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# Report On

RF Exposure Assessment of the
Garmin International Inc
Remote mount marine VHF radio with optional AIS functionality

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IC ID: 1792A-GARVHF3 D

Document 75906328 Report 01 Issue 7 August 2009

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**REPORT ON**

RF Exposure Assessment of the
Garmin International Inc
Remote mount marine VHF radio with optional AIS functionality

Document 75906328 Report 01 Issue 7

August 2009

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**DATED** 20 August 2009

**This report has been up-issued to Issue 7 to correct typographical errors.**

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**SECTION 1**

**REPORT SUMMARY**

RF Exposure Assessment of the
Garmin International Inc
Remote mount marine VHF radio with optional AIS functionality

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## 1.1 INTRODUCTION

The information contained in this report is intended to show verification of the RF Exposure Assessment of the Garmin International Inc Remote mount marine VHF radio with optional AIS functionality 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 | Remote mount marine VHF radio with optional AIS functionality |
| Model Number(s) | VHF300AIS |
| Declared Variant(s) | VHF300i, VHF300 AIS, VHF300 |
| Serial Number(s) | Not Supplied |
| Hardware Version | Not Supplied |
| Software Version | Not Supplied |

**Test Specification/Issue/Date**

1. OET Bulletin 65 Edition 97-01 August 1997 - Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields
2. RSS-102 Issue 3 June 2009 Radio frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
3. 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 (110 MHz – 40 GHz) – General Public

**Related Document(s)**

4. National Council on Radiation Protection and Measurements (NRPC) - Report No. 86(1986) "Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields".
5. Health Canada's Safety Code: Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 KHz to 300 GHz.
6. FCC Guidelines for Evaluating exposure to RF Emissions - 47 CFR § 1.1310; 47 CFR § 1.1307(b) & 47 CFR § 80.83.
7. 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).
8. IEEE Std C95.1-2005: IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3KHz to 300GHz.

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## 1.2 BRIEF SUMMARY OF RESULTS

### 1.2.1 General Public Exposure Levels

Table show the worst Case Gain of 9dBi

| Antenna Gain (Numeric) | Peak 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 |
| | | 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 |
| | | 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 |

The calculations have shown that they **meet** the General Public Exposure Levels described in the ICNIRP Guidelines, FCC 47 CFR § 1.1310 Guidelines and the Health Canada's RF exposure guideline Safety Code 6 and ICNIRP Guidelines 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) | Peak Output Power (mW) | Field | Calculated RF Exposure at 1.5 m (150 cm) | Occupational Exposure Limit | |
|---|---|---|---|---|---|
| 7.943 | 1250 | S | 0.044 Wm-2 | 10.00 | ICNIRP |
| | | S | 0.004 mW/cm2 | 1.00 | FCC 47 CFR § 1.1310 |
| | | S | 0.044 Wm-2 | 10.00 | Canada's RF Safety Code 6 |
| | | E | 4.082V/m | 61.00 | ICNIRP |
| | | E | 4.082 V/m | 27.50 | FCC 47 CFR § 1.1310 |
| | | E | 4.082 V/m | 60.00 | Canada's RF Safety Code 6 |
| | | H | 0.011 A/m | 0.16 | ICNIRP |
| | | H | 0.011 A/m | 0.16 | FCC 47 CFR § 1.1310 |
| | | H | 0.011 A/m | 0.16 | Canada's RF Safety Code 6 |

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

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## 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 Remote mount marine VHF radio with optional AIS functionality 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 Remote mount marine VHF radio with optional AIS functionality operates in the frequency range of 156.025 – 157.425 MHz
The antenna gains used for the calculation was 0 dBi, 3 dBi, 6 dBi, and 9 dBi. However no dedicated antenna is supplied with the product.
The Remote mount marine VHF radio with optional AIS functionality radio power is a maximum 25000 milliwatts.
However when the duty cycle is taken into consideration the 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
Remote mount marine VHF radio with optional AIS functionality

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## 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.

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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 |
| 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 |
| 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 |

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 |
| 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 |
| 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 |

## 2.3 ESTABLISHING WAVELENGTH AND 1/4 WAVELENGTH

| Frequency (MHz) | $\lambda = \frac{3x10^8}{f}$ | | $\frac{\lambda}{4}$ | |
|---|---|---|---|---|
| | 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 |

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## 2.4 FAR FIELD CALCULATIONS

0dBi Unity Gain

The following calculations are based on:

P = 1.25 (Power (Watts)) or 1250 (Power milliwatts)
G = 1.0 (Numeric Gain)
r = 150.0 (Distance (centimetres)) or 1.5 (Distance (meters))

The power flux:

$$S = \frac{PG_{(\theta,\phi)}}{4\pi r^2}$$

*S* = 0.044W/m2

*S* = 0.004mW/cm2

The electric field strength:

$$E = \frac{\sqrt{30PG}_{(\theta,\phi)}}{r}$$

E = 4.082 V/m

The magnetic field strength:

$$H = \frac{E}{\eta_o}$$

H = 0.011 A/m

3dBi Gain

The following calculations are based on:

P = 1.25 (Power (Watts)) or 1250 (Power milliwatts)
G = 1.995 (Numeric Gain)
r = 150.0 (Distance (centimetres)) or 1.5 (Distance (meters))

The power flux:

$$S = \frac{PG_{(\theta,\phi)}}{4\pi r^2}$$

*S* = 0.088 W/m2

*S* = 0.009 mW/cm2

The electric field strength:

$$E = \frac{\sqrt{30PG}_{(\theta,\phi)}}{r}$$

E = 5.767 V/m

The magnetic field strength:

$$H = \frac{E}{\eta_o}$$

H = 0.015 A/m

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6dBi Gain

The following calculations are based on:

P = 1.25 (Power (Watts)) or 1250 (Power milliwatts)
G = 3.981 (Numeric Gain)
r = 150.0 (Distance (centimetres)) or 1.5 (Distance (meters))

The power flux:

$$S = \frac{PG_{(\theta,\phi)}}{4\pi r^2}$$

*S* = 0.176 W/m2

*S* = 0.018 mW/cm2

The electric field strength:

$$E = \frac{\sqrt{30PG}_{(\theta,\phi)}}{r}$$

E = 8.146 V/m

The magnetic field strength:

$$H = \frac{E}{\eta_o}$$

H = 0.022 A/m

9dBi Gain

The following calculations are based on:

P = 1.25 (Power (Watts)) or 1250 (Power milliwatts)
G = 7.943 (Numeric Gain)
r = 150.0 (Distance (centimetres)) or 1.5 (Distance (meters))

The power flux:

$$S = \frac{PG_{(\theta,\phi)}}{4\pi r^2}$$

*S* = 0.351 W/m2

*S* = 0.035 mW/cm2

The electric field strength:

$$E = \frac{\sqrt{30PG}_{(\theta,\phi)}}{r}$$

E = 11.506 V/m

The magnetic field strength:

$$H = \frac{E}{\eta_o}$$

H = 0.031 A/m

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 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

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## 2.5 FIELD REPRESENTATIONS

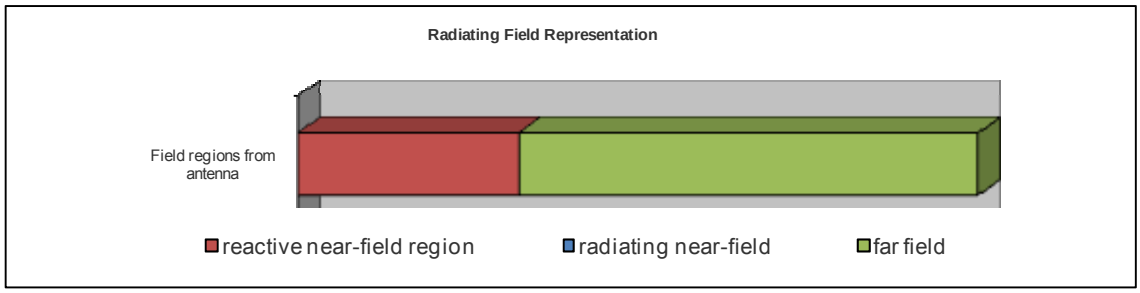


Figure 1 - This graph shows the radiating field representation and is not to scale

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**

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## 3.1 FIELD REPRESENTATIONS – ICNIRP

0dBi Unity Gain

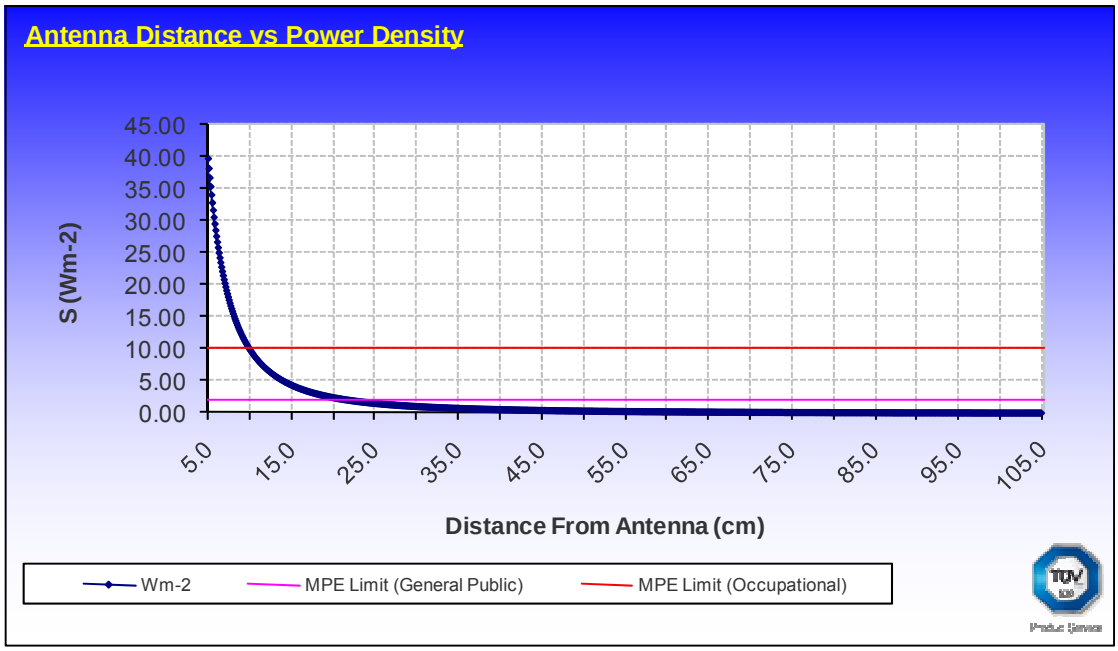


Figure 2 - This graph shows the S field (W/cm$^2$) strength value with regards to distance from the Antenna (cm)

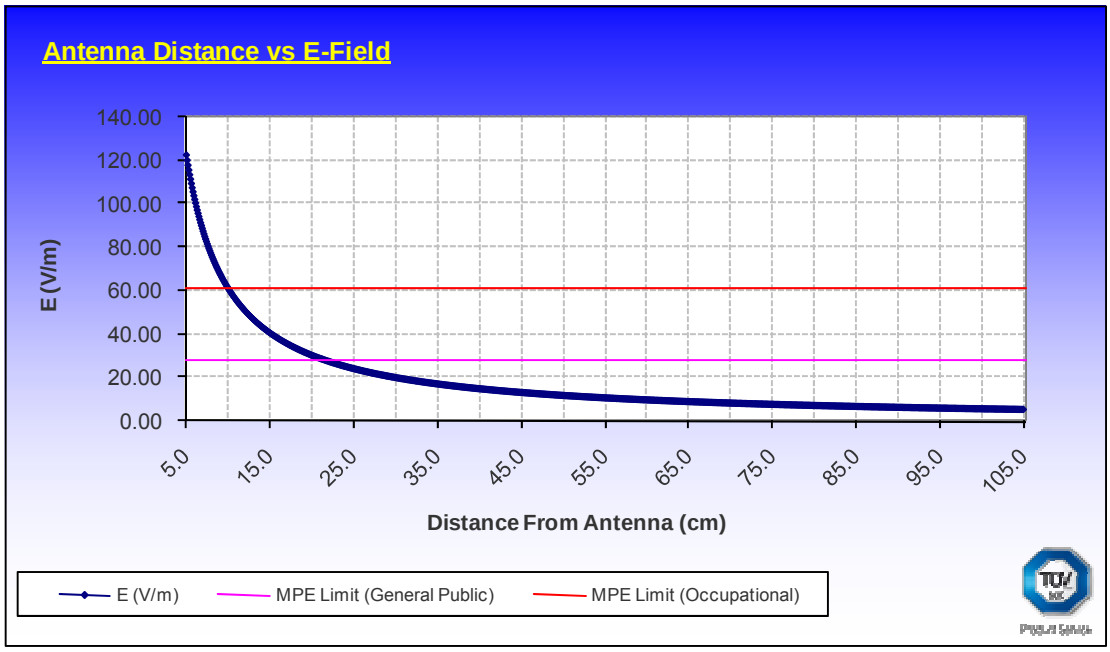


Figure 3 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm)

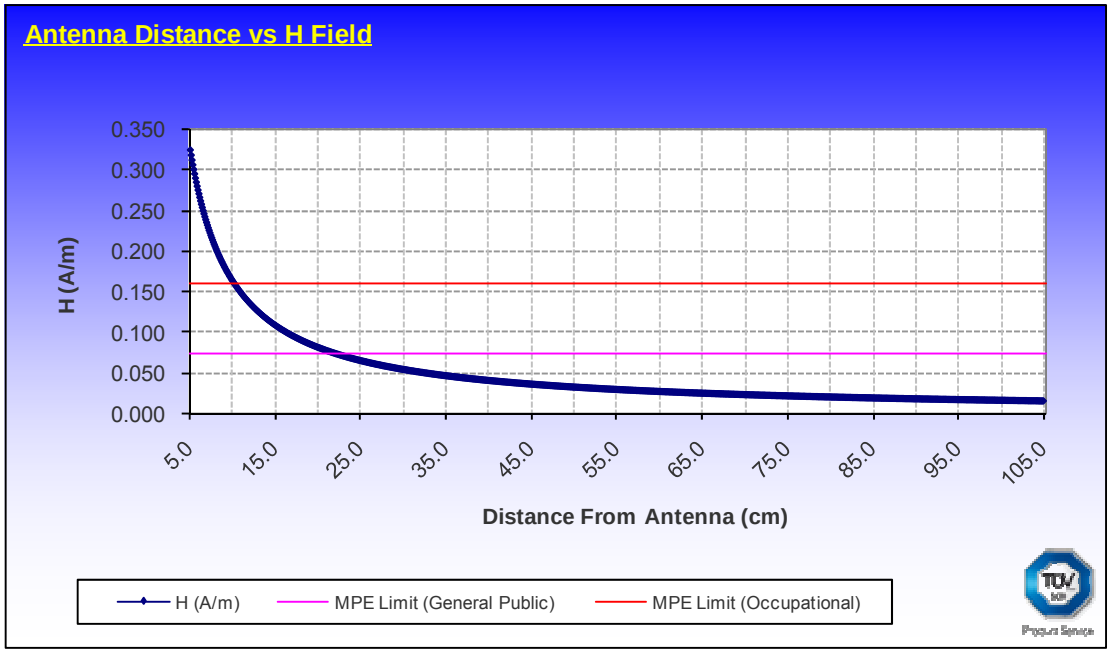


Figure 4 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm)

3dBi Gain

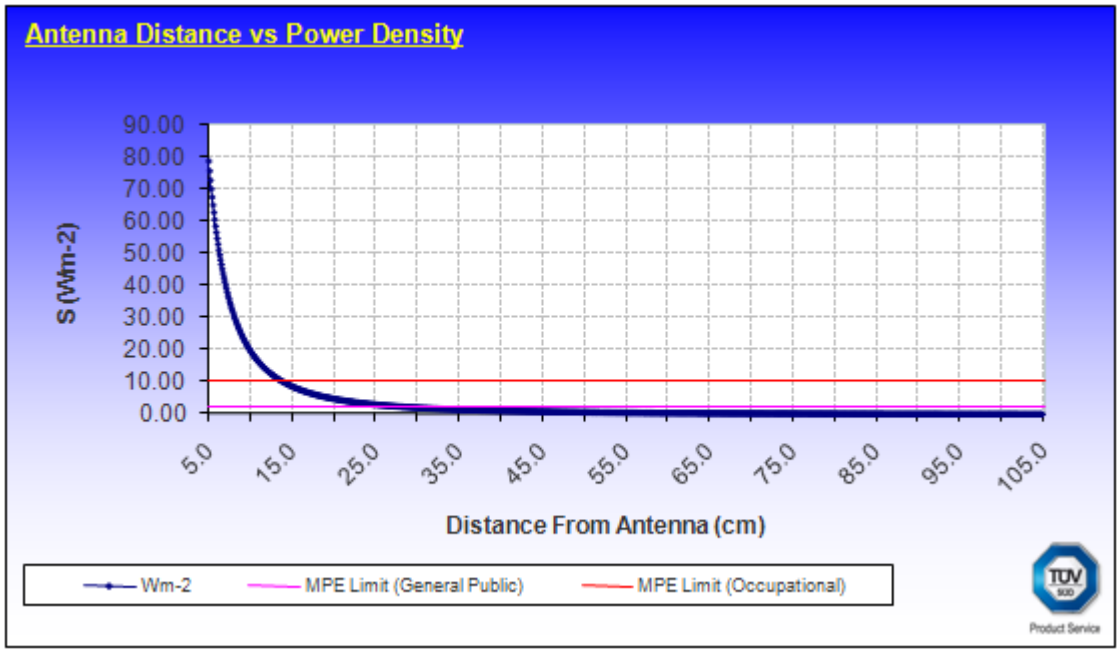


Figure 5 - This graph shows the S field (W/cm$^2$) strength value with regards to distance from the Antenna (cm)

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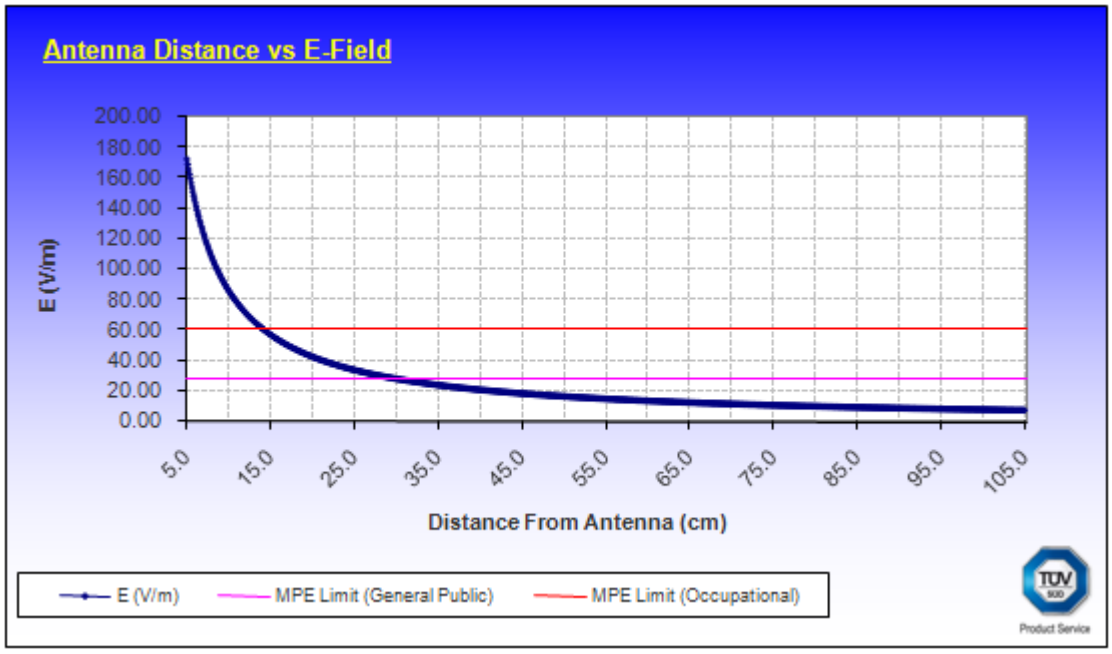


Figure 6 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm)

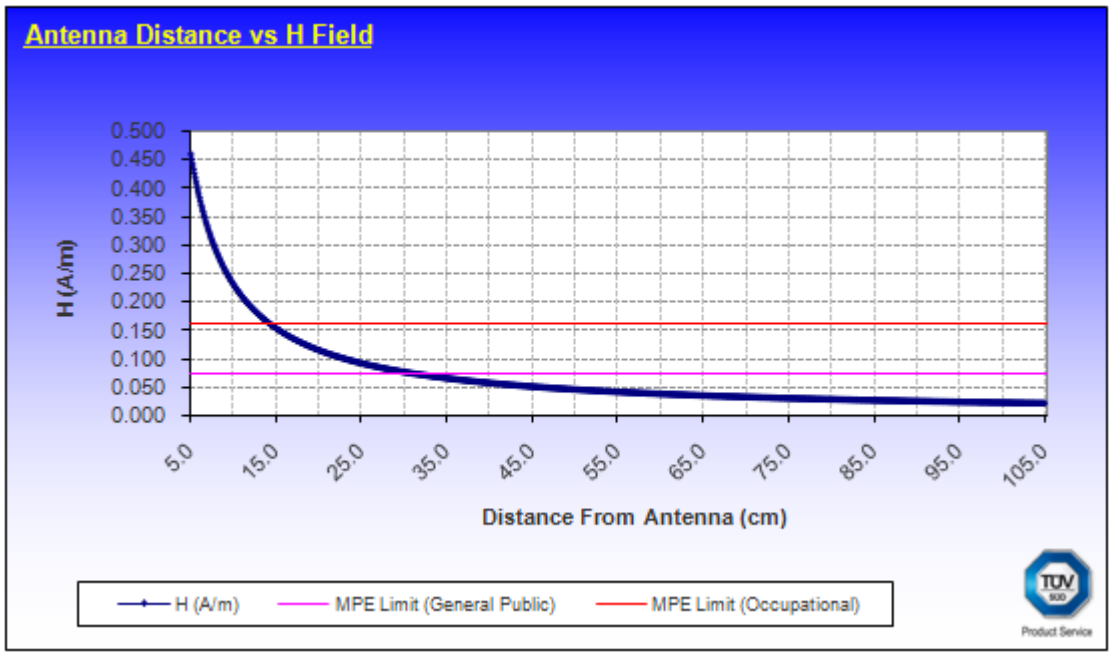


Figure 7 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm)

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6dBi Gain

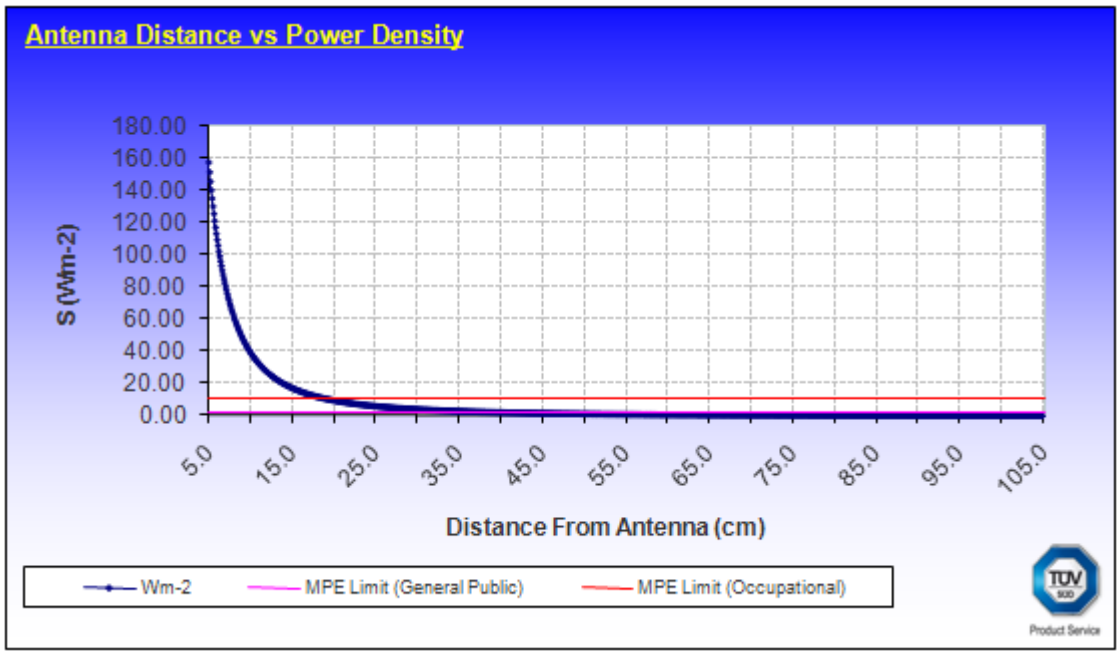


Figure 8 - This graph shows the S field (W/cm$^2$) strength value with regards to distance from the Antenna (cm)

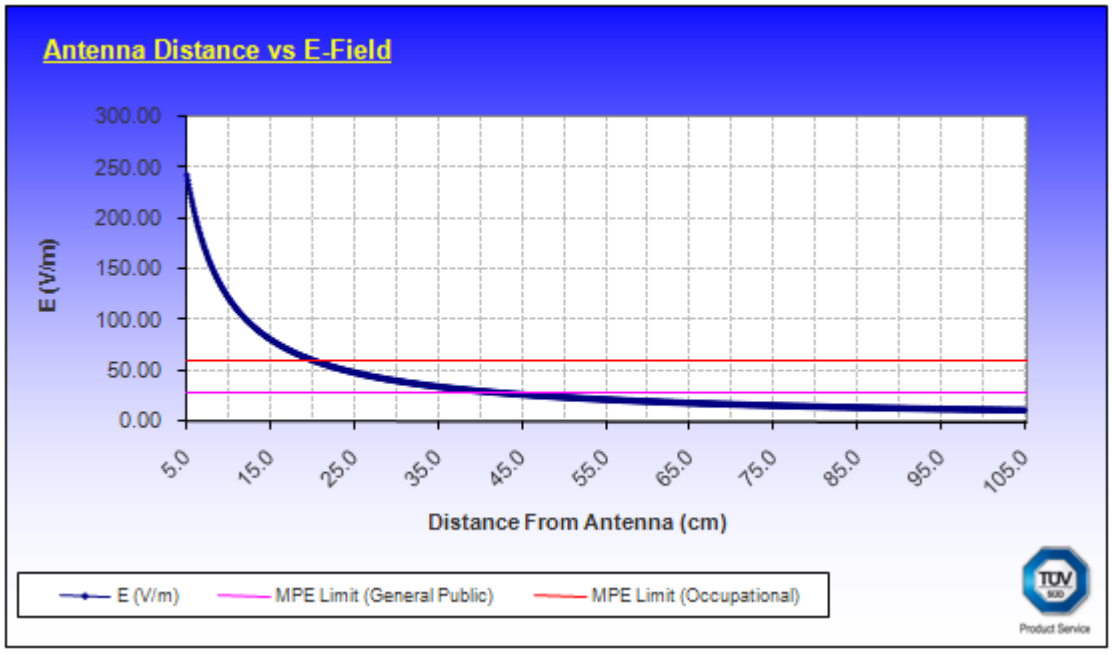


Figure 9 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm)

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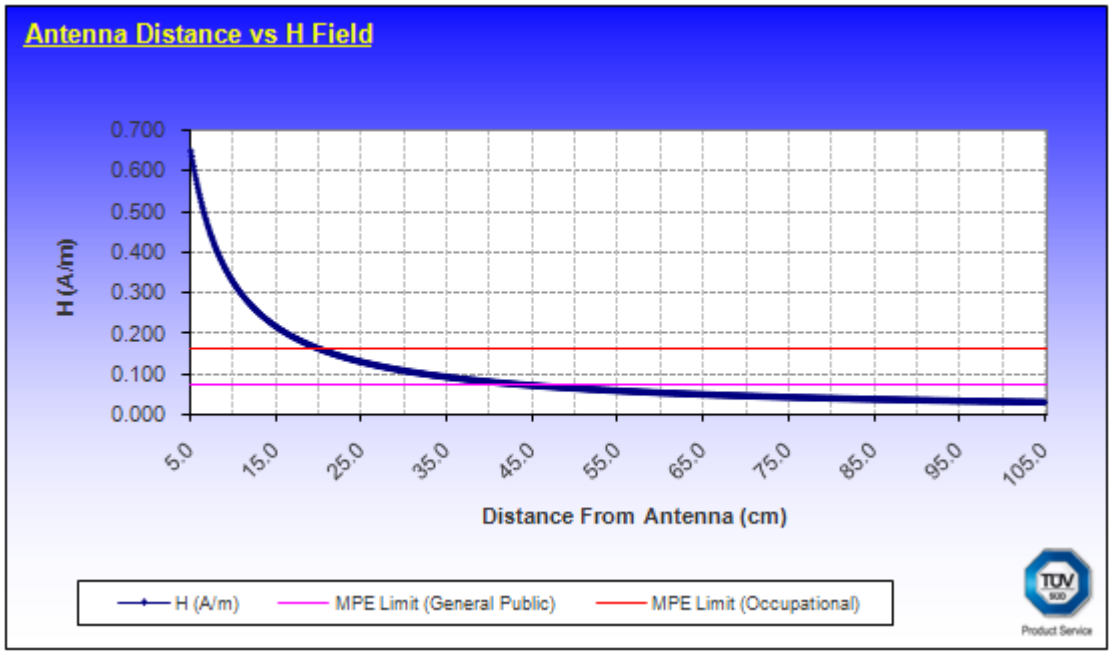


Figure 10 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm)

9dBi Gain

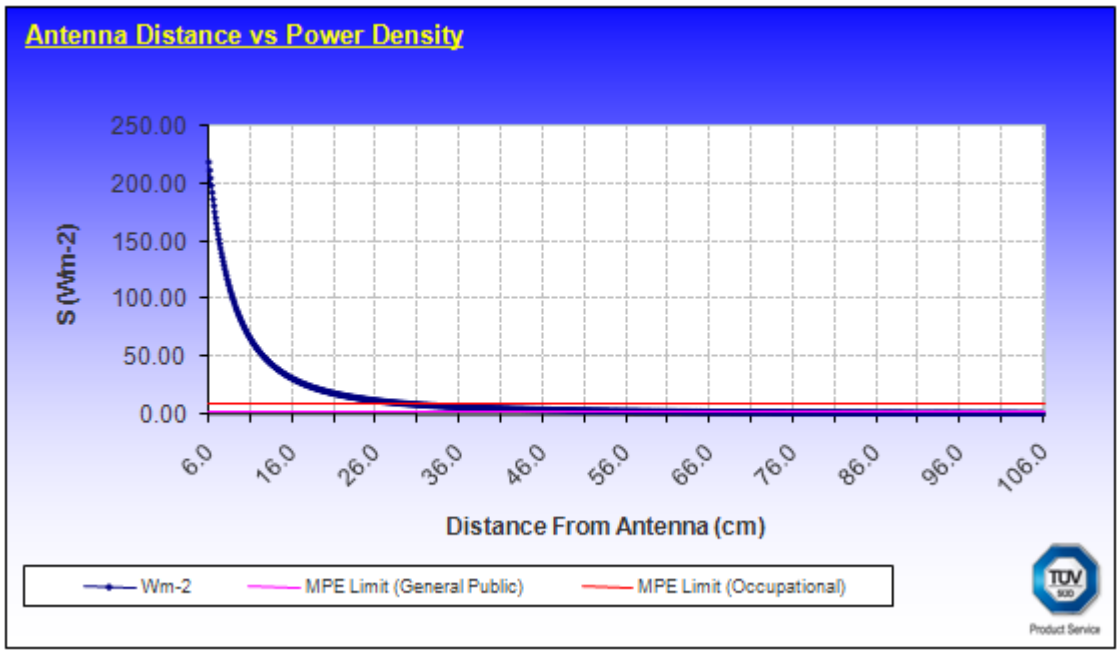


Figure 11 - This graph shows the S field (W/cm$^2$) strength value with regards to distance from the Antenna (cm)

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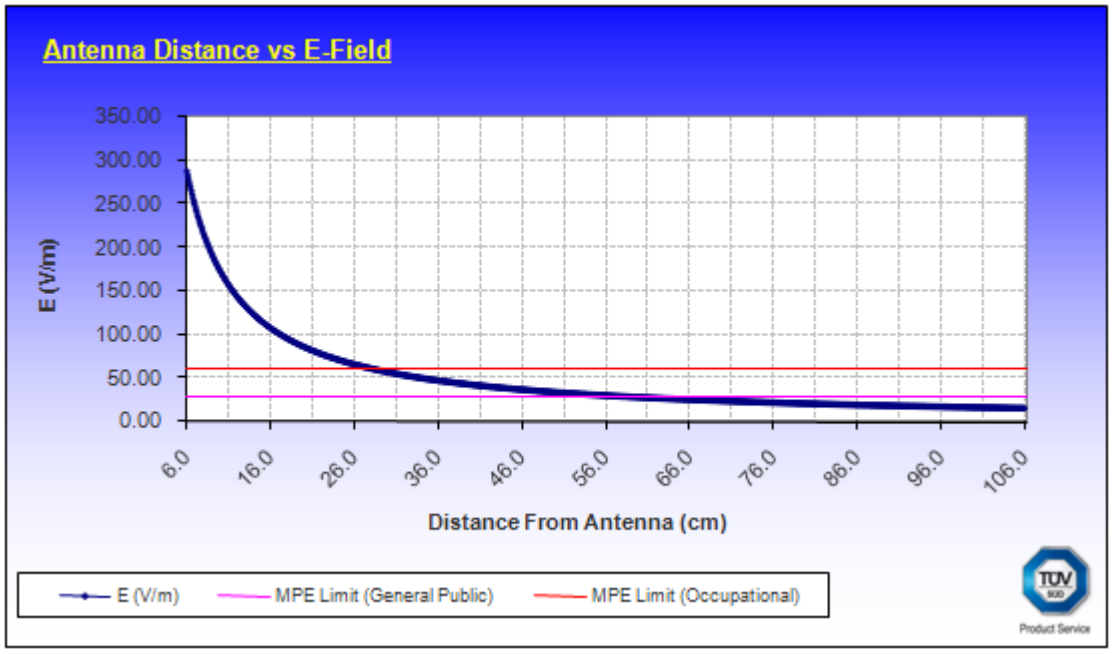


Figure 12 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm)

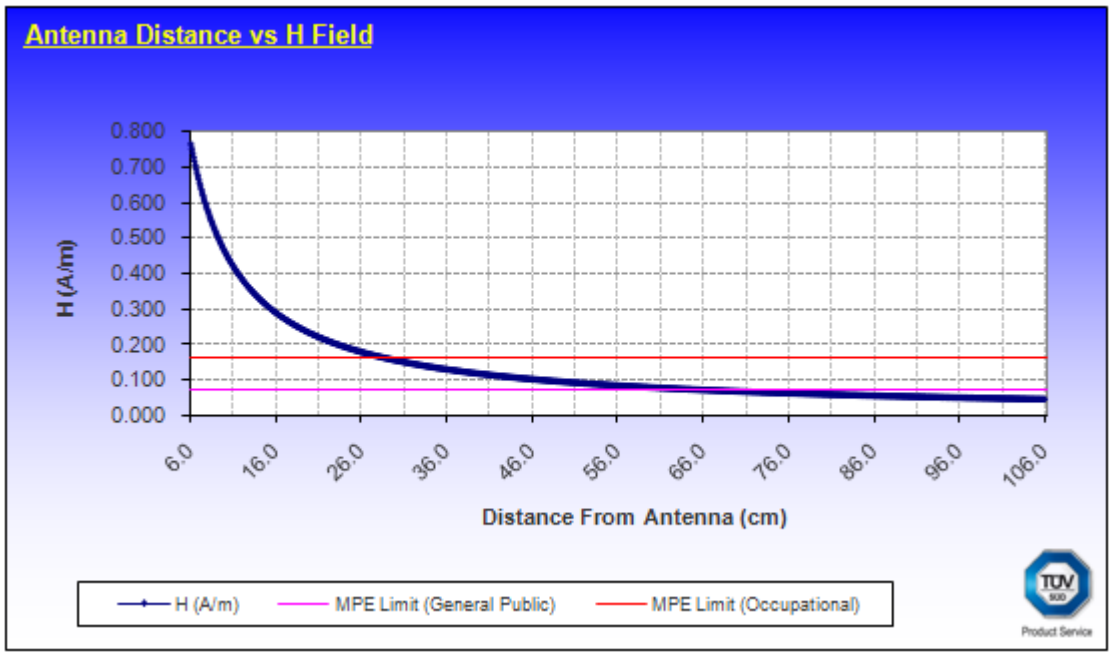


Figure 13 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm)

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## 3.2 FIELD REPRESENTATIONS – FCC

0dBi Unity Gain

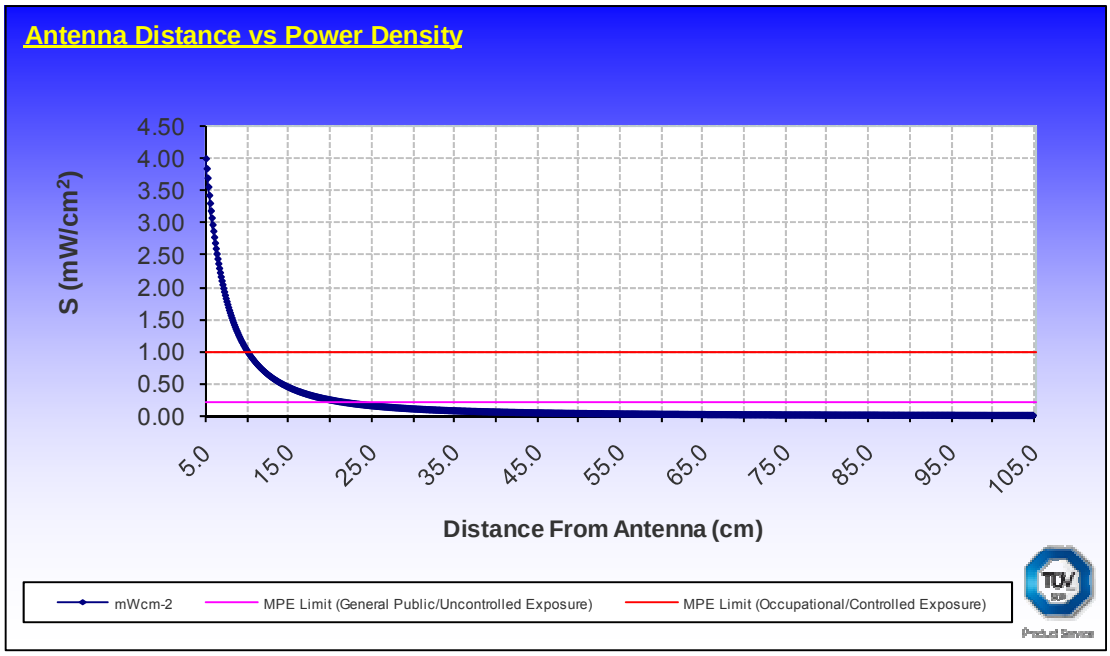


Figure 14 - This graph shows the S field (mW/cm$^2$) strength value with regards to distance from the Antenna (cm)

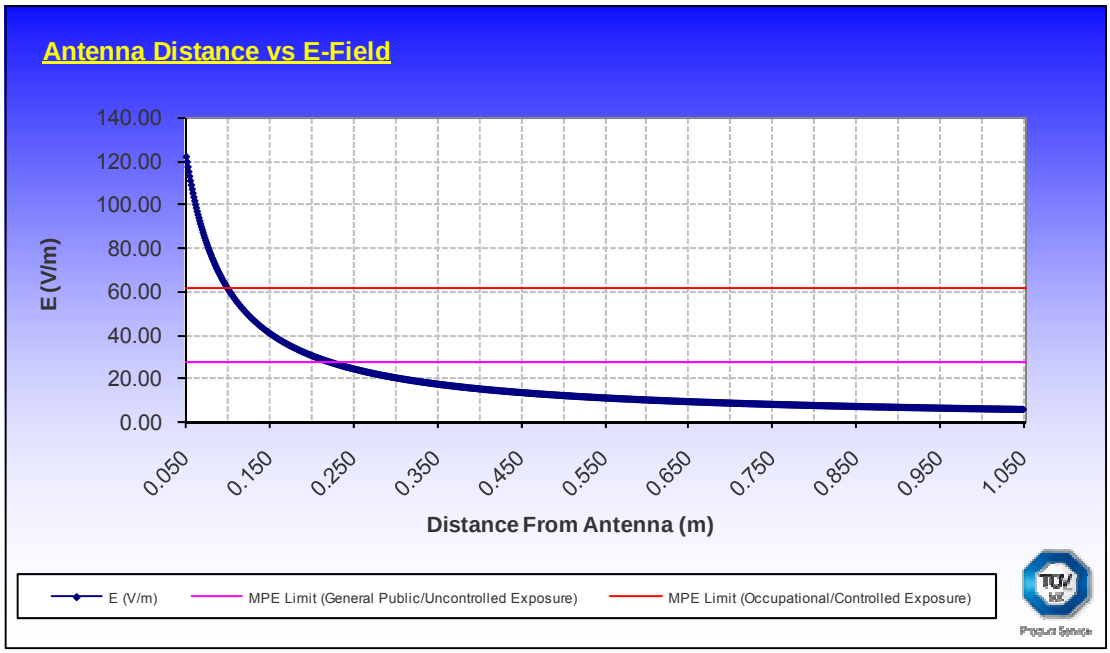


Figure 15 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm).

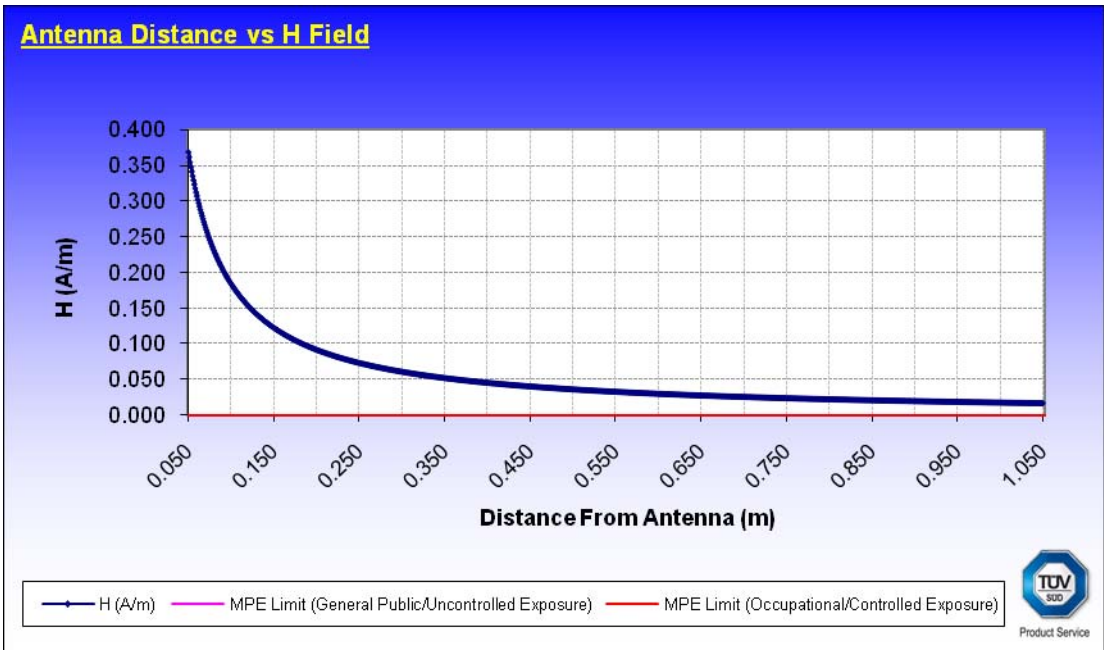


Figure 16 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm).

3dBi Gain

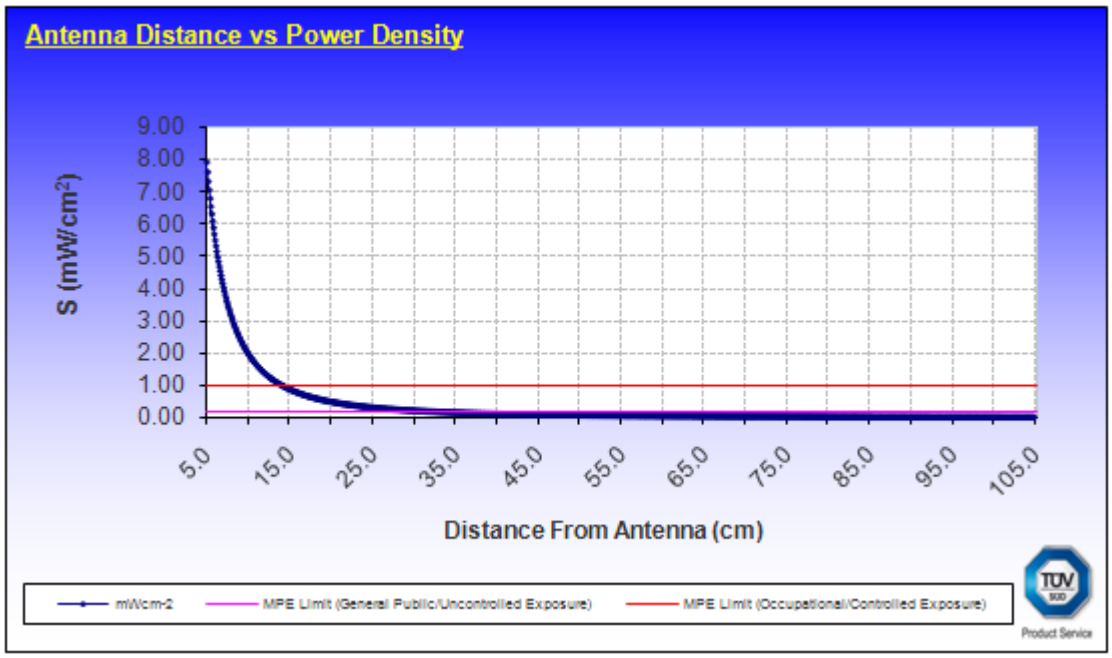


Figure 17 - This graph shows the S field (mW/cm$^2$) strength value with regards to distance from the Antenna (cm)

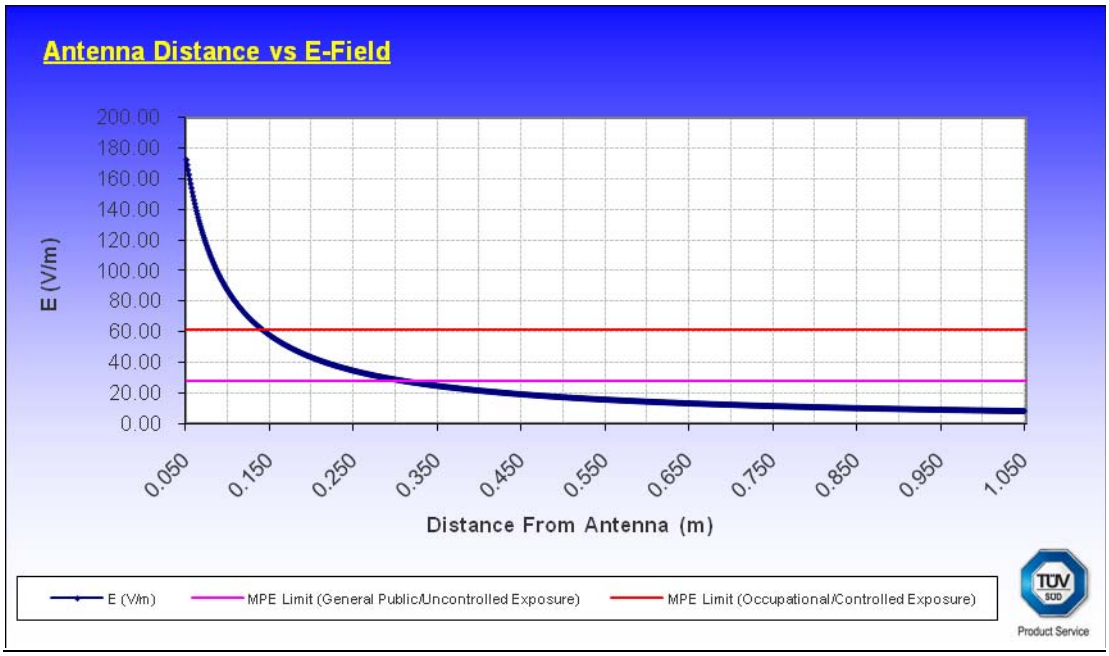


Figure 18 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm).

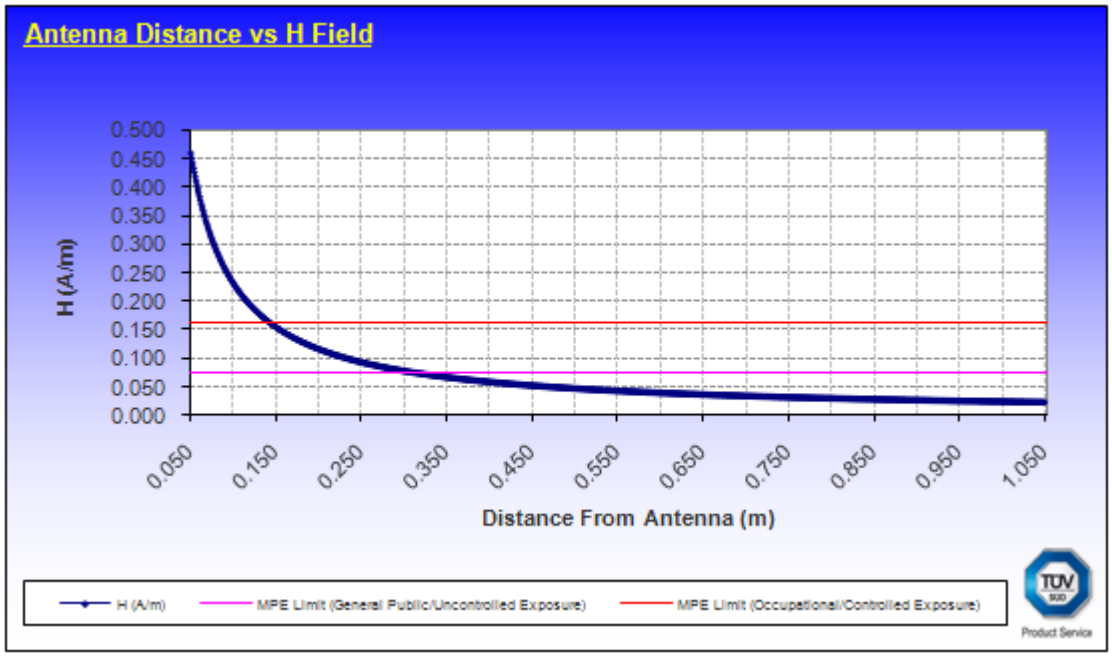


Figure 19 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm)

6dBi Unity Gain

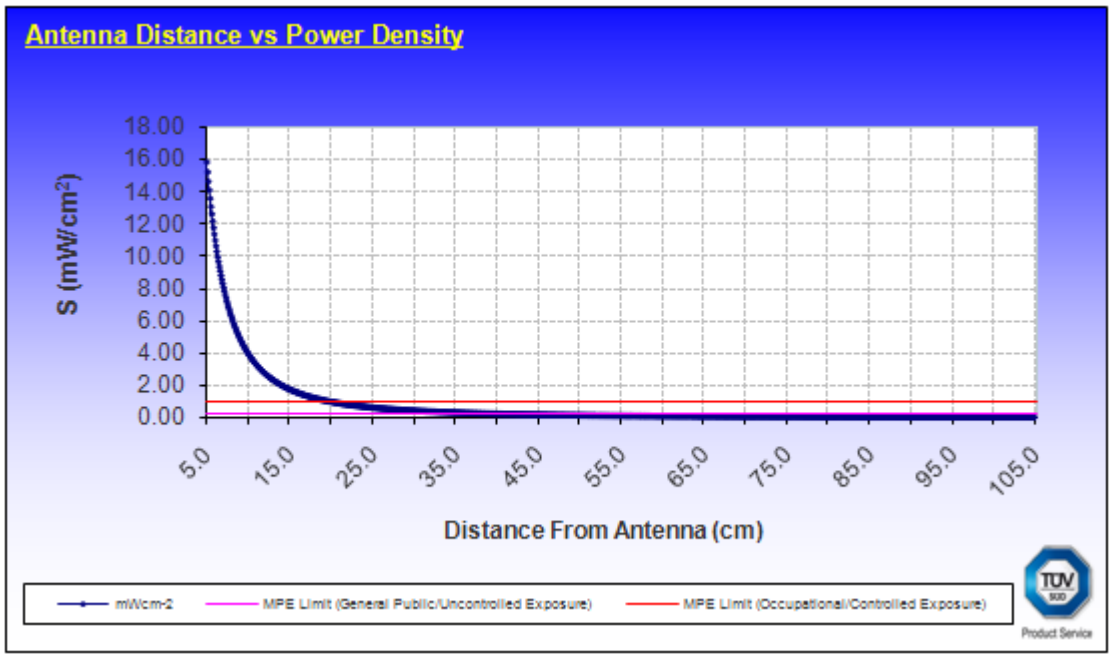


Figure 20 - This graph shows the S field (mW/cm$^2$) strength value with regards to distance from the Antenna (cm)

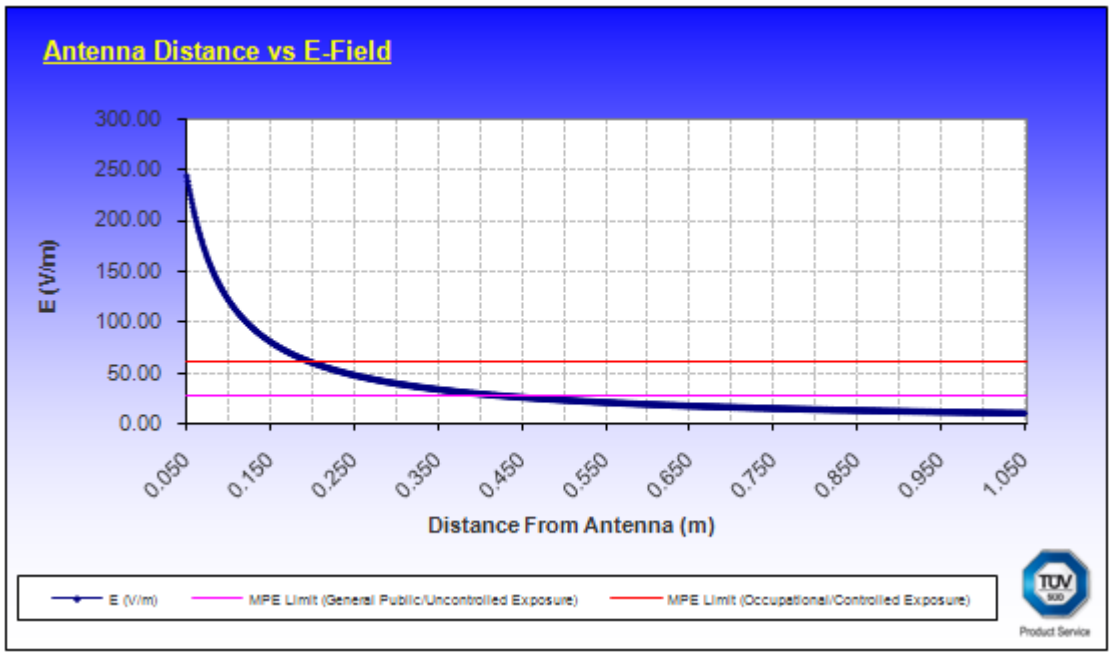


Figure 21 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm).

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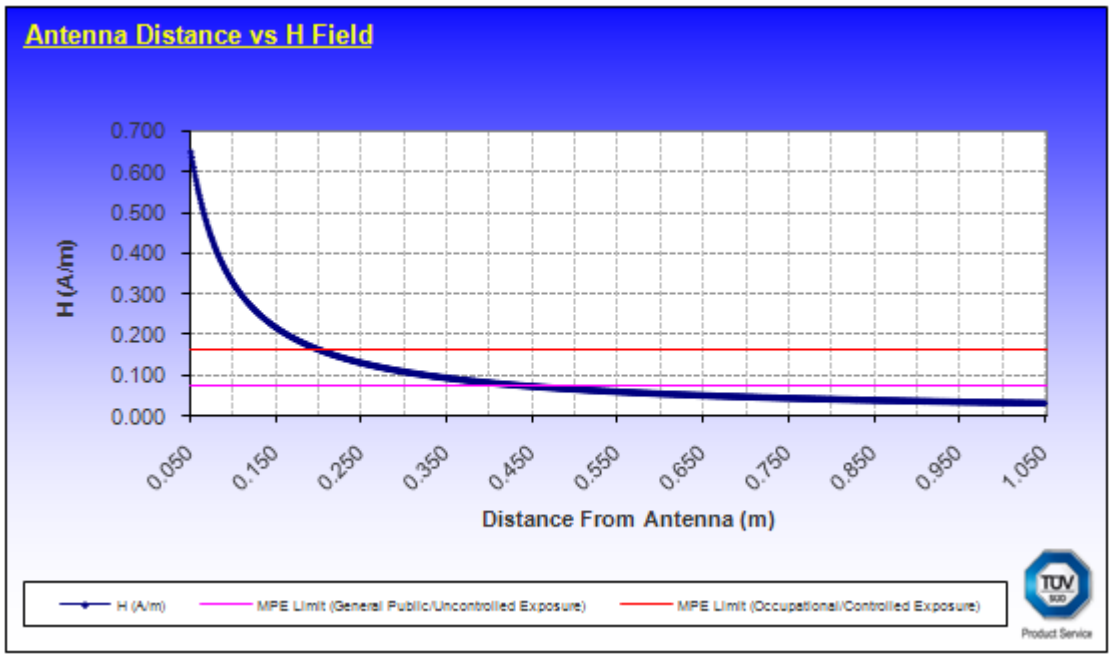


Figure 22 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm).

9dBi Gain

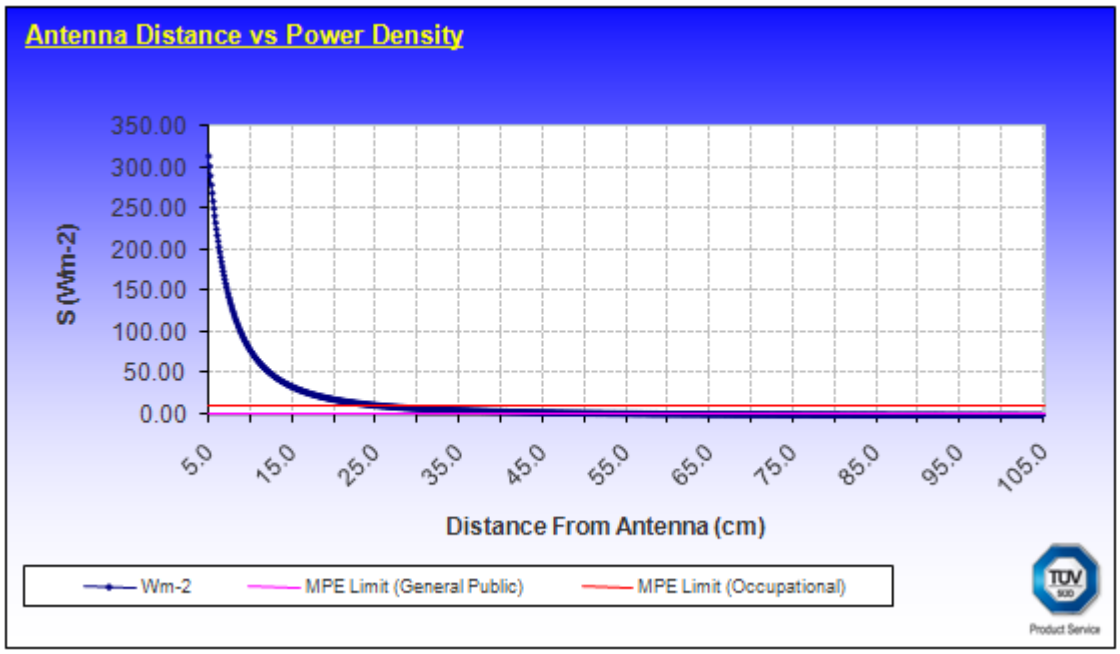


Figure 23 - This graph shows the S field (mW/cm$^2$) strength value with regards to distance from the Antenna (cm)

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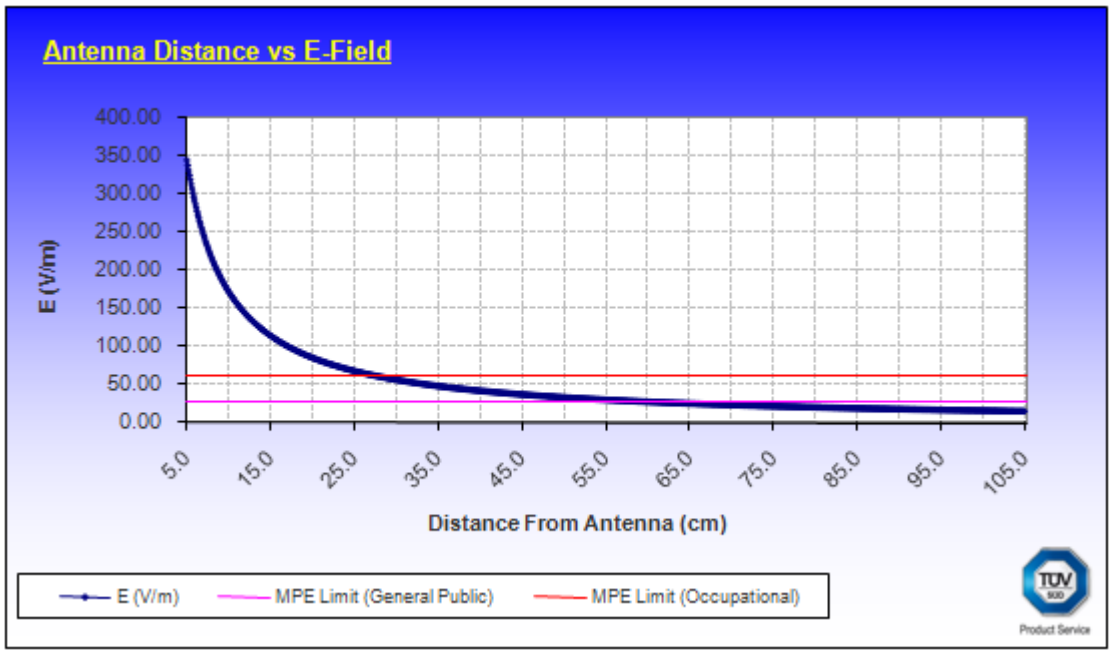


Figure 24 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm).

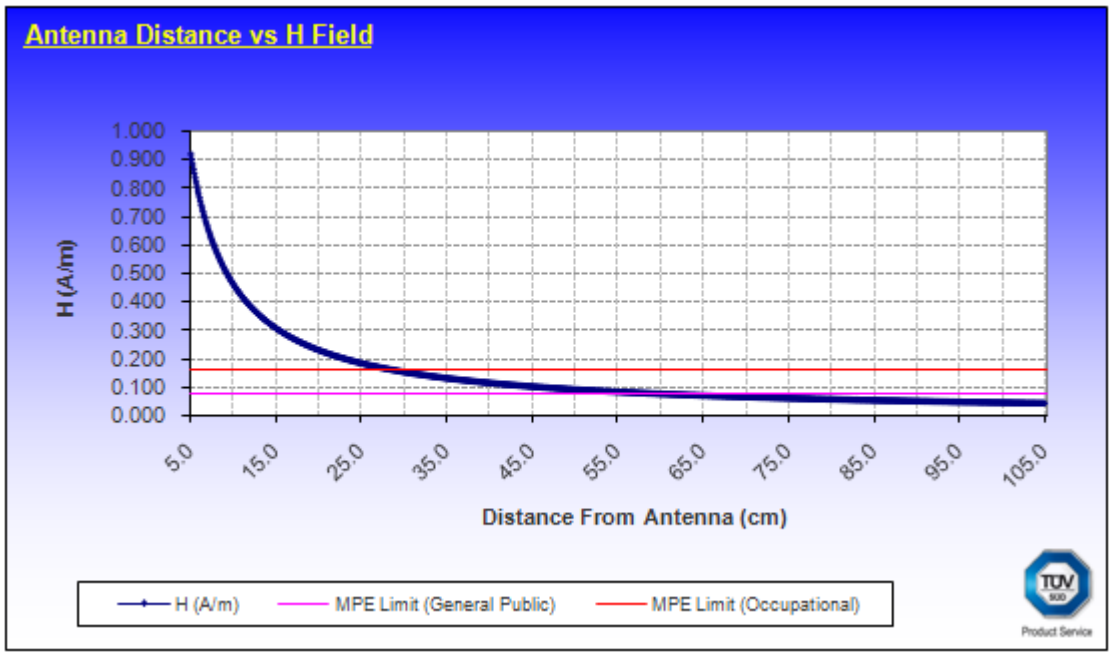


Figure 25 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm).

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## 3.3 FIELD REPRESENTATIONS – IC

0dBi Unity Gain

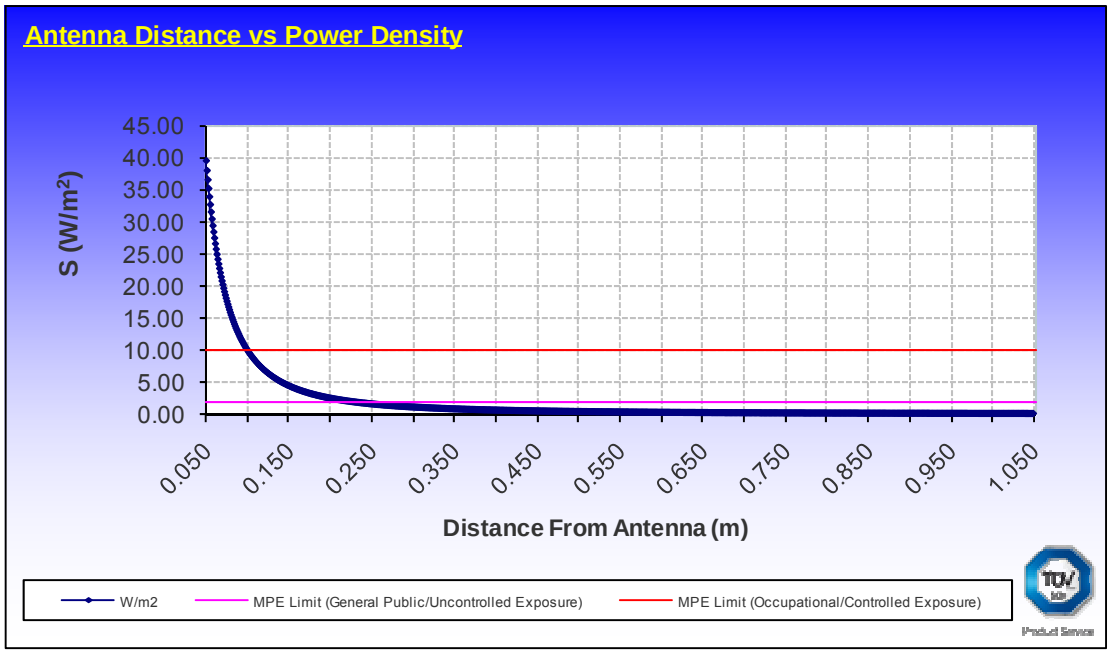


Figure 26 - This graph shows the S field (W/cm$^2$) strength value with regards to distance from the Antenna (cm)

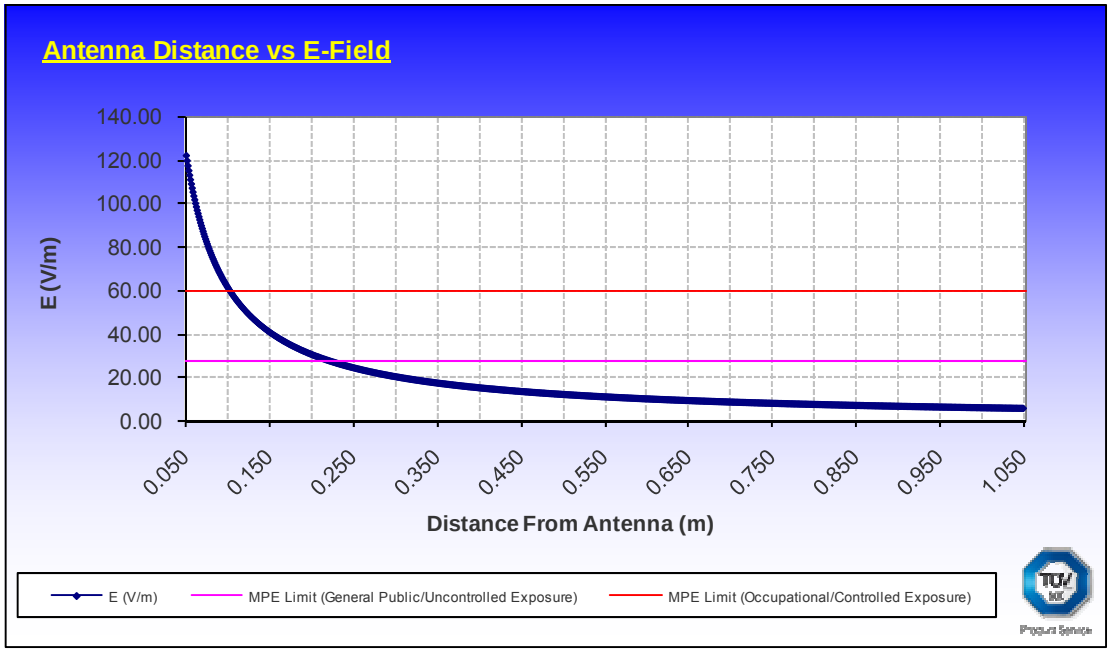


Figure 27 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm).

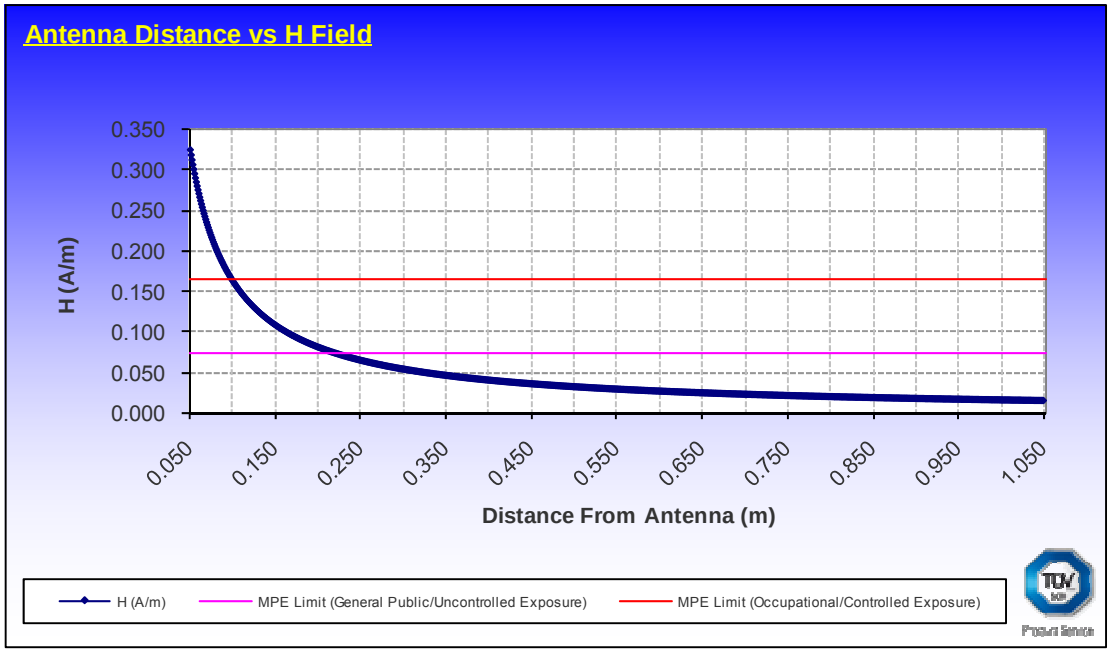


Figure 28 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm).

3dBi Gain

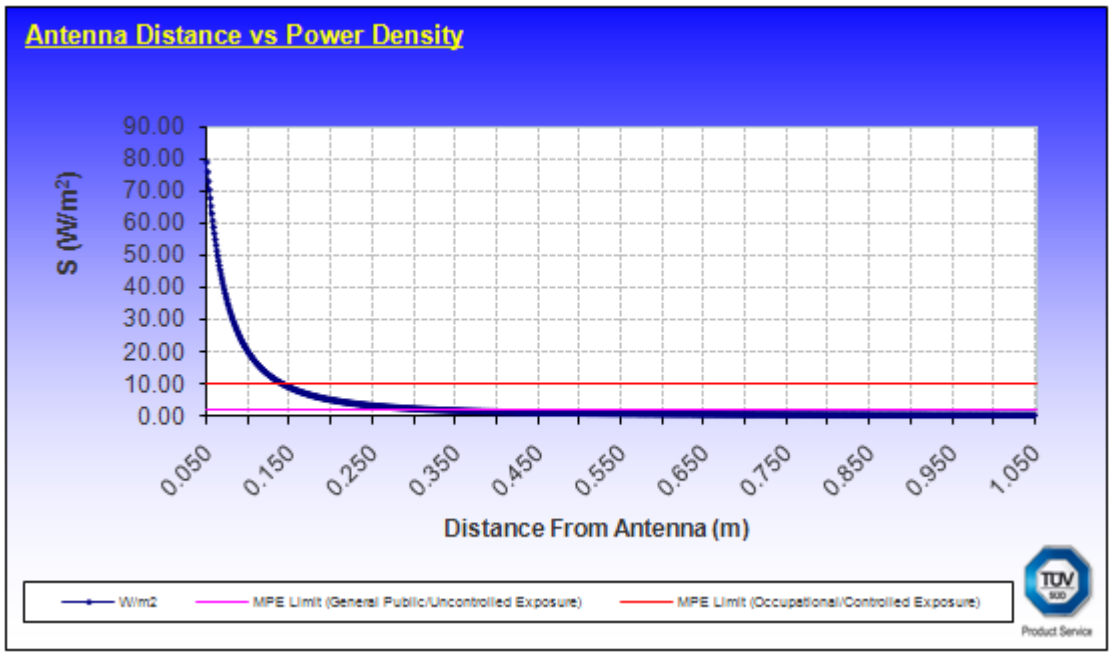


Figure 29 - This graph shows the S field (W/cm$^2$) strength value with regards to distance from the Antenna (cm)

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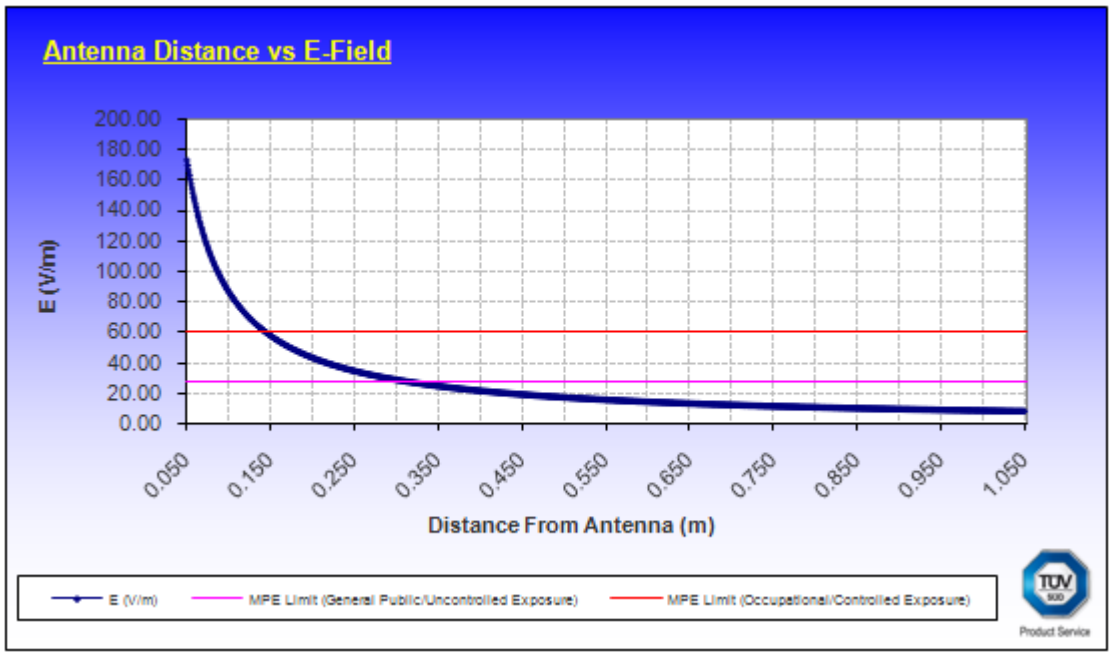


Figure 30 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm)

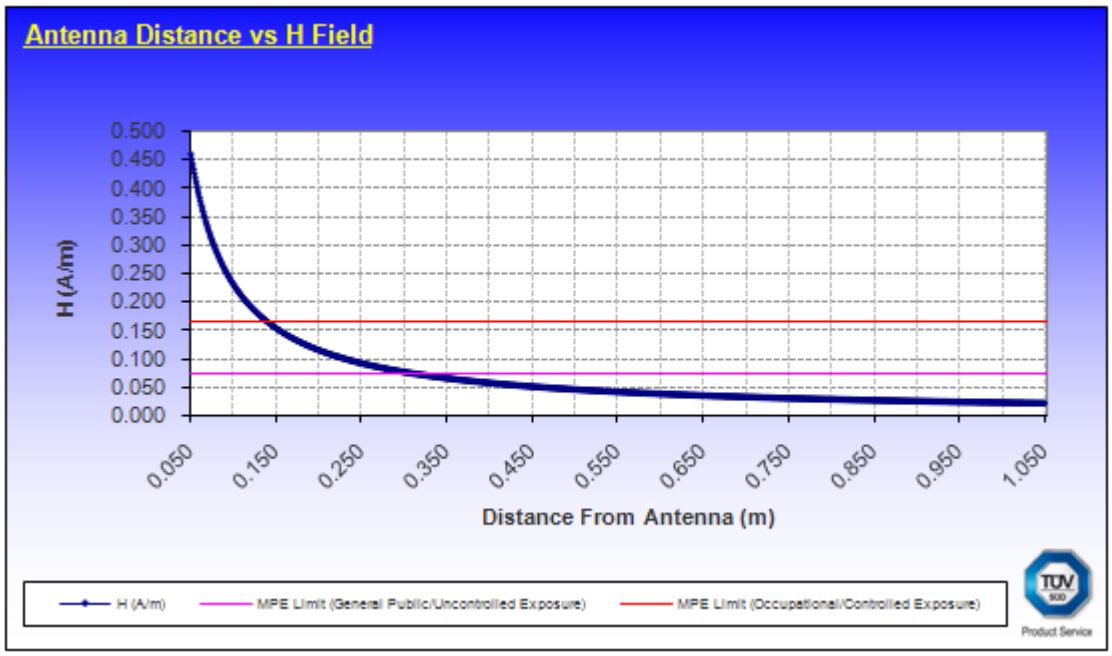


Figure 31 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm)

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6dBi Gain

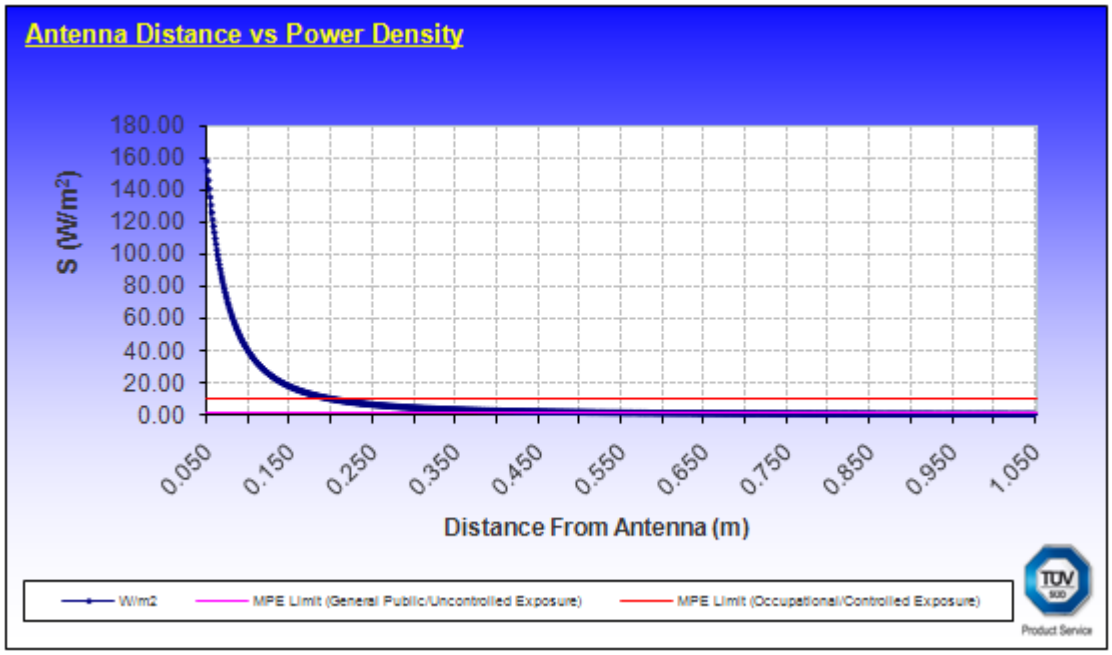


Figure 32 - This graph shows the S field (W/cm$^2$) strength value with regards to distance from the Antenna (cm)

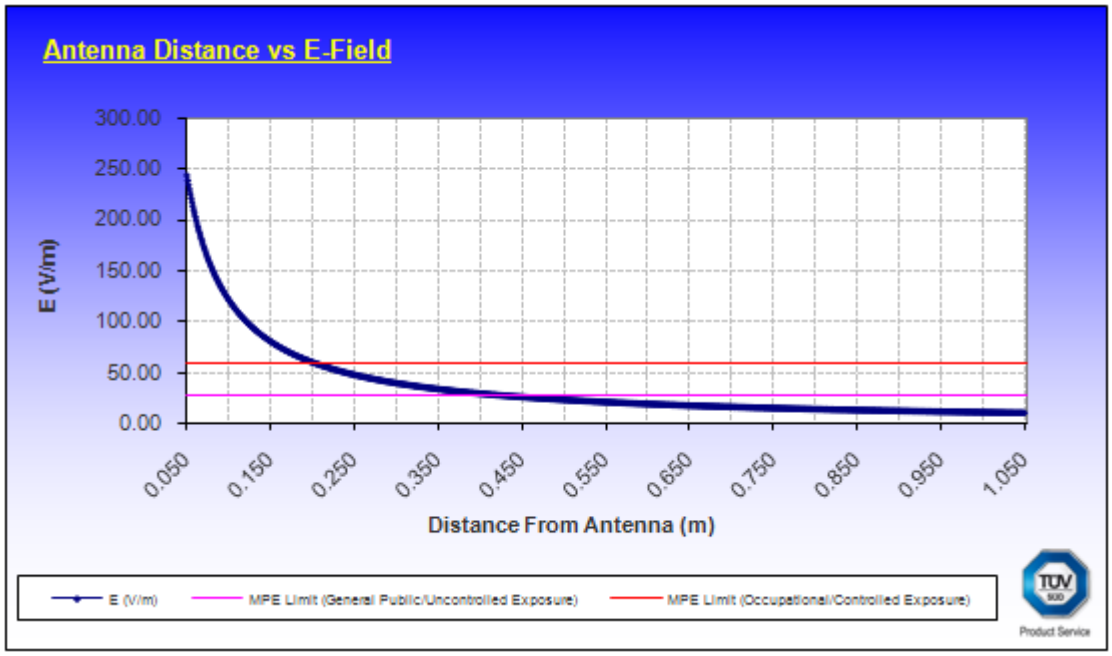


Figure 33 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm)

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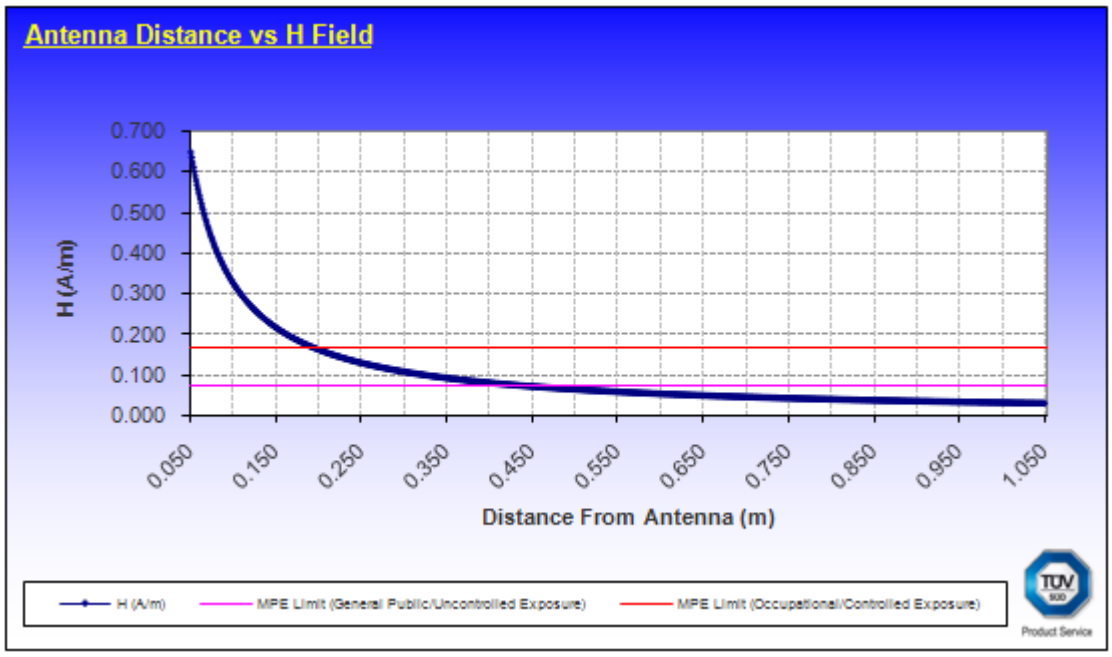


Figure 34 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm)

9dBi Gain

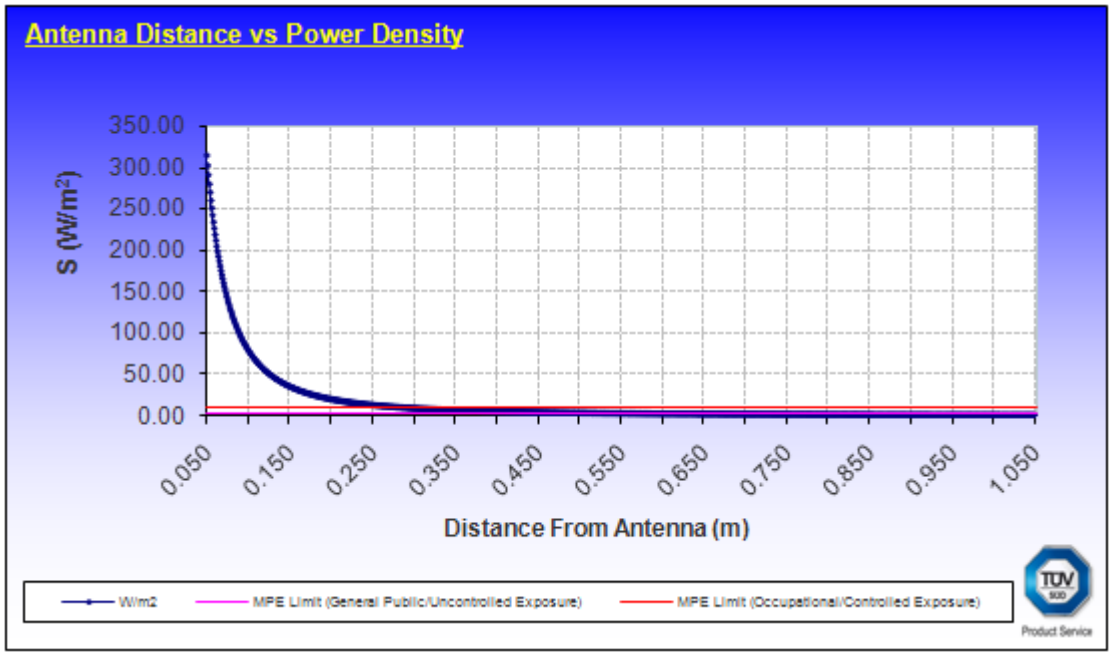


Figure 35 - This graph shows the S field (W/cm$^2$) strength value with regards to distance from the Antenna (cm)

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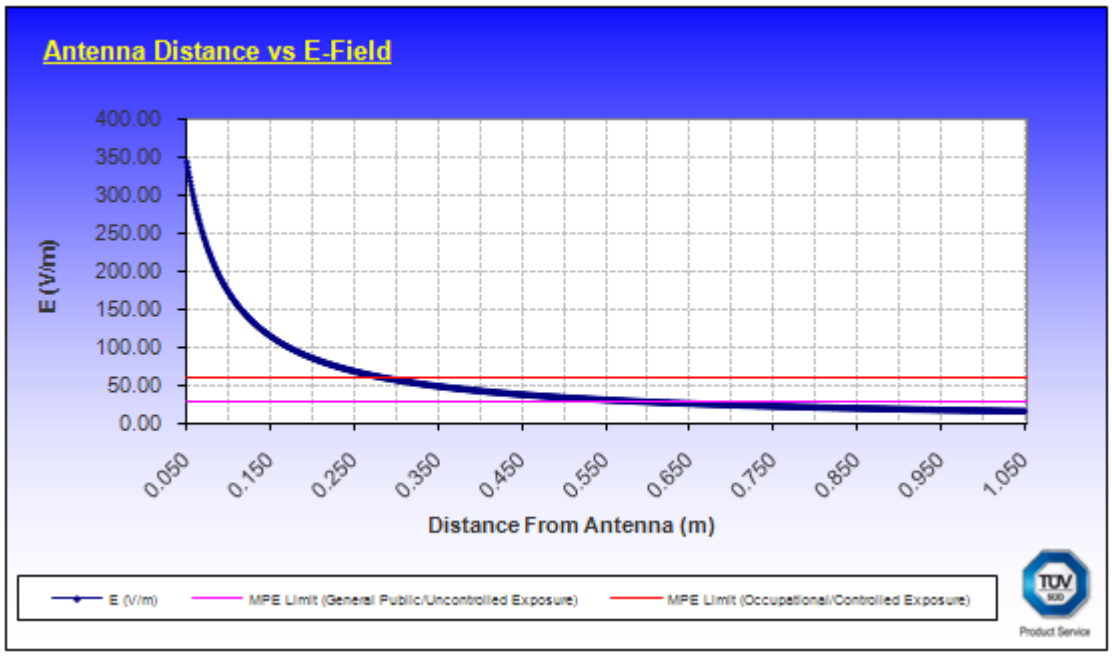


Figure 36 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm)

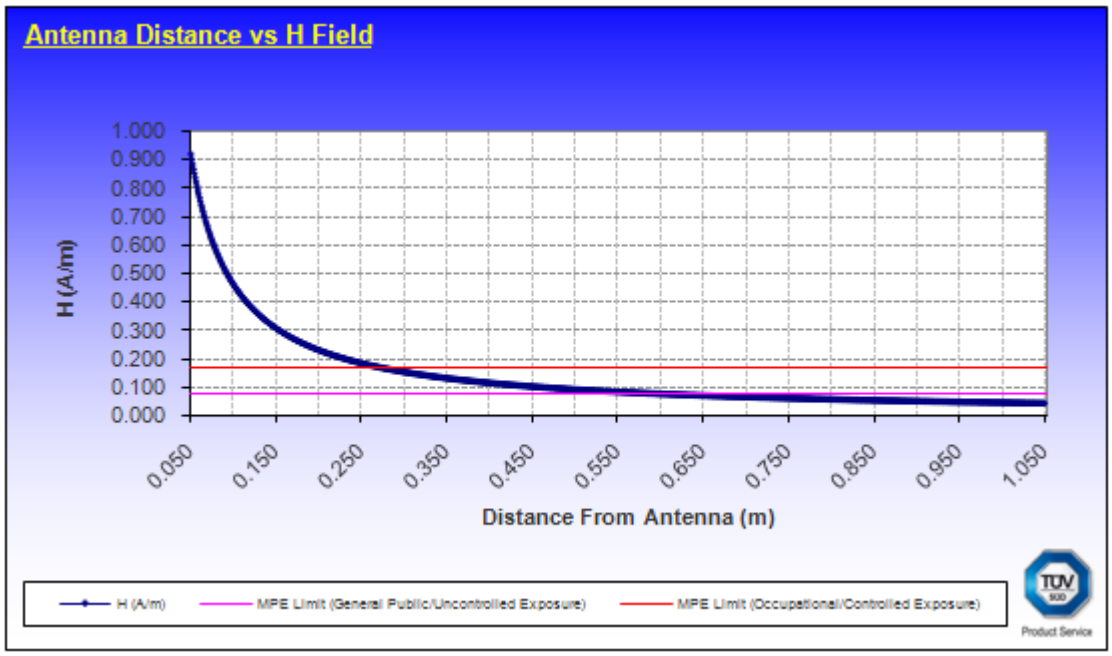


Figure 37 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm)

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## SECTION 4

## DISCLAIMERS AND COPYRIGHT

## 4.1 DISCLAIMERS AND COPYRIGHT

This report relates only to the actual item/items tested.