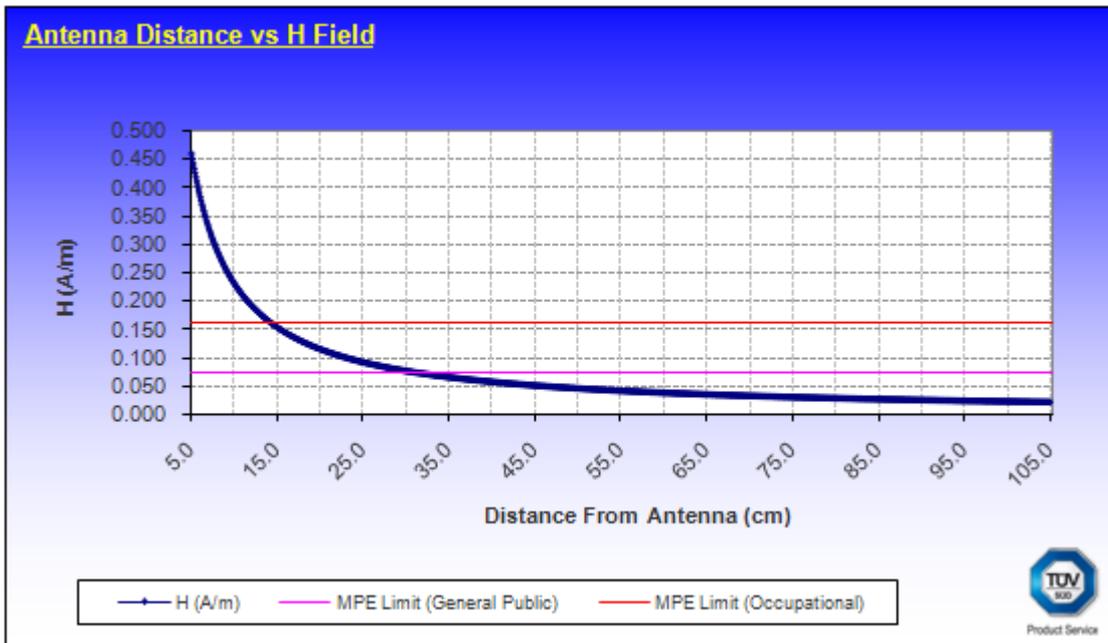


Figure 7 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm)



6dBi Gain

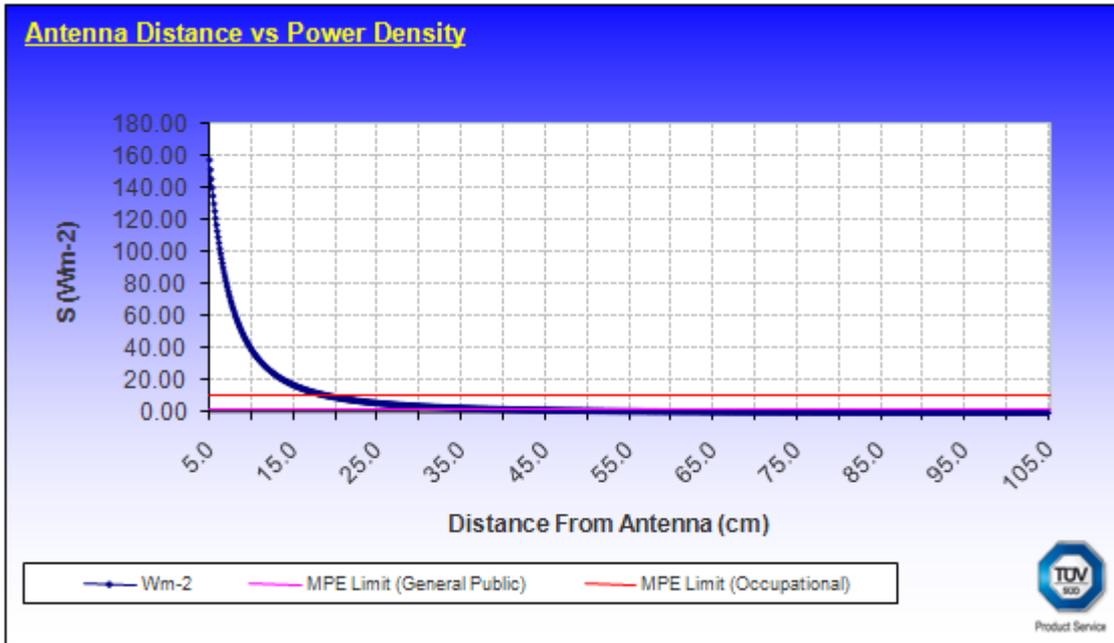


Figure 8 - This graph shows the S field (W/cm²) strength value with regards to distance from the Antenna (cm)

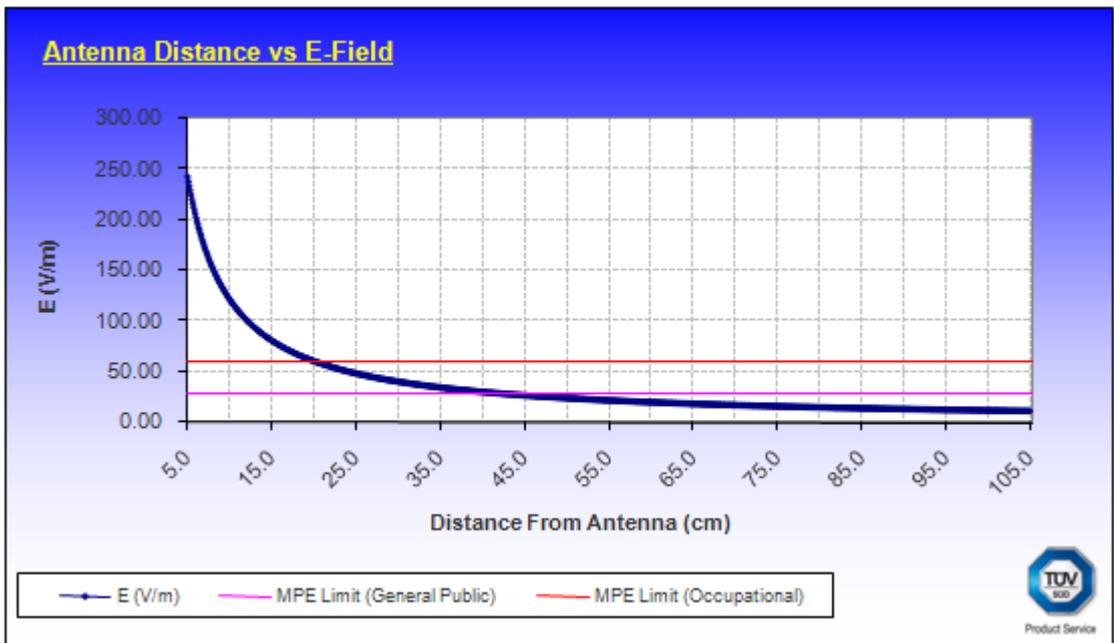


Figure 9 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm)

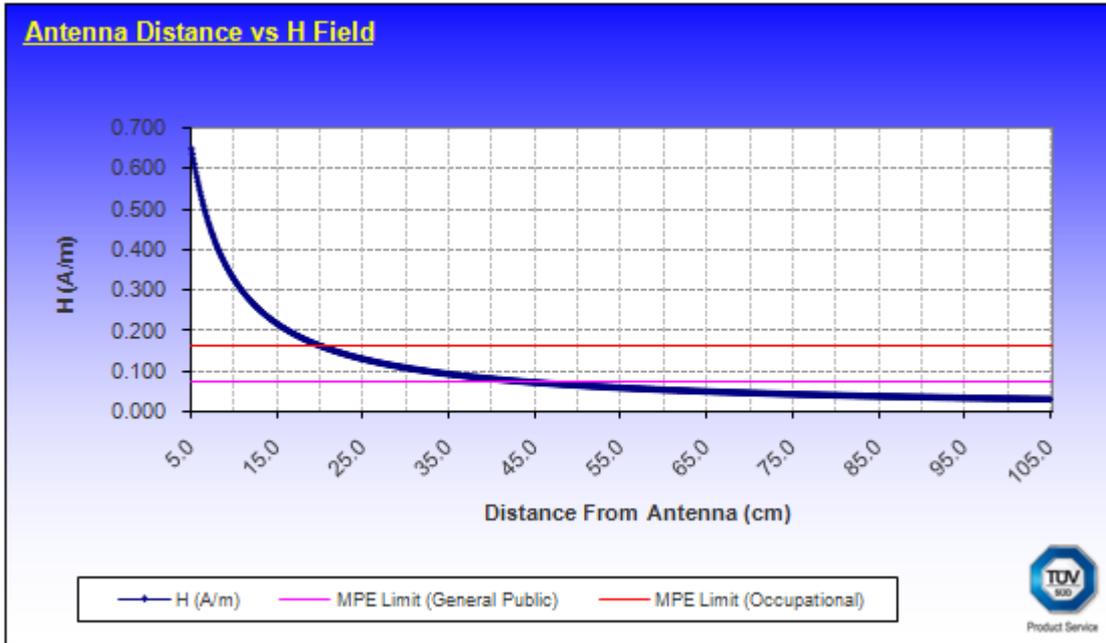


Figure 10 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm)

9dBi Gain

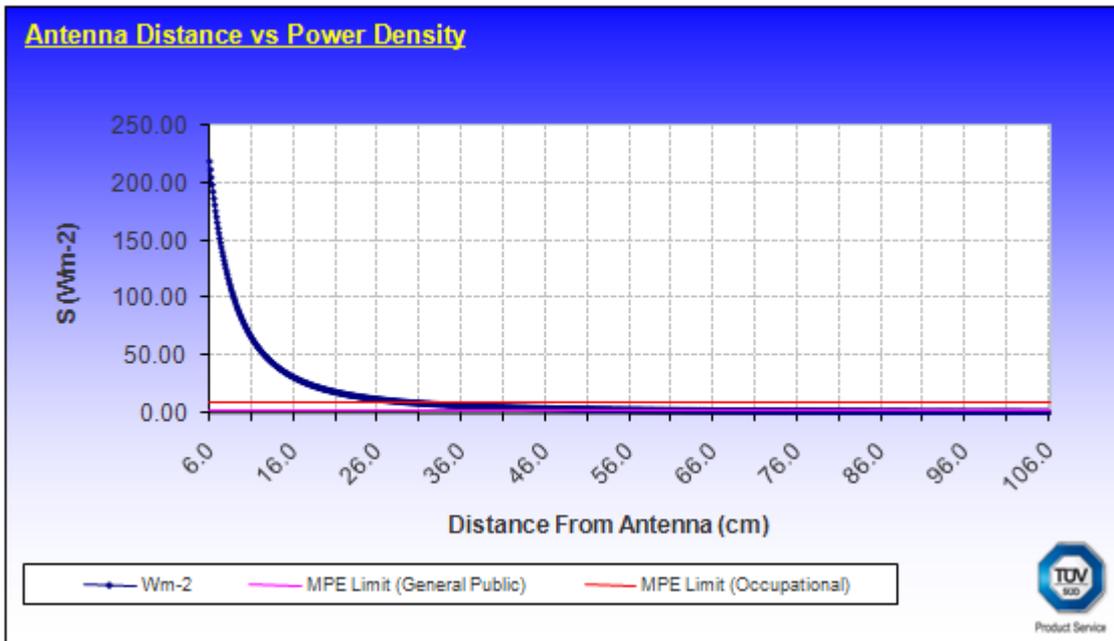


Figure 11 - This graph shows the S field (W/cm²) strength value with regards to distance from the Antenna (cm)

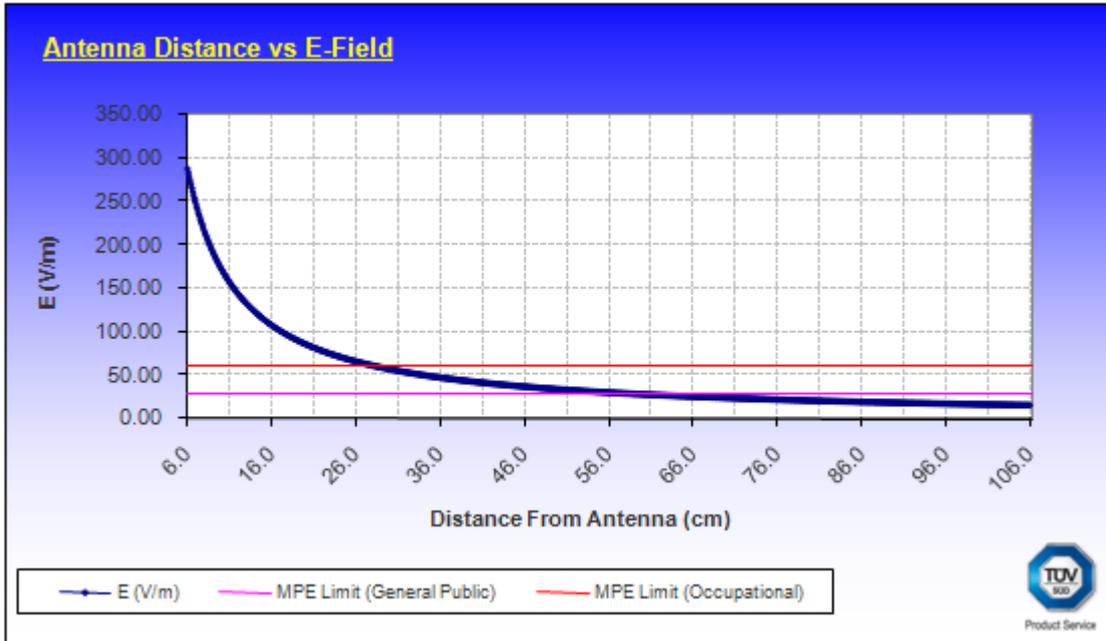


Figure 12 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm)

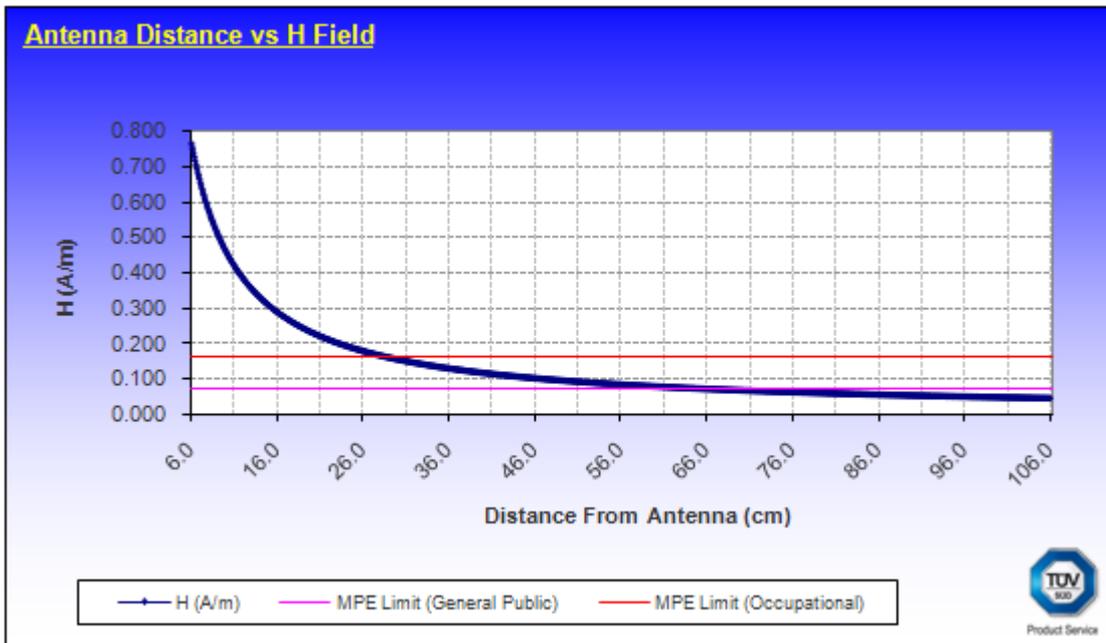


Figure 13 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm)



3.2 FIELD REPRESENTATIONS – FCC

0dBi Unity Gain

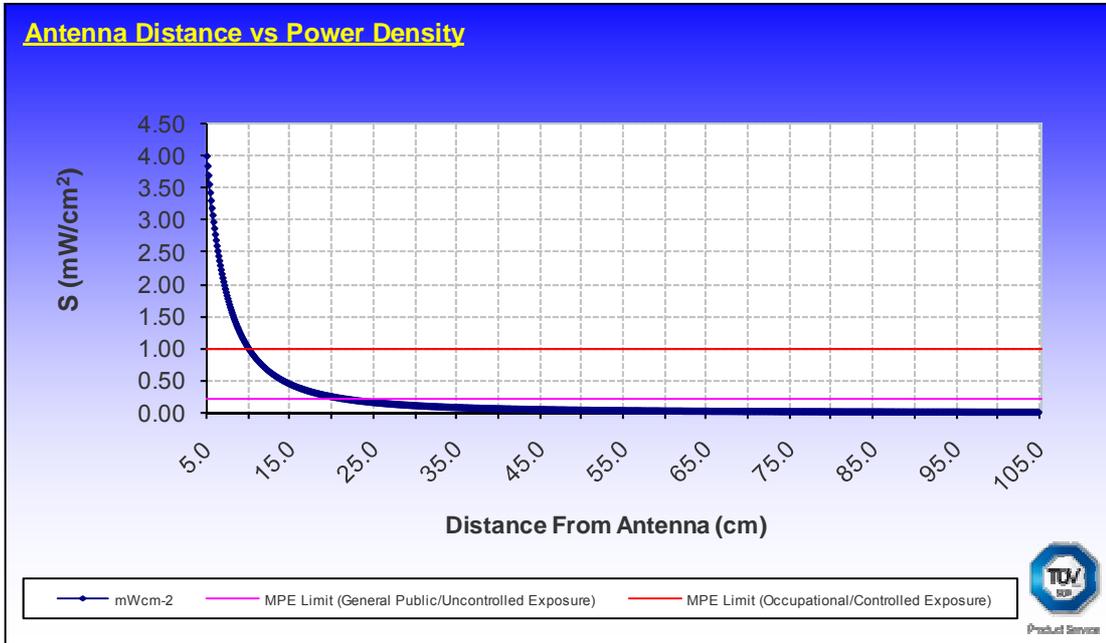


Figure 14 - This graph shows the S field (mW/cm²) strength value with regards to distance from the Antenna (cm)

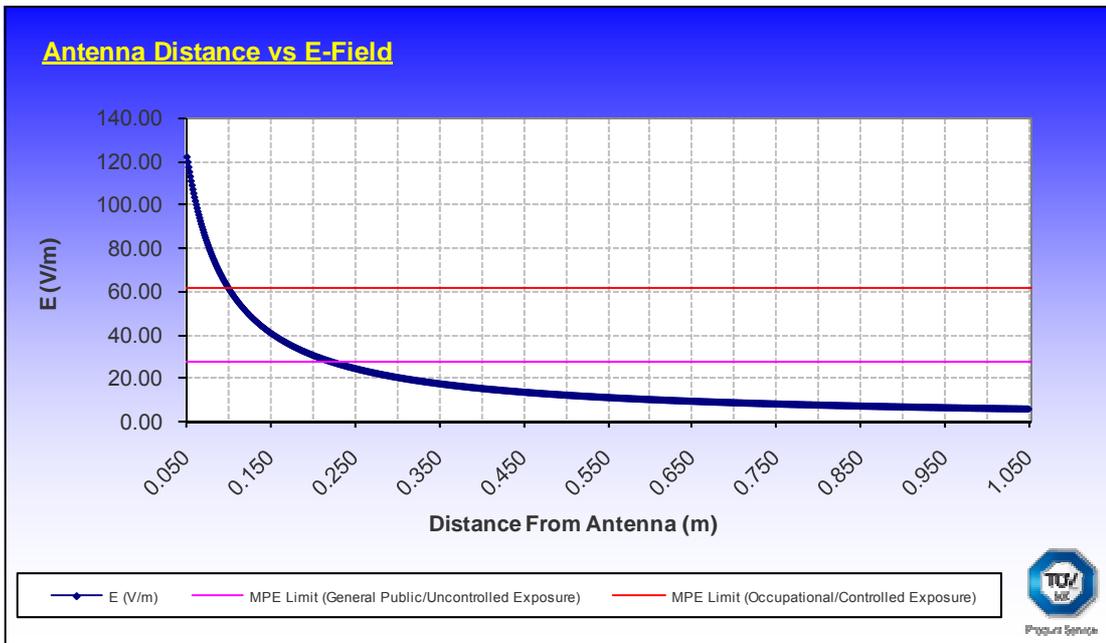


Figure 15 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm).

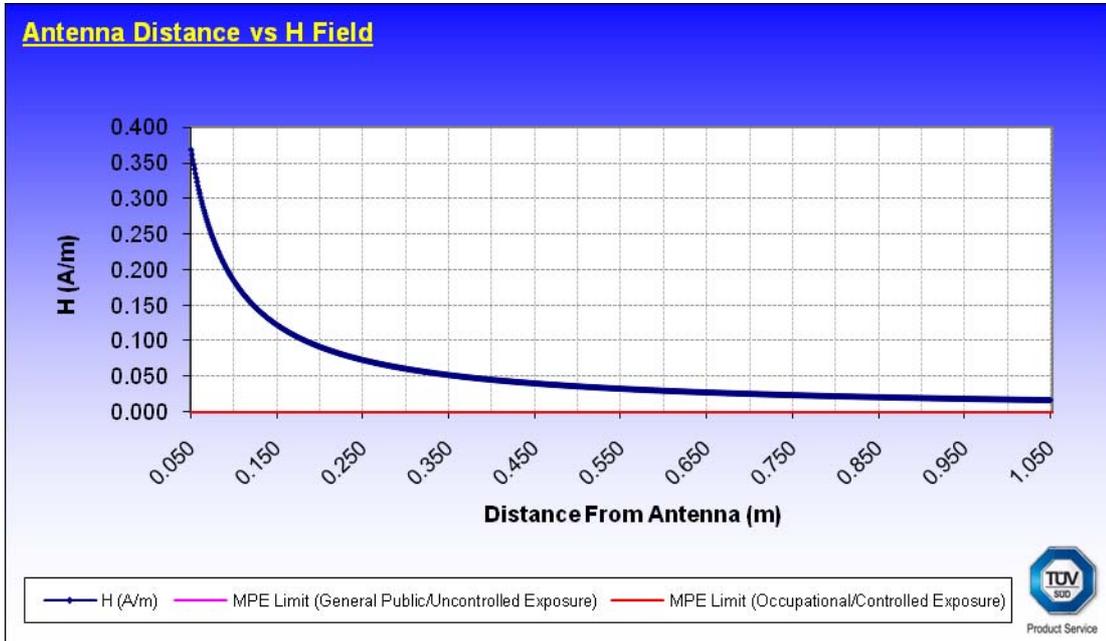


Figure 16 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm).

3dBi Gain

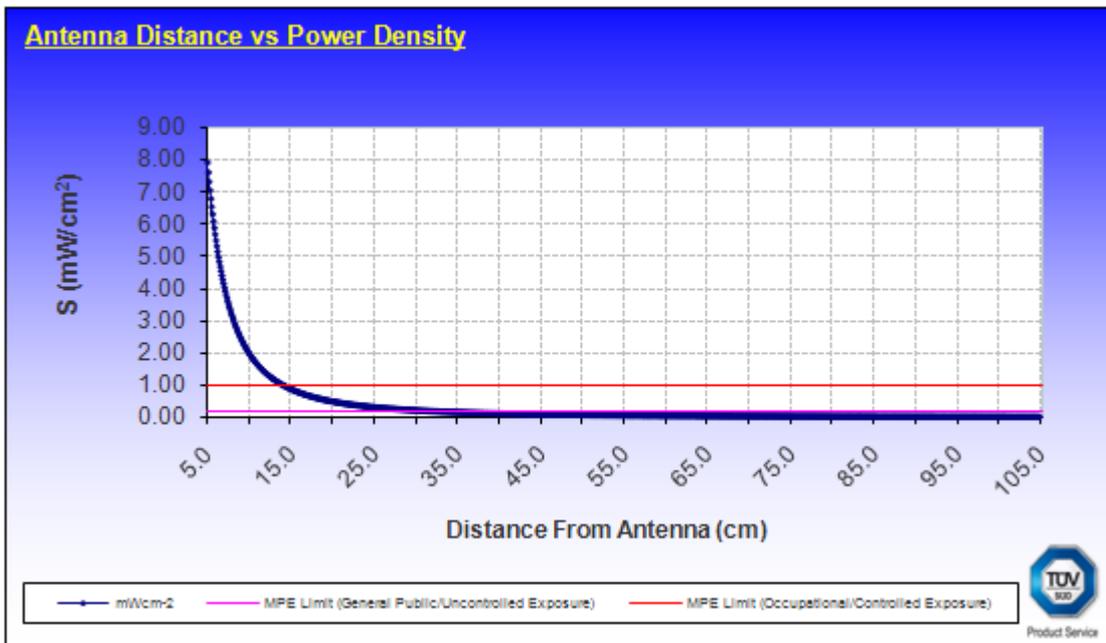


Figure 17 - This graph shows the S field (mW/cm²) strength value with regards to distance from the Antenna (cm)

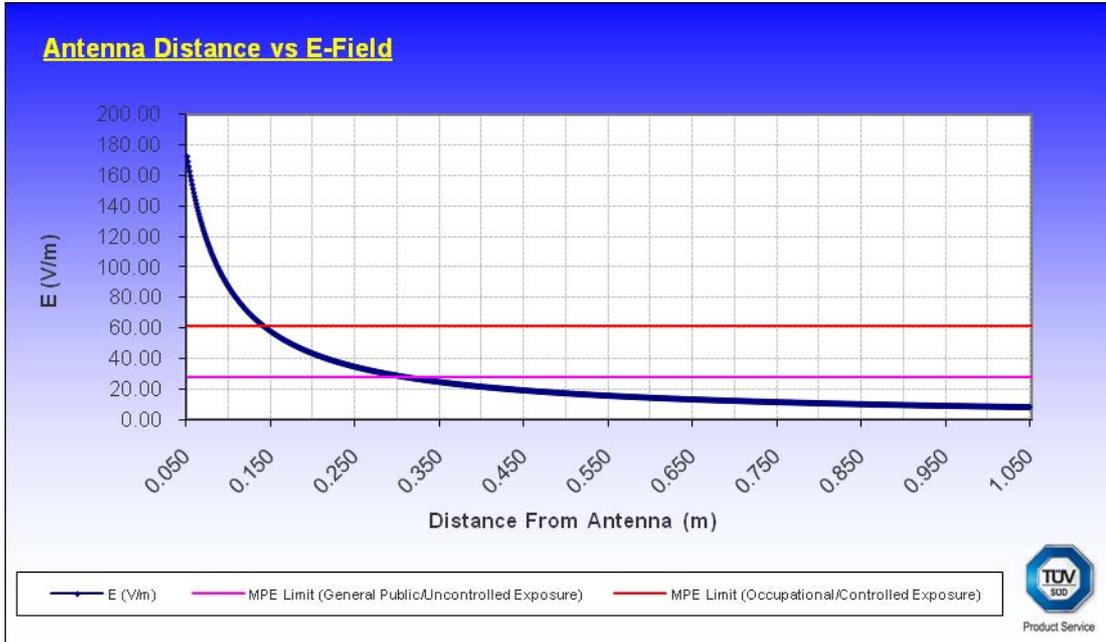


Figure 18 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm).

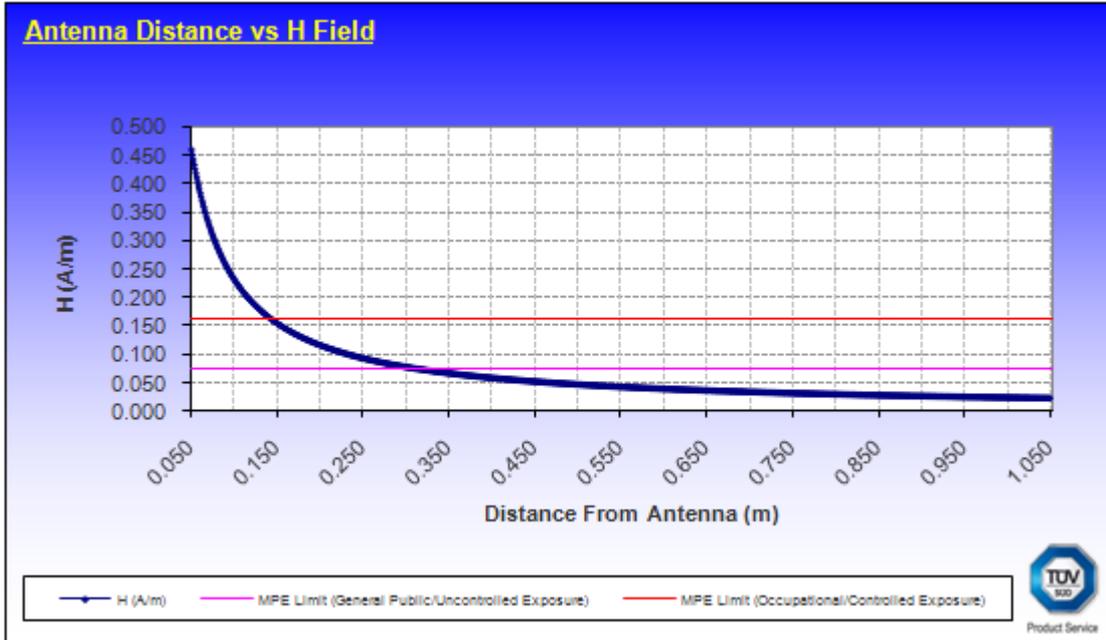


Figure 19 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm)



6dBi Gain

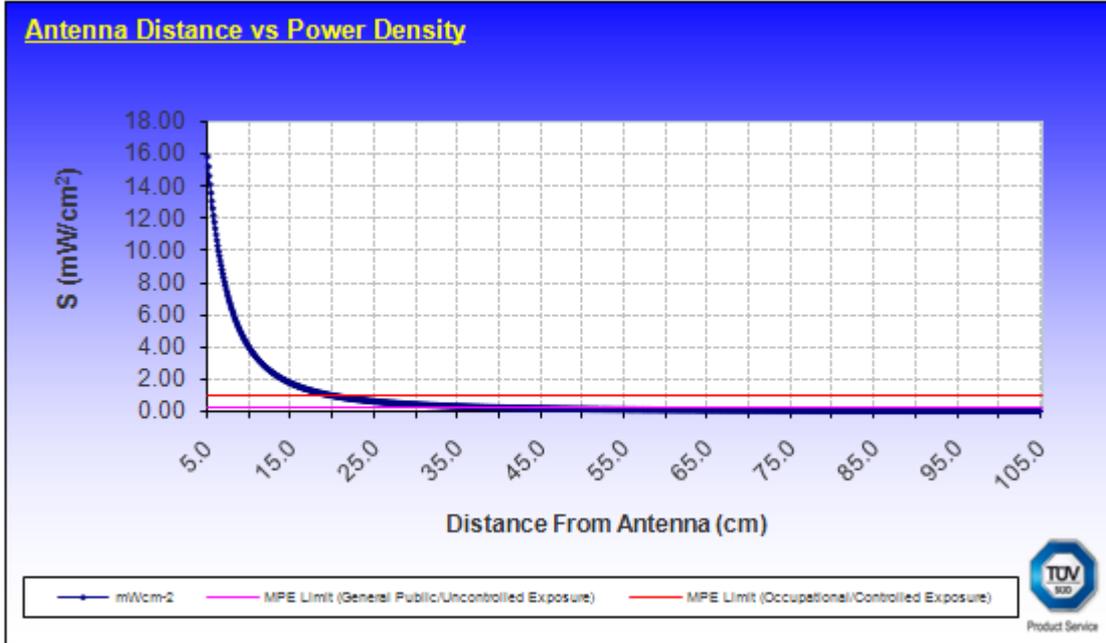


Figure 20 - This graph shows the S field (mW/cm²) strength value with regards to distance from the Antenna (cm)

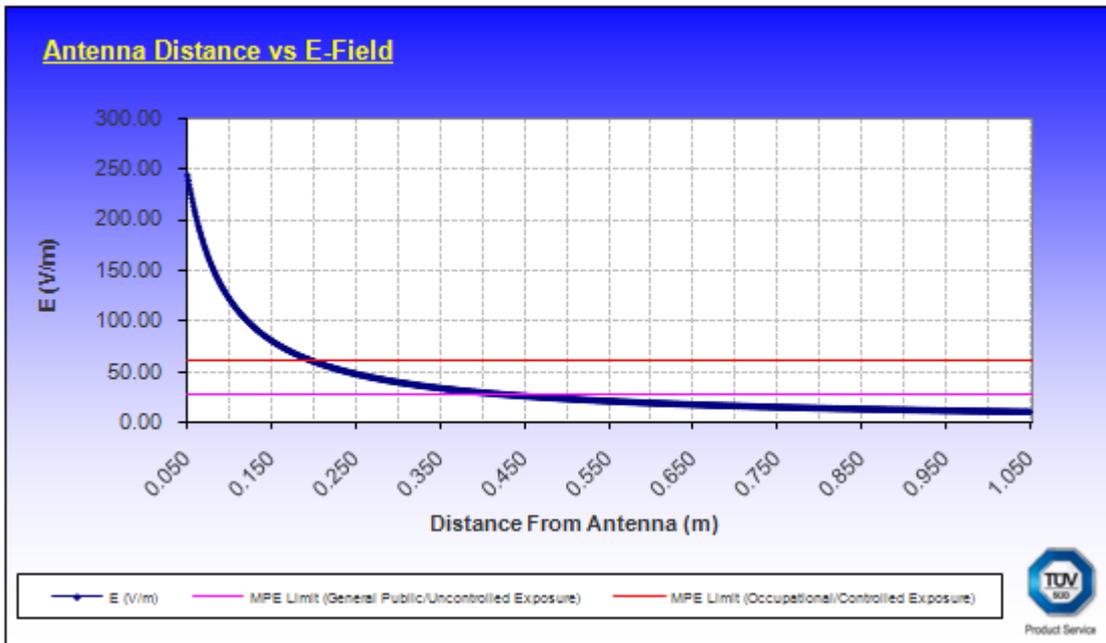


Figure 21 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm).

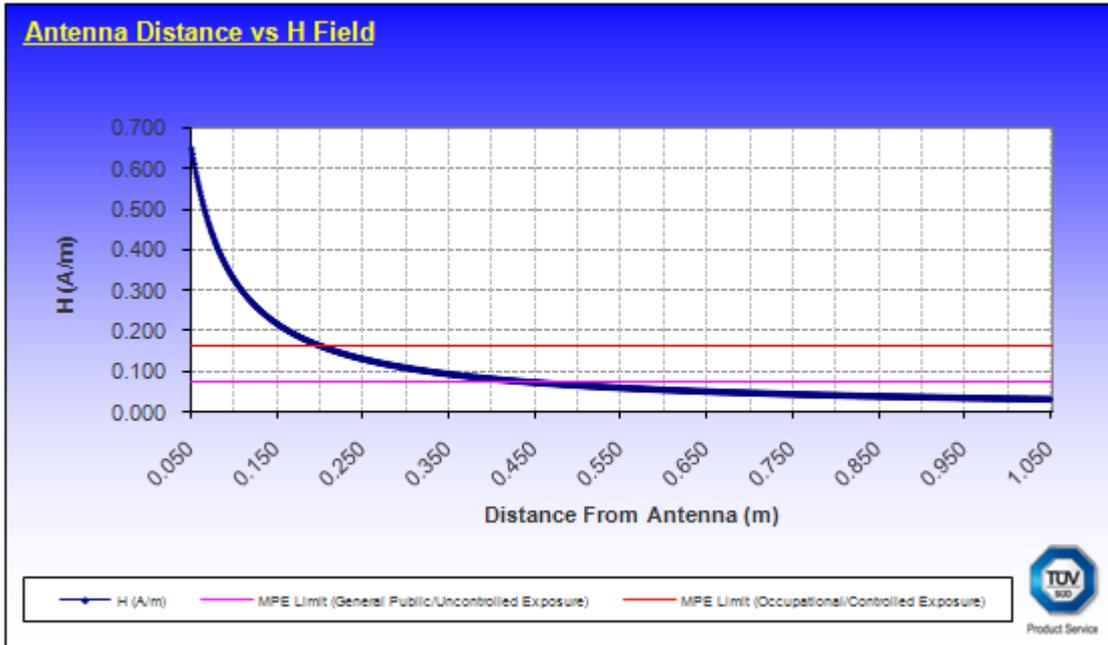


Figure 22 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm).

9dBi Gain

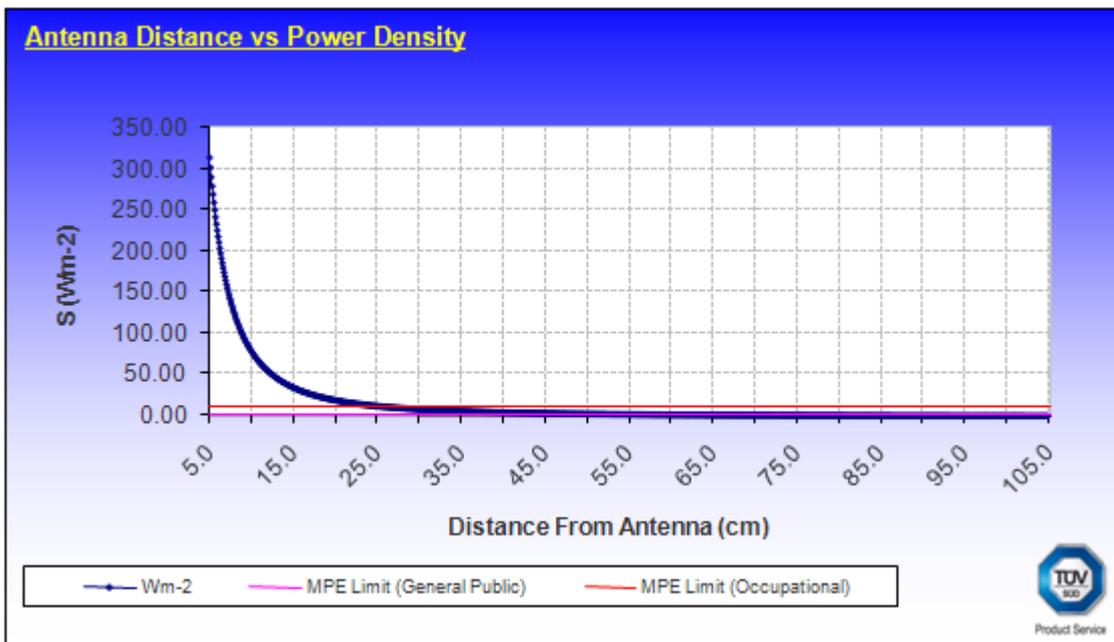


Figure 23 - This graph shows the S field (mW/cm²) strength value with regards to distance from the Antenna (cm)

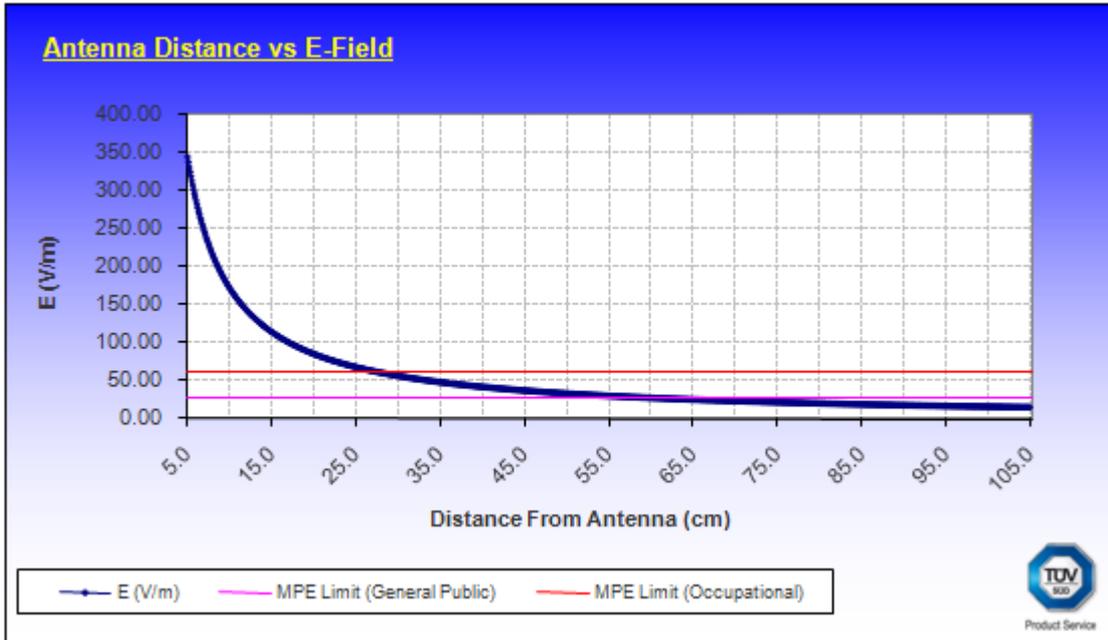


Figure 24 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm).

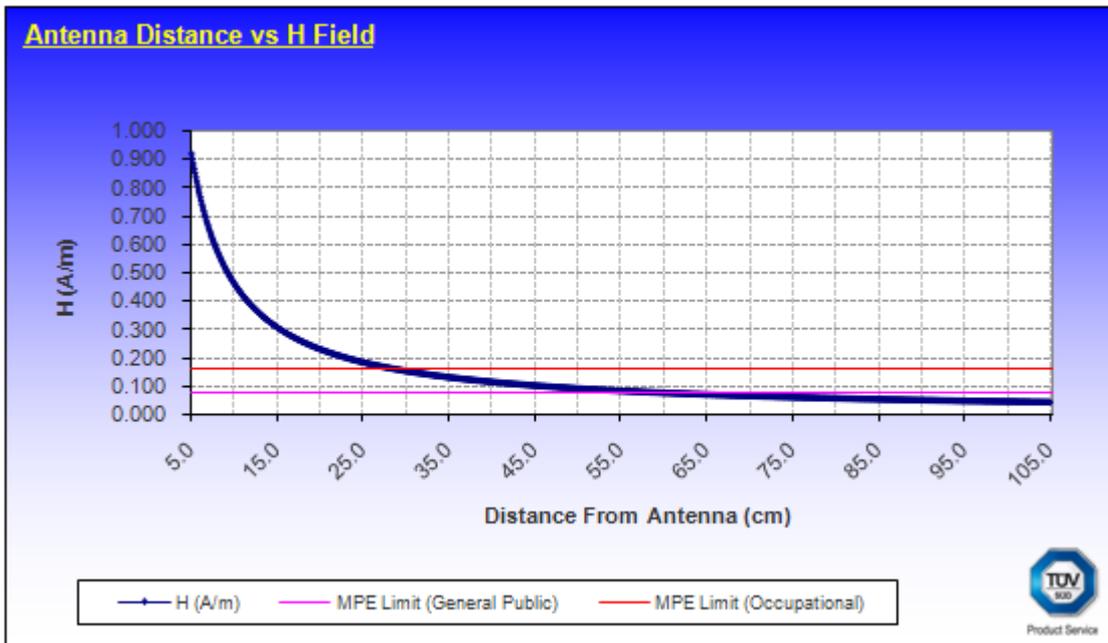


Figure 25 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm).



3.3 FIELD REPRESENTATIONS – IC

0dBi Unity Gain

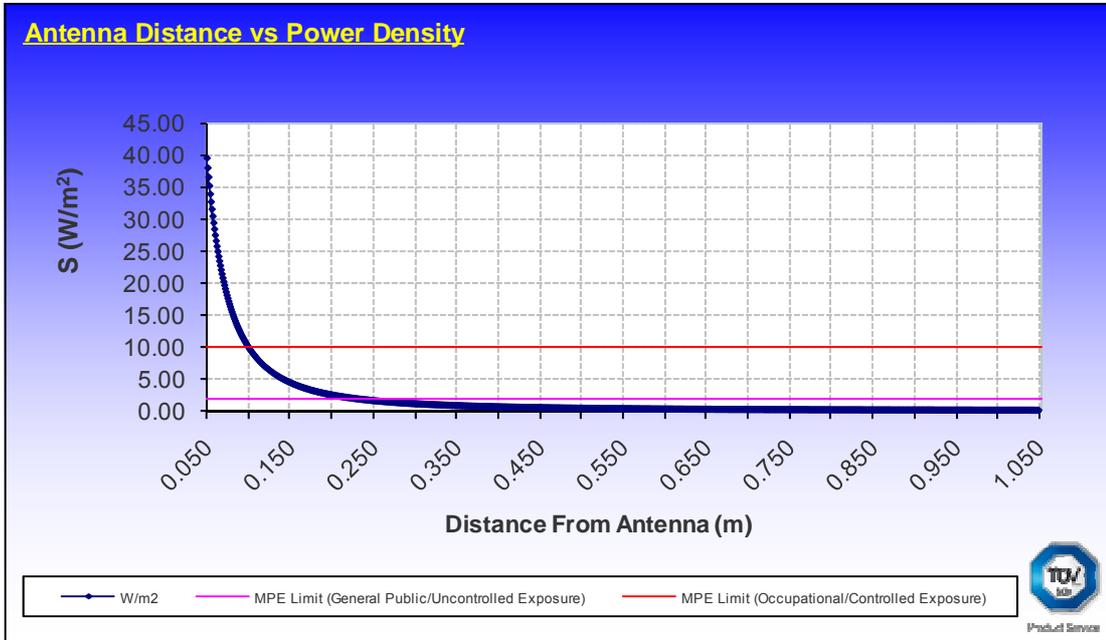


Figure 26 - This graph shows the S field (W/cm²) strength value with regards to distance from the Antenna (cm)

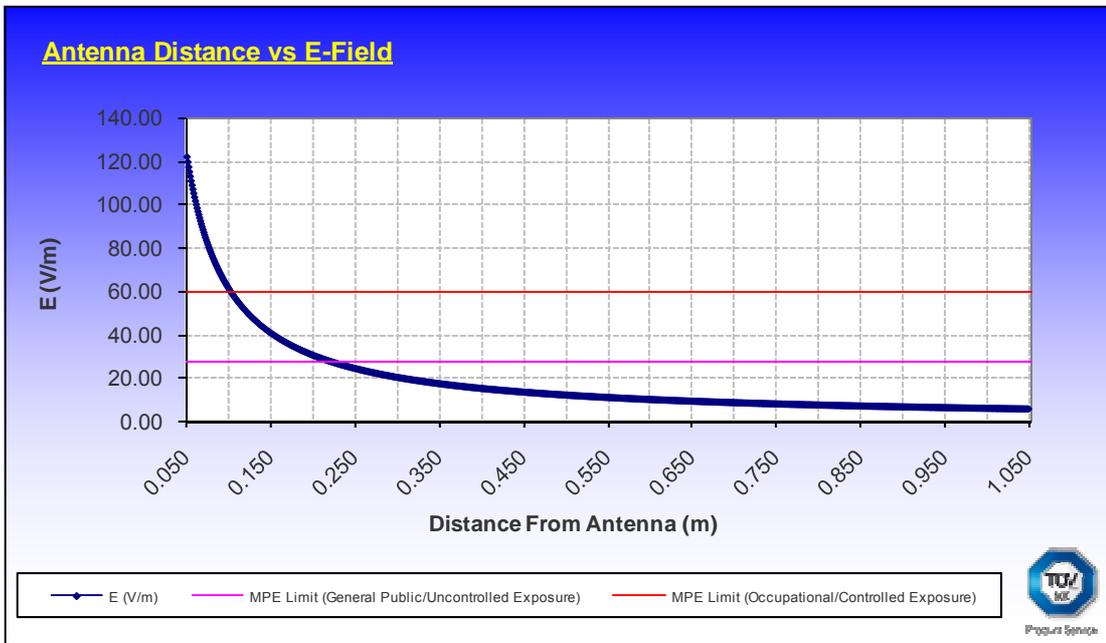


Figure 27 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm).

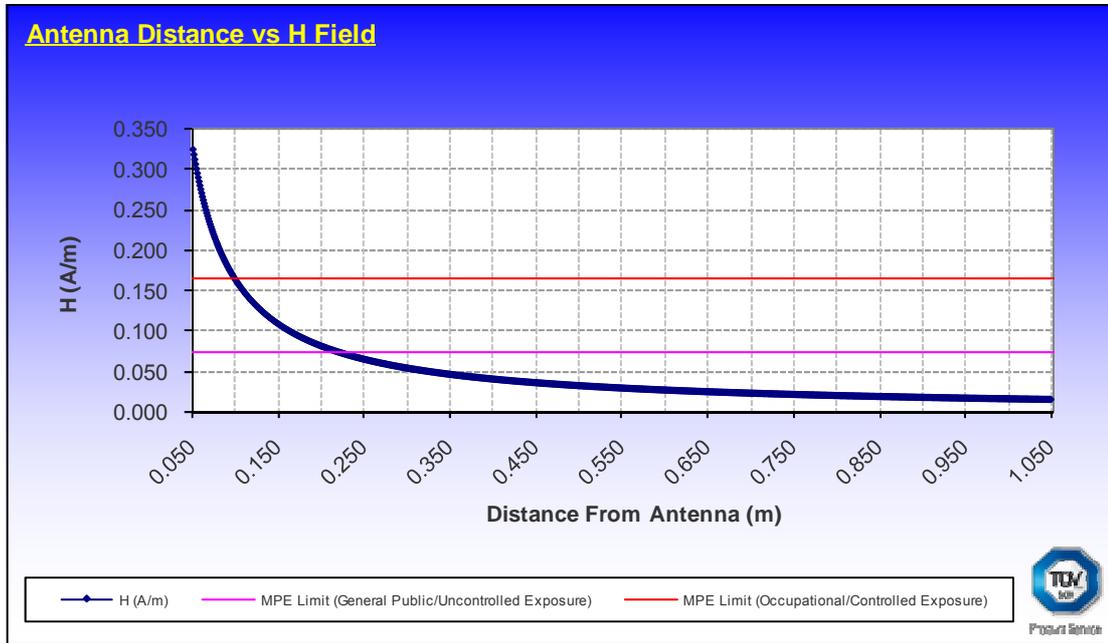


Figure 28 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm).

3dBi Gain

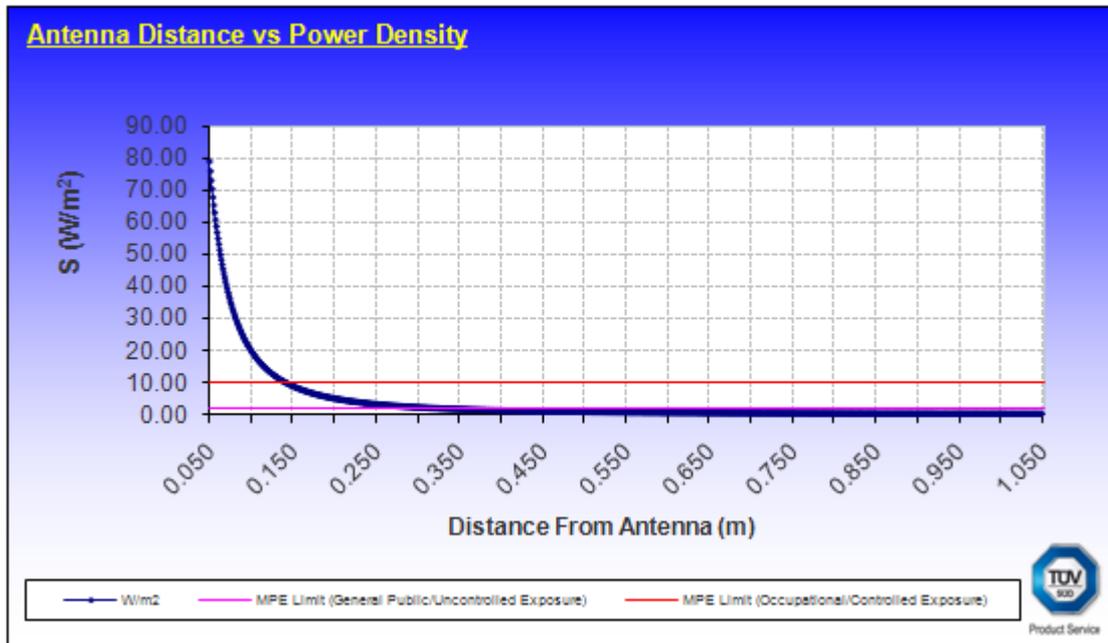


Figure 29 - This graph shows the S field (W/cm²) strength value with regards to distance from the Antenna (cm)

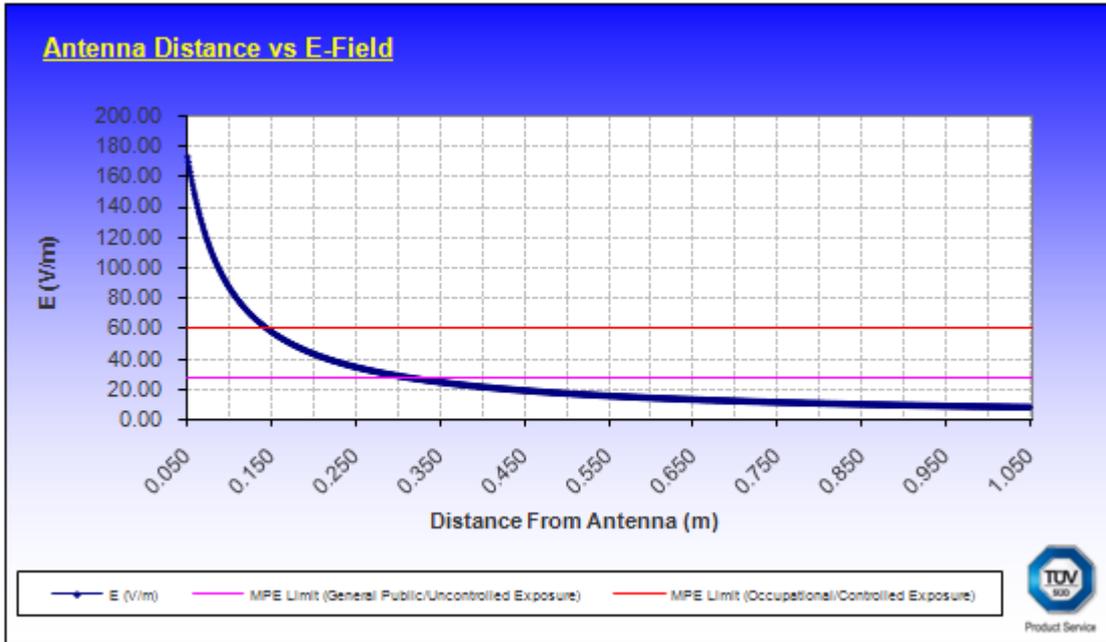


Figure 30 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm)

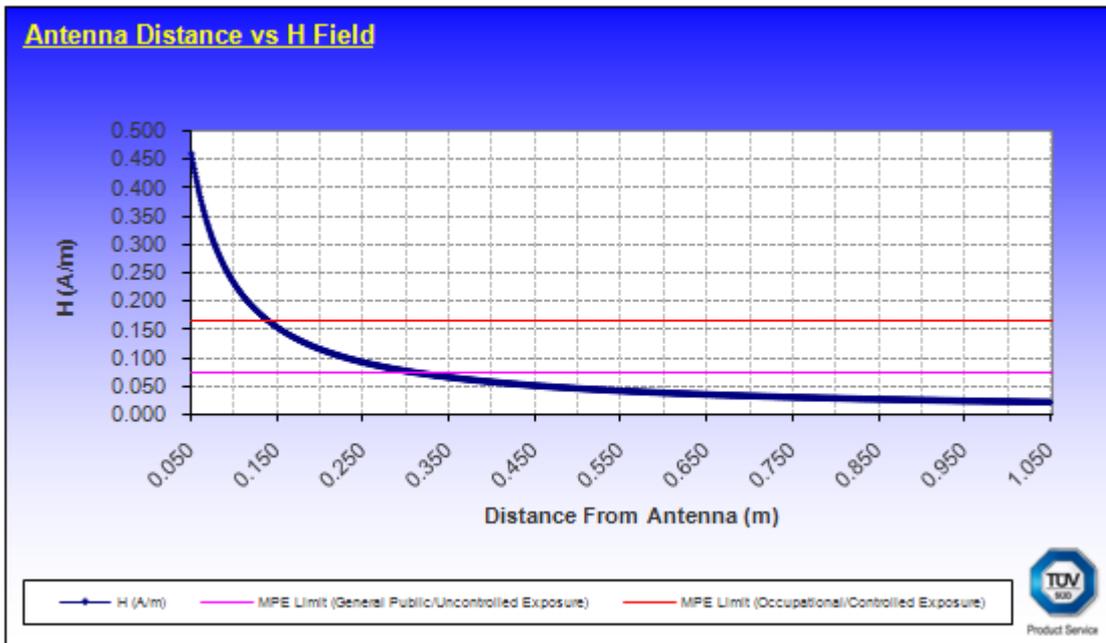


Figure 31 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm)



6dBi Gain

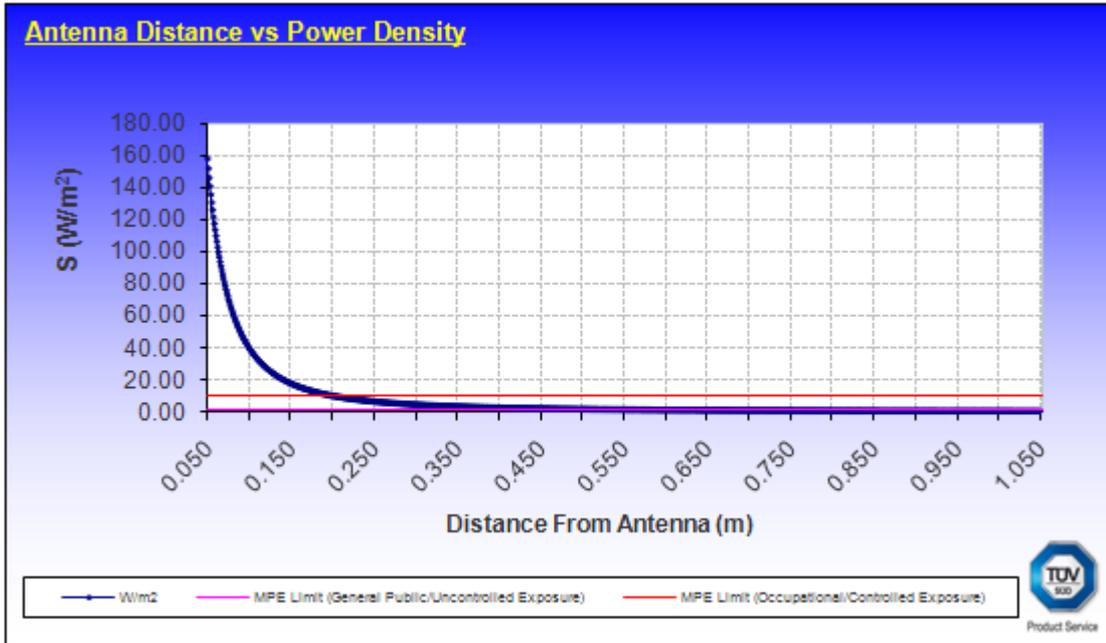


Figure 32 - This graph shows the S field (W/cm²) strength value with regards to distance from the Antenna (cm)

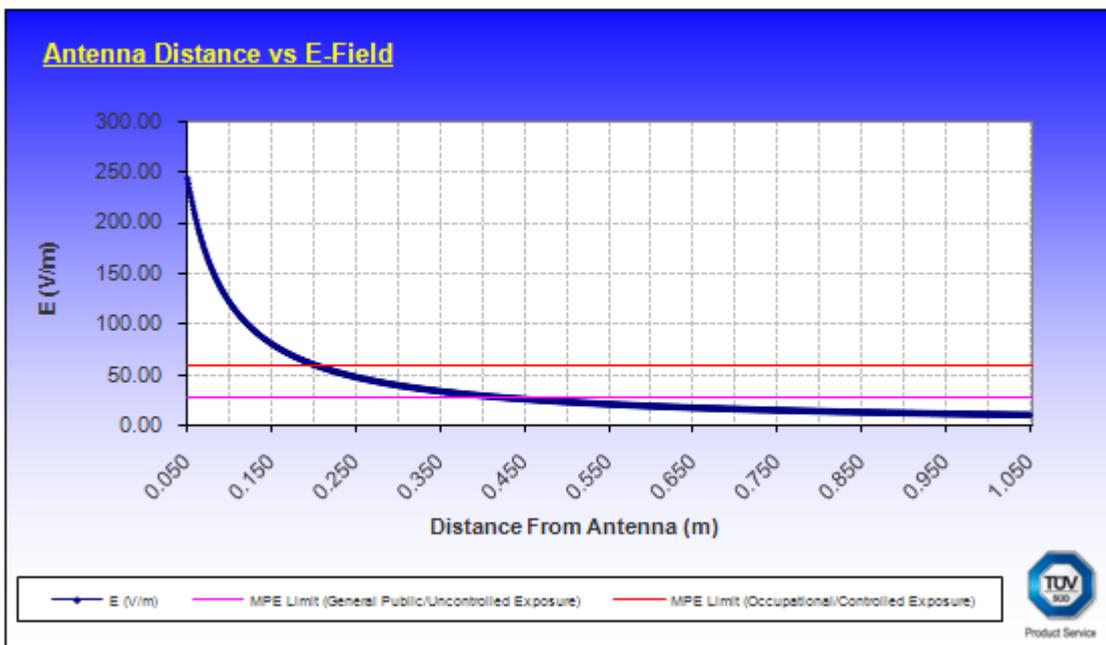


Figure 33 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm)

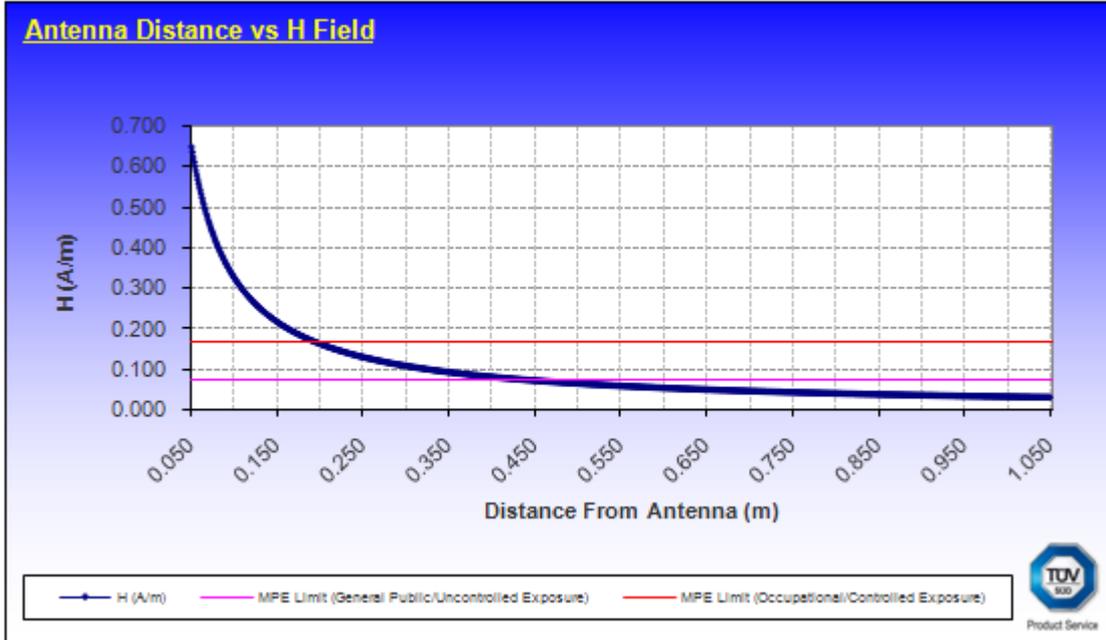


Figure 34 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm)

9dBi Gain

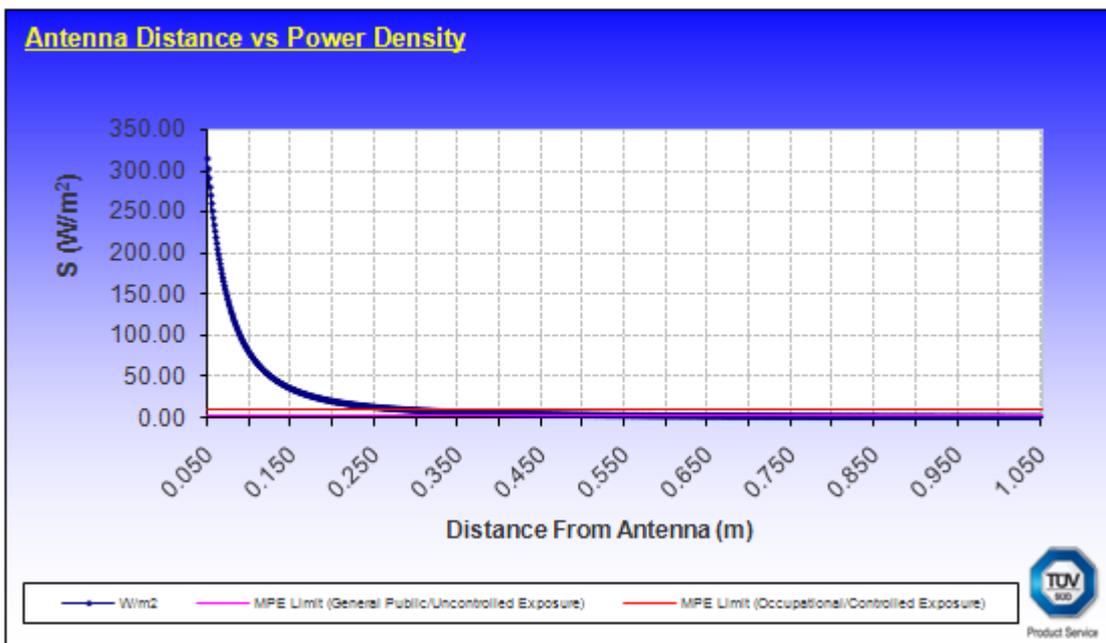


Figure 35 - This graph shows the S field (W/cm²) strength value with regards to distance from the Antenna (cm)

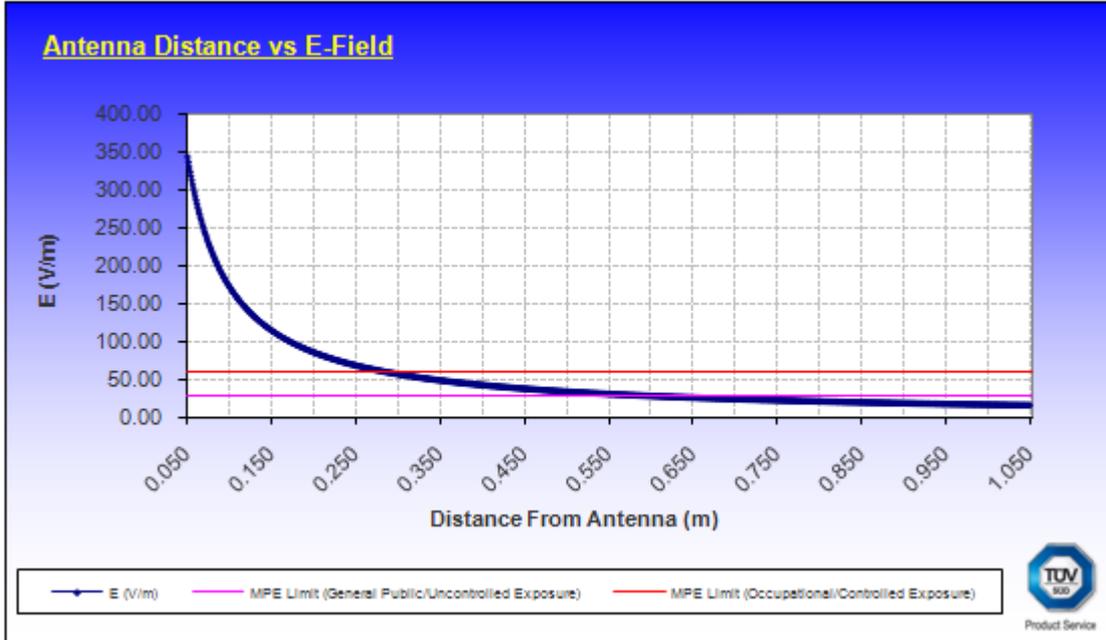


Figure 36 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm)

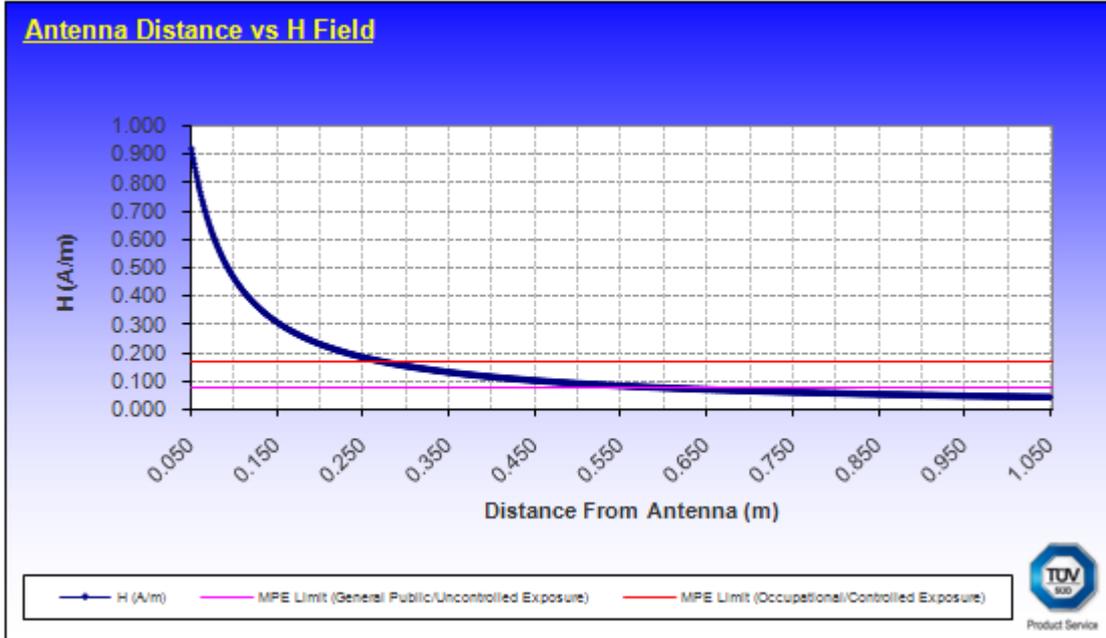


Figure 37 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm)



3.4 FIELD REPRESENTATIONS: AUSTRALIAN – ARPANSA LIMITS

0dBi Unity Gain

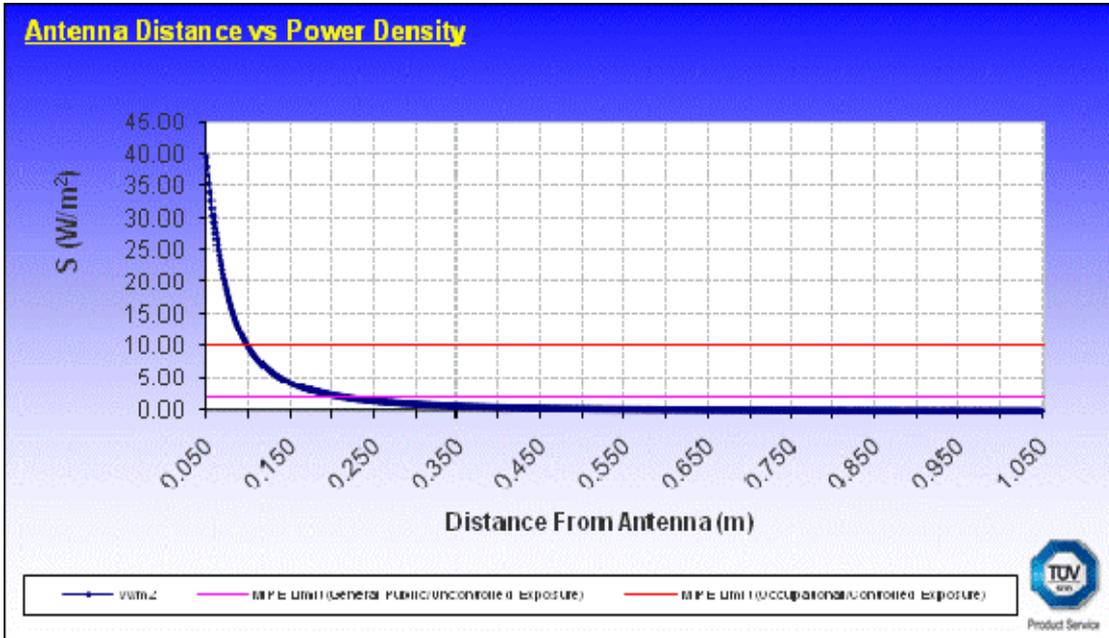


Figure 38 – This graph shows the S field (W/cm^2) strength value with regards to distance from the Antenna (cm)

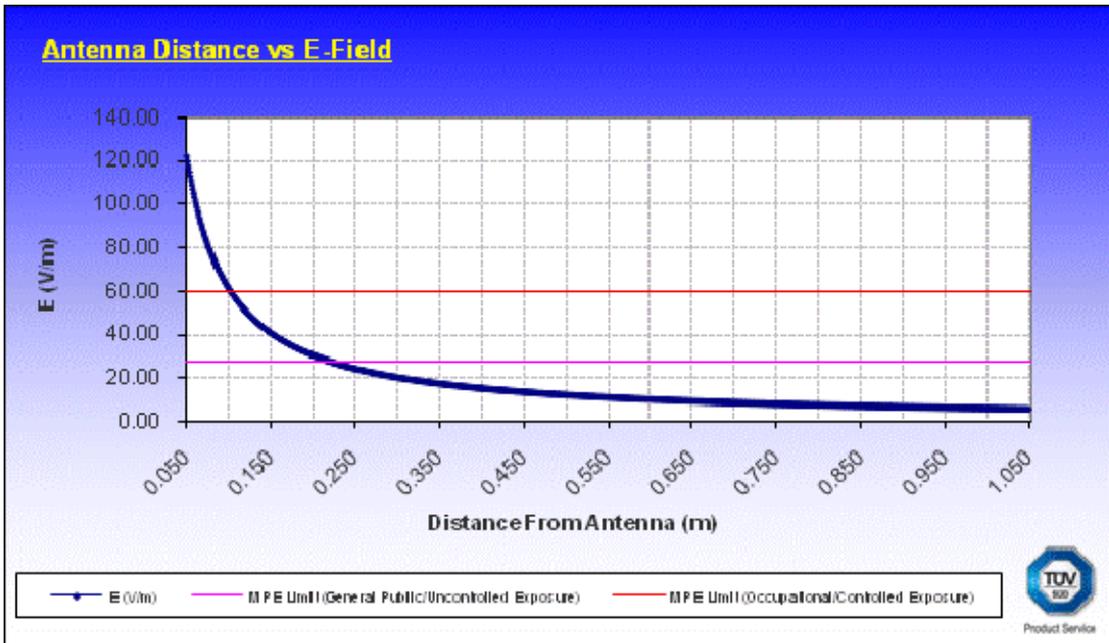


Figure 39 – This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm)

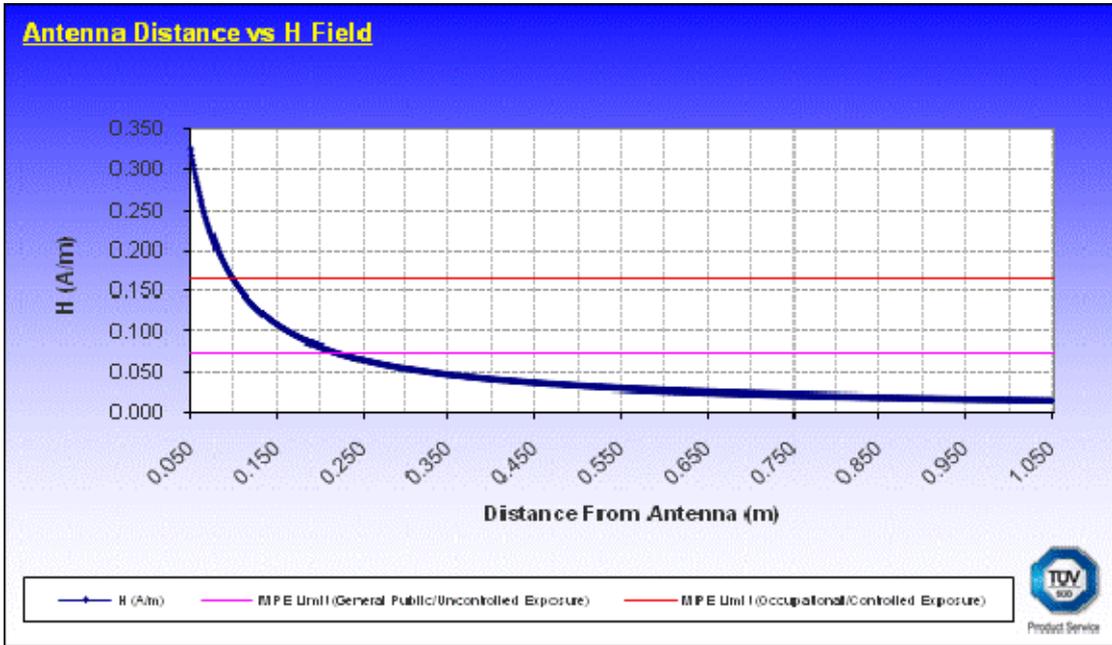


Figure 40 – This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm)

3dBi Gain

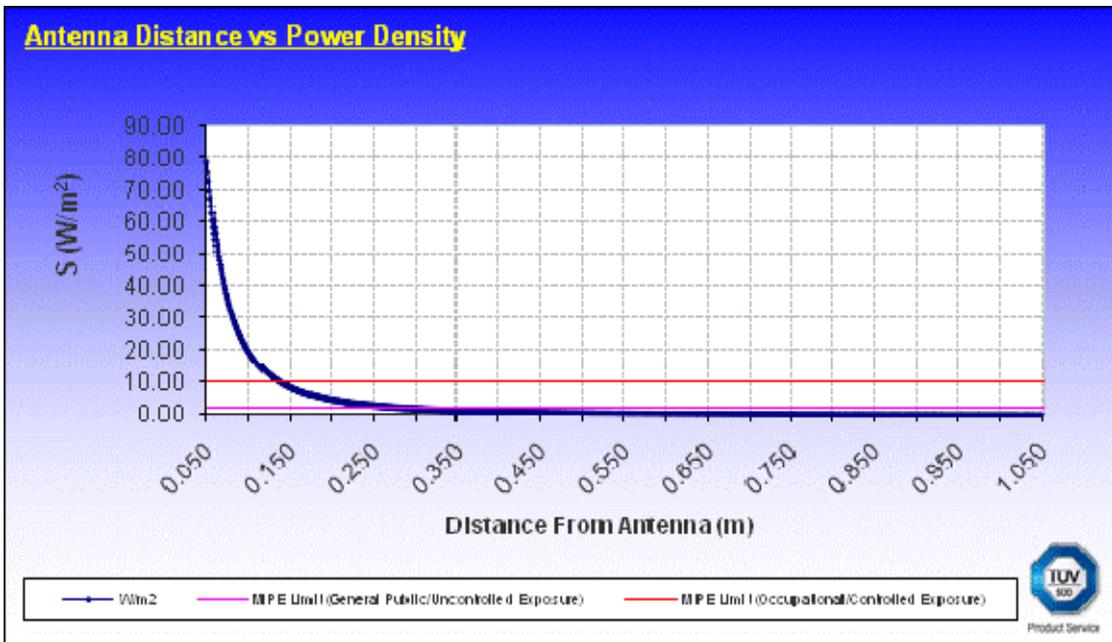


Figure 41 – This graph shows the S field (W/cm²) strength value with regards to distance from the Antenna (cm)

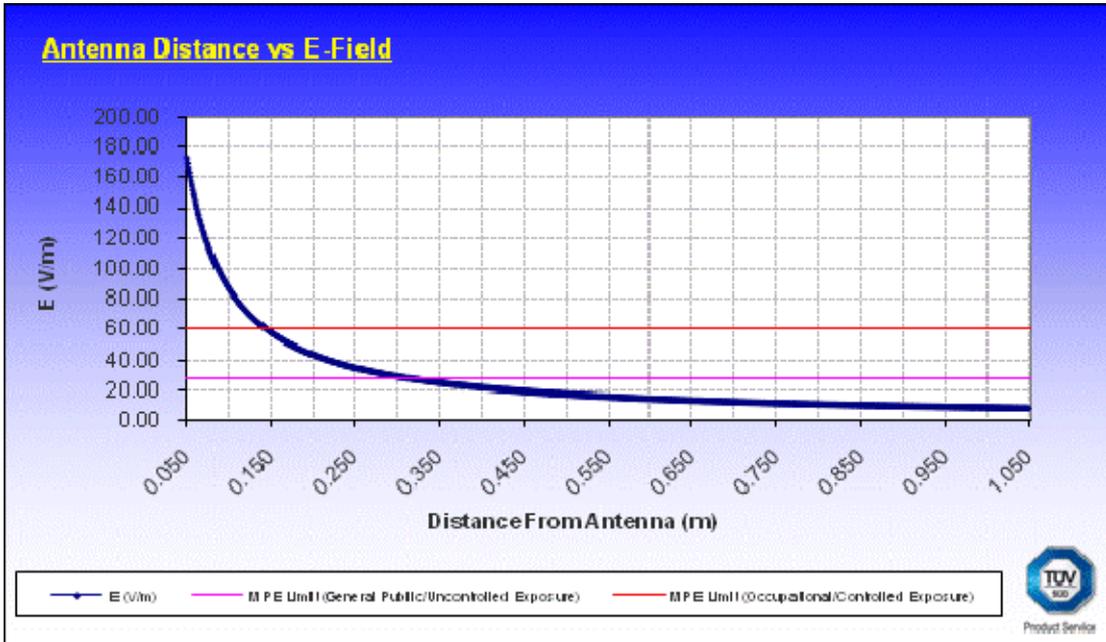


Figure 42 – This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm)

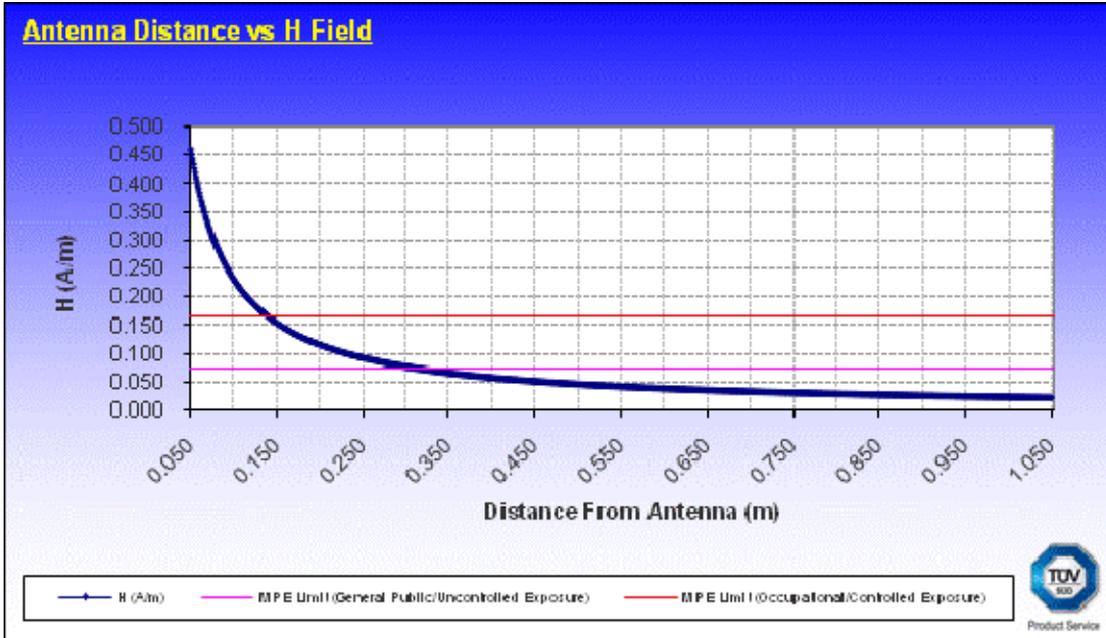


Figure 43 – This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm)



6dBi Gain

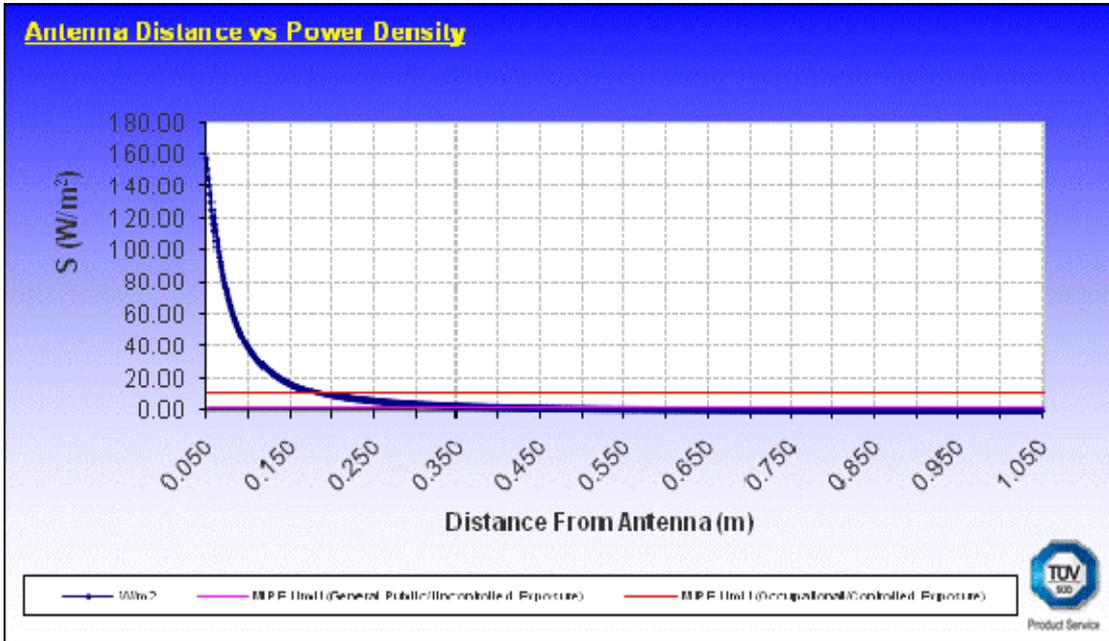


Figure 44 – This graph shows the S field (W/cm²) strength value with regards to distance from the Antenna (cm)

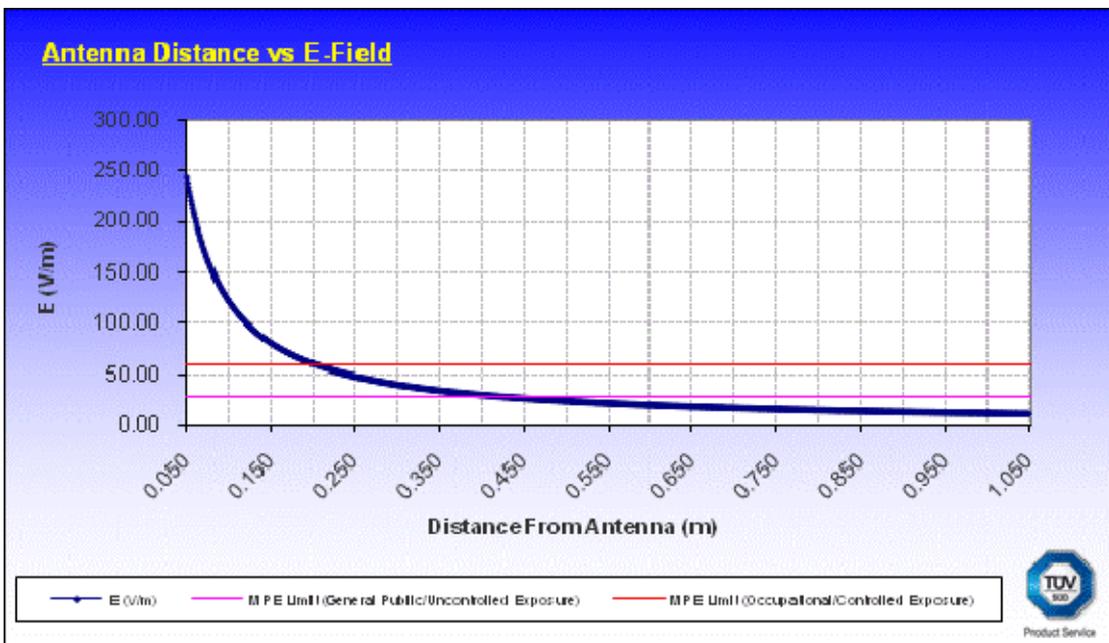


Figure 45 – This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm)

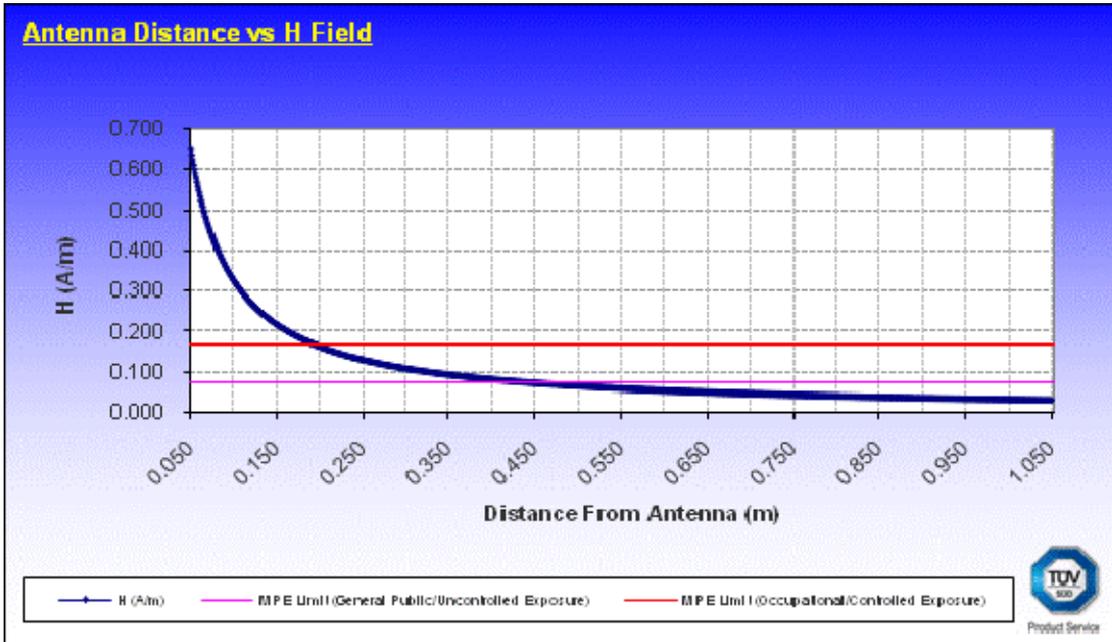


Figure 46 – This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm)

9dBi Gain

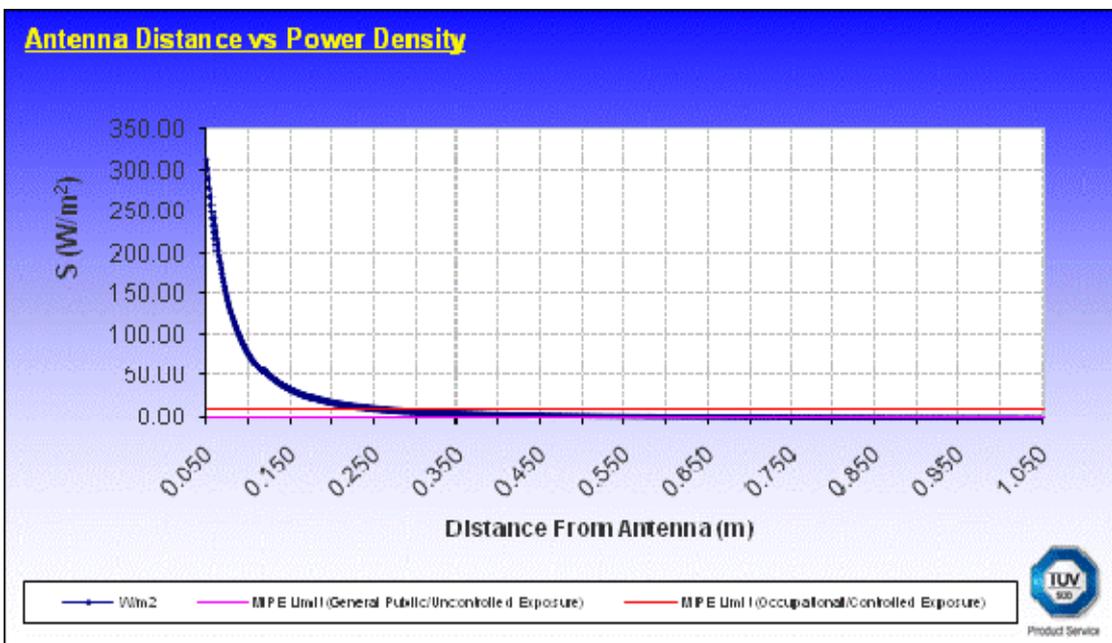


Figure 47 – This graph shows the S field (W/cm²) strength value with regards to distance from the Antenna (cm)

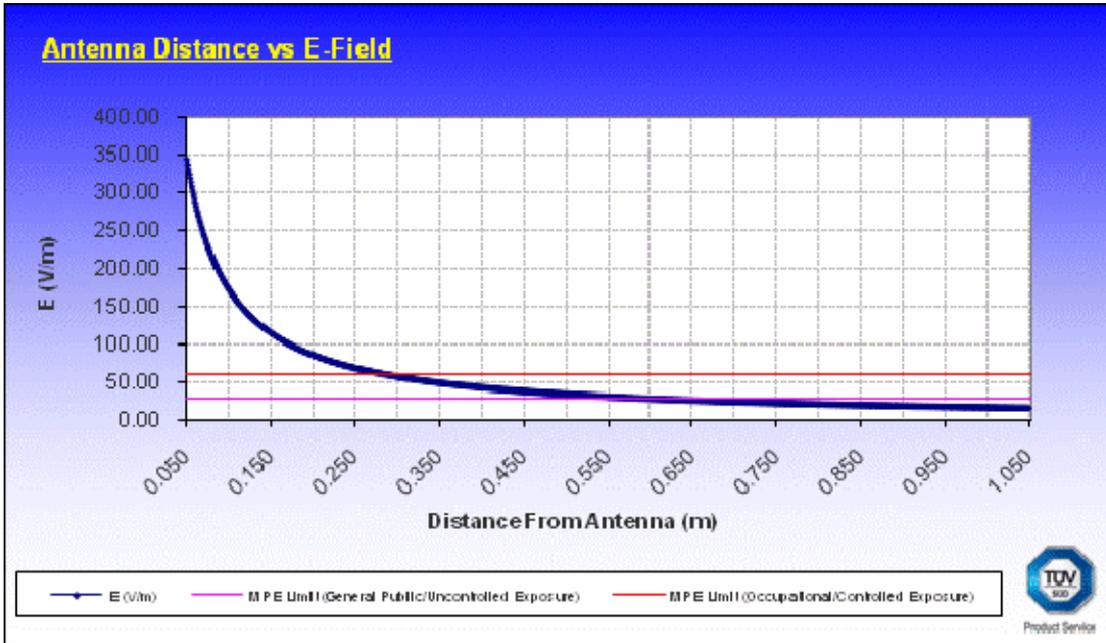


Figure 48 – This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm)

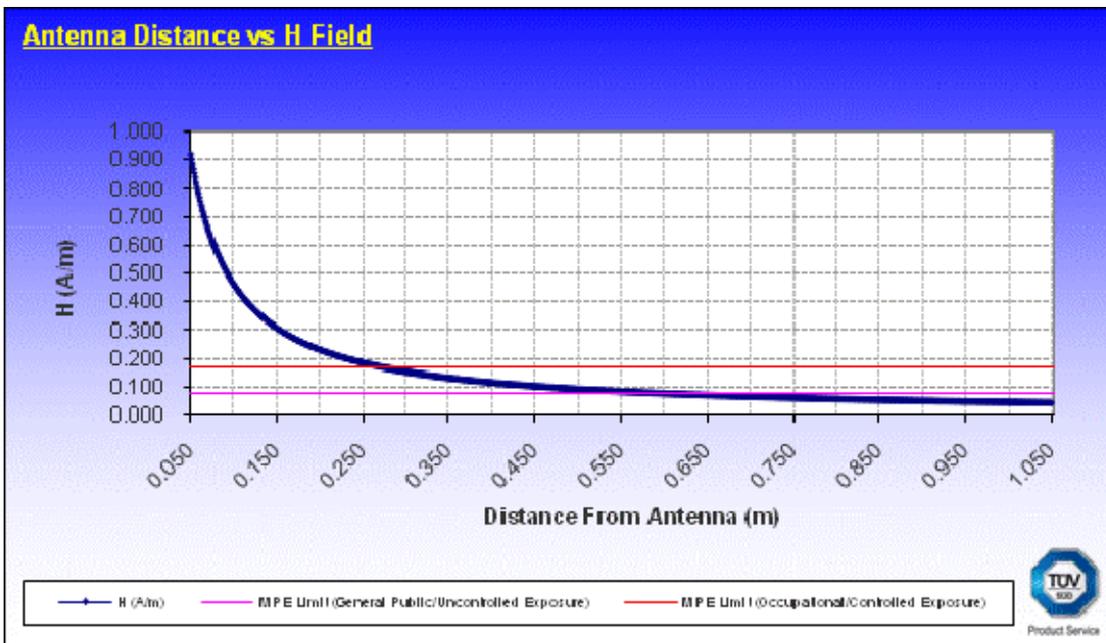


Figure 49 – This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm)



Product Service

SECTION 4

DISCLAIMERS AND COPYRIGHT



Product Service

4.1 DISCLAIMERS AND COPYRIGHT

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