Radiation Hazard Study

University of California San Diego, Scripps Institution of Oceanography ESV network.

This document contains a series of reports that detail the analysis of the potential RF human exposure levels caused by the Electro Magnetic (EM) fields of the antennas to be used in the University of California San Diego, Scripps Institution of Oceanography ESV network.

The ESV remote stations include the Seatel models 4006, 4996, and 6006 antennas. The Hub antenna is a Prodelin 3.8 meter antenna.

Radiation Hazard Study - Seatel 4006 Antenna

1. Introduction

The purpose of this report is to analyze the potential RF human exposure levels caused by the Electro Magnetic (EM) fields of a Seatel 4006 antenna operating with a maximum power at the flange of 0.33 Watts.

The analysis and calculations performed in this report comply with the methods described in the FCC Office of Engineering and Technology Bulletin, No. 65, published in 1985 and revised in 1997 in Edition 97-01. The radiation safety limits used in the following analysis conform to FCC R&O 96-326. Bulletin No. 65.

Maximum Permissible Exposure (MPE)

There are two separate levels of exposure limits. These depend on the situation where the exposure takes place and the type of individuals who are subject to the exposure. The first level applies to people in the general population who are in an uncontrolled environment. The second level applies to trained personnel in a controlled environment. According to 47 C.F.R. § 1.1310, the Maximum Permissible Exposure (MPE) limits for frequencies above 1.5 GHz are as follows:

General Population / Uncontrolled Exposure	**1.0 mW/cm2**
Occupational / Controlled Exposure	**5.0 mW/cm2**

The purpose of this study is to determine the power density levels for the Seatel 4006 antenna and compare them with the published MPE limits. The power density level comparisons are done for six individual regions These regions are:

1. Far-field region
2. Near-field region
3. Transition region
4. The region between the feed and the antenna surface
5. The main reflector region
6. The region between the antenna edge and the ground

2. Configuration

The antenna under study is a Seatel Model 4006 antenna. It has a diameter of 1.0 meter.

2.1 Input Parameters

The following input parameters were used in the calculations:

Parameter	Unit	Symbol	Value
Antenna Diameter	m	D	1.0
Antenna Transmit Gain	dBi	G_{ant}	42.1
Transmit Frequency	MHz	f	14250
Antenna Feed Flange Diameter	cm	d	2.9
Power input to Antenna	Watts	P	0.33

2.2 Calculated Parameters

Following are the calculated parameter values and their formulas using the above input parameters.

Parameter	Unit	Symbol	Value	Formula
Antenna Surface Area	m^2	A	.79	$\pi D^2/4$
Antenna Flange Area	cm^2	a	6.61	$\pi d^2/4$
Antenna Efficiency		η	0.59	$G\lambda^2/(\pi^2 D^2)$
Gain Factor		G	13182.6	$10^{G/10}$
Wavelength	m	λ	0.0211	$300/f$

2.3 Region Definition

The effect of exposure to RF radiation depends on the distance from the antenna radiating the energy. The primary area of interest is divided into three regions: Near Field, Far Field, and Transition Region. The limit of the Near Field (R_{nf}) and the beginning of the Far Field (R_{ff}) are calculated as follows

$$\text{Near Field Distance } (R_{nf}) = D^2 / 4\lambda$$

$$(R_{nf}) = (1)^2 / 4(0.0211)$$

$$(R_{nf}) = 11.85 \text{ m}$$

$$\text{Far Field Distance } (R_{ff}) = 0.6(D)^2 / \lambda$$

$$(R_{ff}) = 0.6(1)^2 / 0.0211$$

$$(R_{ff}) = 28.44 \text{ m}$$

The distance between the end of the near field and the beginning of the far field is designated as the Transition Region and is expressed as $R_{nf} \le R_t \le R_{ff.}$ In this case, the region between 11.85 m and 28.44 m is designated as the Transition Region. However, the power density in this region will not exceed the power in the Near Field region. As a result, for the following calculations the distance of the Transition Region will be equal to the Near Field distance.

$$\text{Transition Region } R_t = R_{nf}$$

$$(R_{nf}) = 11.85 \text{ m}$$

3. Field Strength

3.1 Near Field Strength

The Near Field Power Density is calculated as follows:

$$S_{nf} = 16.0\ \eta\ P/(\pi D^2)$$

$$S_{nf} = 16.0\ (0.59)\ (0.33) / (3.14)\ (1^2)$$

$$S_{nf} = 0.099 \text{ mW/cm}^2$$

This value satisfies the FCC MPE requirement for both the Uncontrolled Environment (1 mW/cm^2) and Controlled Environment (5 mW/cm^2).

3.2 Transition Region

The Power Density in the Transition Region is calculated as follows:

$$S_t = S_{nf}\ R_{nf} / (R)$$

The maximum power density in the transition Region is when R = Rnf, at which point

$$S_t = S_{nf} = 0.099 \text{ mW/cm}^2$$

This value satisfies the FCC MPE requirement for both the Uncontrolled Environment (1.0 mW/cm^2) and Controlled Environment (5.0 mW/cm^2).

3.3 Far Field Region

The Far Field Power Density is calculated as follows:

$$S_{ff} = PG/(4\pi R_{ff}^2)$$

$$S_{ff} = (0.33)(13182.6) / (4)(3.14)(28.44)$$

$$S_{ff} = 0.043 \text{ mW/cm}^2$$

This value satisfies the FCC MPE requirement for both the Uncontrolled Environment (1.0 mW/cm^2) and Controlled Environment (5.0 mW/cm^2).

3.4 Region between Main Reflector and Subreflector

The region between the antenna's main reflector and subreflector is a conically shaped region defined by the feed assembly which is a waveguide flange. The power density of this region is calculated as follows:

$$S_{fa} = 4P / a$$

$$S_{fa} = 199.7 \text{ mW / cm}^2$$

This value exceeds the FCC MPE requirement for both the Uncontrolled Environment (1.0 mW/cm^2) and Controlled Environment (5.0 mW/cm^2).

3.5 Power Density at Main Reflector

The power density in the main reflector is calculated using the area of the main reflector instead of the feed waveguide flange.

$$S_{reflector} = 4P / A$$

$$S_{reflector} = 16.71 \text{ mW / cm}^2$$

This value exceeds the FCC MPE requirement for both the Uncontrolled Environment (1.0 mW/cm^2) and Controlled Environment (5.0 mW/cm^2).

3.6 Power Density between Main Reflector and Ground

The power density level between the antenna main reflector and the ground is calculated as follows:

$$S_g = P / A$$

$$S_g = 0.042 \text{ mW / cm}^2$$

This value satisfies the FCC MPE requirement for both the Uncontrolled Environment (1.0 mW/cm^2) and Controlled Environment (5.0 mW/cm^2).

4. Power Density Summary

The values listed in the Power Density Summary table below show that the only regions where the power density exceeds FCC limits are the regions between the Main Reflector and the Subreflector and the Main Reflector Region.

These regions are not accessible to the general population since the antennas are mounted inside radomes that have restricted entry access. Also, the antennas are designed to be mounted on pedestals that are typically six feet tall or higher.

These regions are only accessible to trained network technicians. These technicians follow a strict set of procedures to work on the antennas that include turning the transmit power off before entering the radome.

Consequently, the analysis shows that the Seatel 4006 antenna, operating with an input power level of 0.33 watts at the waveguide flange, and with the proper mitigation procedures in place, complies with the guidelines specified in § 1.1310 of the FCC Regulations.

Power Density Region	Value (mW / cm^2)	Uncontrolled Environment (1 mW / cm^2)	Controlled Environment (5 mW / cm^2)
Far Field Region	.043	Satisfies FCC MPE	Satisfies FCC MPE
Near Field Region	.099	Satisfies FCC MPE	Satisfies FCC MPE
Transition Region	.099	Satisfies FCC MPE	Satisfies FCC MPE
Main Reflector Region	16.71	Exceeds FCC MPE	Exceeds FCC MPE
Region between Main and Subreflectors	199.7	Exceeds FCC MPE	Exceeds FCC MPE
Region between Main Reflector and Ground	0.042	Satisfies FCC MPE	Satisfies FCC MPE

Radiation Hazard Study - Seatel 4996 Antenna

1. Introduction

The purpose of this report is to analyze the potential RF human exposure levels caused by the Electro Magnetic (EM) fields of a Seatel 4996 antenna operating with a maximum power at the flange of 0.245 Watts.

The analysis and calculations performed in this report comply with the methods described in the FCC Office of Engineering and Technology Bulletin, No. 65, published in 1985 and revised in 1997 in Edition 97-01. The radiation safety limits used in the following analysis conform to FCC R&O 96-326. Bulletin No. 65.

Maximum Permissible Exposure (MPE)

There are two separate levels of exposure limits. These depend on the situation where the exposure takes place and the type of individuals who are subject to the exposure The first level applies to people in the general population who are in an uncontrolled environment. The second level applies to trained personnel in a controlled environment. According to 47 C.F.R. § 1.1310, the Maximum Permissible Exposure (MPE) limits for frequencies above 1.5 GHz are as follows:

General Population / Uncontrolled Exposure	**1.0 mW/cm2**
Occupational / Controlled Exposure	**5.0 mW/cm2**

The purpose of this study is to determine the power density levels for the Seatel 4006 antenna and compare them with the published MPE limits. The power density level comparisons are done for six individual regions. These regions are:

1. Far-field region
2. Near-field region
3. Transition region
4. The region between the feed and the antenna surface
5. The main reflector region
6. The region between the antenna edge and the ground

2. Configuration

The antenna under study is a Seatel Model 4996 antenna. It has a diameter of 1.2 meters.

2.1 Input Parameters

The following input parameters were used in the calculations:

Parameter	Unit	Symbol	Value
Antenna Diameter	m	D	1.2
Antenna Transmit Gain	dBi	G_{ant}	42.45
Transmit Frequency	MHz	f	14250
Antenna Feed Flange Diameter	cm	d	12.0
Power input to Antenna	Watts	P	0.245

2.2 Calculated Parameters

Following are the calculated parameter values and their formulas using the above input parameters.

Parameter	Unit	Symbol	Value	Formula
Antenna Surface Area	m^2	A	1.13	$\pi D^2/4$
Antenna Flange Area	cm^2	a	113.1	$\pi d^2/4$
Antenna Efficiency		η	0.55	$G\lambda^2/(\pi^2 D^2)$
Gain Factor		G	17579.2	$10^{G/10}$
Wavelength	m	λ	0.0211	300/ f

2.3 Region Definition

The effect of exposure to RF radiation depends on the distance from the antenna radiating the energy. The primary area of interest is divided into three regions: Near Field, Far Field, and Transition Region. The limit of the Near Field (R_{nf}) and the beginning of the Far Field (R_{ff}) are calculated as follows

$$\text{Near Field Distance } (R_{nf}) = D^2 / 4\lambda$$

$$(R_{nf}) = (1.2)^2 / 4(0.0211)$$

$$(R_{nf}) = 17.06 \text{ m}$$

$$\text{Far Field Distance } (R_{ff}) = 0.6(D)^2 / \lambda$$

$$(R_{ff}) = 0.6(1.2)^2 / 0.0211$$

$$(R_{ff}) = 40.95 \text{ m}$$

The distance between the end of the near field and the beginning of the far field is designated as the Transition Region and is expressed as $R_{nf} \leq R_t \leq R_{ff.}$ In this case, the region between 17.06 m and 40.95 m is designated as the Transition Region. However, the power density in this region will not exceed the power in the Near Field region. As a result, for the following calculations the distance of the Transition Region will be equal to the Near Field distance.

$$\text{Transition Region } R_t = R_{nf}$$

$$(R_{nf}) = 17.06 \text{ m}$$

3. Field Strength

3.1 Near Field Strength

The Near Field Power Density is calculated as follows:

$$S_{nf} = 16.0\ \eta\ P/(\pi D^2)$$

$$S_{nf} = 16.0\ (0.55)\ (0.245)\ /\ (3.14)\ (1.2^2)$$

$$S_{nf} = 0.048 \text{ mW/cm}^2$$

This value satisfies the FCC MPE requirement for both the Uncontrolled Environment (1 mW/cm^2) and Controlled Environment (5 mW/cm^2).

3.2 Transition Region

The Power Density in the Transition Region is calculated as follows:

$$S_t = S_{nf}\ R_{nf}\ /(R)$$

The maximum power density in the transition Region is when R = Rnf, at which point

$$S_t = S_{nf} = 0.048 \text{ mW/cm}^2$$

This value satisfies the FCC MPE requirement for both the Uncontrolled Environment (1.0 mW/cm^2) and Controlled Environment (5.0 mW/cm^2).

3.3 Far Field Region

The Far Field Power Density is calculated as follows:

$$S_{ff} = PG/(4\pi\ R_{ff}^2)$$

$$S_{ff} = (0.245)\ (17579.2)\ /\ (4)(3.14)\ (40.95)^2$$

$$S_{ff} = 0.020\ \text{mW/cm}^2$$

This value satisfies the FCC MPE requirement for both the Uncontrolled Environment (1.0 mW/cm^2) and Controlled Environment (5.0 mW/cm^2).

3.4 Region between Main Reflector and Subreflector

The region between the antenna's main reflector and subreflector is a conically shaped region defined by the feed assembly which is a waveguide flange. The power density of this region is calculated as follows:

$$S_{fa} = 4P\ /\ a$$

$$S_{fa} = 8.66\ \text{mW / cm}^2$$

This value exceeds the FCC MPE requirement for both the Uncontrolled Environment (1.0 mW/cm^2) and Controlled Environment (5.0 mW/cm^2).

3.5 Power Density at Main Reflector

The power density in the main reflector is calculated using the area of the main reflector instead of the feed waveguide flange.

$$S_{reflector} = 4P\ /\ A$$

$$S_{reflector} = 0.87\ \text{mW / cm}^2$$

This value satisfies the FCC MPE requirement for both the Uncontrolled Environment (1.0 mW/cm^2) and Controlled Environment (5.0 mW/cm^2).

3.6 Power Density between Main Reflector and Ground

The power density level between the antenna main reflector and the ground is calculated as follows:

$$S_g = P\ /\ A$$

$$S_g = 0.22\ \text{mW / cm}^2$$

This value satisfies the FCC MPE requirement for both the Uncontrolled Environment (1.0 mW/cm^2) and Controlled Environment (5.0 mW/cm^2).

4. Power Density Summary

The values listed in the Power Density Summary table below show that the only region where the power density exceeds FCC limits is the region between the Main Reflector and the Subreflector.

This region is not accessible to the general population since the antennas are mounted inside radomes that have restricted entry access. Also, the antennas are designed to be mounted on pedestals that are typically six feet tall or higher.

This region is only accessible to trained network technicians. These technicians follow a strict set of procedures to work on the antennas that include turning the transmit power off before entering the radome.

Consequently, the analysis shows that the Seatel 4996 antenna, operating with an input power level of 0.245 watts at the waveguide flange, and with the proper mitigation procedures in place, complies with the guidelines specified in § 1.1310 of the FCC Regulations.

Power Density Region	Value (mW / cm^2)	Uncontrolled Environment (1 mW / cm^2)	Controlled Environment (5 mW / cm^2)
Far Field Region	.0020	Satisfies FCC MPE	Satisfies FCC MPE
Near Field Region	.048	Satisfies FCC MPE	Satisfies FCC MPE
Transition Region	.048	Satisfies FCC MPE	Satisfies FCC MPE
Main Reflector Region	0.87	Satisfies FCC MPE	Satisfies FCC MPE
Region between Main and Subreflectors	8.66	Exceeds FCC MPE	Exceeds FCC MPE
Region between Main Reflector and Ground	0.22	Satisfies FCC MPE	Satisfies FCC MPE

Radiation Hazard Study - Seatel 6006 Antenna

1. Introduction

The purpose of this report is to analyze the potential RF human exposure levels caused by the Electro Magnetic (EM) fields of a Seatel 6006 antenna operating with a maximum power at the flange of 0.233 Watts.

The analysis and calculations performed in this report comply with the methods described in the FCC Office of Engineering and Technology Bulletin, No. 65, published in 1985 and revised in 1997 in Edition 97-01. The radiation safety limits used in the following analysis conform to FCC R&O 96-326. Bulletin No. 65.

Maximum Permissible Exposure (MPE)

There are two separate levels of exposure limits. These depend on the situation where the exposure takes place and the type of individuals who are subject to the exposure. The first level applies to people in the general population who are in an uncontrolled environment. The second level applies to trained personnel in a controlled environment. According to 47 C.F.R. § 1.1310, the Maximum Permissible Exposure (MPE) limits for frequencies above 1.5 GHz are as follows:

General Population / Uncontrolled Exposure	**1.0 mW/cm2**
Occupational / Controlled Exposure	**5.0 mW/cm2**

The purpose of this study is to determine the power density levels for the Seatel 4006 antenna and compare them with the published MPE limits. The power density level comparisons are done for six individual regions. These regions are:

1. Far-field region
2. Near-field region
3. Transition region
4. The region between the feed and the antenna surface
5. The main reflector region
6. The region between the antenna edge and the ground

2. Configuration

The antenna under study is a Seatel Model 6006 antenna. It has a diameter of 1.5 meters.

2.1 Input Parameters

The following input parameters were used in the calculations:

Parameter	Unit	Symbol	Value
Antenna Diameter	m	D	1.5
Antenna Transmit Gain	dBi	G_{ant}	42.75
Transmit Frequency	MHz	f	14250
Antenna Feed Flange Diameter	cm	d	5.08
Power input to Antenna	Watts	P	0.233

2.2 Calculated Parameters

Following are the calculated parameter values and their formulas using the above input parameters.

Parameter	Unit	Symbol	Value	Formula
Antenna Surface Area	m^2	A	1.77	$\pi D^2/4$
Antenna Flange Area	cm^2	a	20.27	$\pi d^2/4$
Antenna Efficiency		η	0.41	$G\lambda^2/(\pi^2 D^2)$
Gain Factor		G	18836.5	$10^{G/10}$
Wavelength	m	λ	0.0211	$300/f$

2.3 Region Definition

The effect of exposure to RF radiation depends on the distance from the antenna radiating the energy. The primary area of interest is divided into three regions: Near Field, Far Field, and Transition Region. The limit of the Near Field (R_{nf}) and the beginning of the Far Field (R_{ff}) are calculated as follows

$$\text{Near Field Distance } (R_{nf}) = D^2 / 4\lambda$$

$$(R_{nf}) = (1.5)^2 / 4(0.0211)$$

$$(R_{nf}) = 26.7 \text{ m}$$

$$\text{Far Field Distance } (R_{ff}) = 0.6(D)^2 / \lambda$$

$$(R_{ff}) = 0.6(1.5)^2 / 0.0211$$

$$(R_{ff}) = 64.1 \text{ m}$$

The distance between the end of the near field and the beginning of the far field is designated as the Transition Region and is expressed as $R_{nf} \leq R_t \leq R_{ff.}$ In this case, the region between 26.7 m and 64.1 m is designated as the Transition Region. However, the power density in this region will not exceed the power in the Near Field region. As a result, for the following calculations the distance of the Transition Region will be equal to the Near Field distance.

$$\text{Transition Region } R_t = R_{nf}$$

$$(R_{nf}) = 26.7 \text{ m}$$

3. Field Strength

3.1 Near Field Strength

The Near Field Power Density is calculated as follows:

$$S_{nf} = 16.0\ \eta\ P/(\pi D^2)$$

$$S_{nf} = 16.0\ (0.41)\ (0.233) / (3.14)\ (1.5^2)$$

$$S_{nf} = 0.022 \text{ mW/cm}^2$$

This value satisfies the FCC MPE requirement for both the Uncontrolled Environment (1 mW/cm^2) and Controlled Environment (5 mW/cm^2).

3.2 Transition Region

The Power Density in the Transition Region is calculated as follows:

$$S_t = S_{nf}\ R_{nf} /(R)$$

The maximum power density in the transition Region is when R = Rnf, at which point

$$S_t = S_{nf} = 0.022 \text{ mW/cm}^2$$

This value satisfies the FCC MPE requirement for both the Uncontrolled Environment (1.0 mW/cm^2) and Controlled Environment (5.0 mW/cm^2).

3.3 Far Field Region

The Far Field Power Density is calculated as follows:

$$S_{ff} = PG/(4\pi R_{ff}^2)$$

$$S_{ff} = (0.233)\ (18836.5)\ /\ (4)(3.14)\ (64.1)$$

$$S_{ff} = 0.0085\ \text{mW/cm}^2$$

This value satisfies the FCC MPE requirement for both the Uncontrolled Environment (1.0 mW/cm^2) and Controlled Environment (5.0 mW/cm^2).

3.4 Region between Main Reflector and Subreflector

The region between the antenna's main reflector and subreflector is a conically shaped region defined by the feed assembly which is a waveguide flange. The power density of this region is calculated as follows:

$$S_{fa} = 4P\ /\ a$$

$$S_{fa} = 45.98\ \text{mW / cm}^2$$

This value exceeds the FCC MPE requirement for both the Uncontrolled Environment (1.0 mW/cm^2) and Controlled Environment (5.0 mW/cm^2).

3.5 Power Density at Main Reflector

The power density in the main reflector is calculated using the area of the main reflector instead of the feed waveguide flange.

$$S_{reflector} = 4P\ /\ A$$

$$S_{reflector} = 0.53\ \text{mW / cm}^2$$

This value satisfies the FCC MPE requirement for both the Uncontrolled Environment (1.0 mW/cm^2) and Controlled Environment (5.0 mW/cm^2).

3.6 Power Density between Main Reflector and Ground

The power density level between the antenna main reflector and the ground is calculated as follows:

$$S_g = P / A$$

$$S_g = .013 \text{ mW / cm}^2$$

This value satisfies the FCC MPE requirement for the Uncontrolled Environment (1.0 mW/cm^2) and satisfies Controlled Environment (5.0 mW/cm^2)

4. Power Density Summary

The values listed in the Power Density Summary table below show that the only region where the power density exceeds FCC limits is the region between the Main Reflector and the Subreflector.

This region is not accessible to the general population since the antennas are mounted inside radomes that have restricted entry access. Also, the antennas are designed to be mounted on pedestals that are typically six feet tall or higher.

This region is only accessible to trained network technicians. These technicians follow a strict set of procedures to work on the antennas that include turning the transmit power off before entering the radome.

Consequently, the analysis shows that the Seatel 6006 antenna, operating with an input power level of 0.233 watts at the waveguide flange, and with the proper mitigation procedures in place, complies with the guidelines specified in § 1.1310 of the FCC Regulations.

Power Density Region	Value (mW / cm^2)	Uncontrolled Environment (1 mW / cm^2)	Controlled Environment (5 mW / cm^2)
Far Field Region	.0085	Satisfies FCC MPE	Satisfies FCC MPE
Near Field Region	.022	Satisfies FCC MPE	Satisfies FCC MPE
Transition Region	.022	Satisfies FCC MPE	Satisfies FCC MPE
Main Reflector Region	0.53	Satisfies FCC MPE	Satisfies FCC MPE
Region between Main and Subreflectors	45.98	Exceeds FCC MPE	Exceeds FCC MPE
Region between Main Reflector and Ground	0.013	Satisfies FCC MPE	Satisfies FCC MPE

Radiation Hazard Study – Prodelin 1383 Antenna

1. Introduction

The purpose of this report is to analyze the potential RF human exposure levels caused by the Electro Magnetic (EM) fields of a Prodelin Model 1383 antenna operating with a maximum power at the flange of 0.755 Watts.

The analysis and calculations performed in this report comply with the methods described in the FCC Office of Engineering and Technology Bulletin, No. 65, published in 1985 and revised in 1997 in Edition 97-01. The radiation safety limits used in the following analysis conform to FCC R&O 96-326. Bulletin No. 65.

Maximum Permissible Exposure (MPE)

There are two separate levels of exposure limits. These depend on the situation where the exposure takes place and the type of individuals who are subject to the exposure. The first level applies to people in the general population who are in an uncontrolled environment. The second level applies to trained personnel in a controlled environment. According to 47 C.F.R. § 1.1310, the Maximum Permissible Exposure (MPE) limits for frequencies above 1.5 GHz are as follows:

General Population / Uncontrolled Exposure	**1.0 mW/cm2**
Occupational / Controlled Exposure	**5.0 mW/cm2**

The purpose of this study is to determine the power density levels for the Prodelin 1383 antenna and compare them with the published MPE limits. The power density level comparisons are done for six individual regions. These regions are:

1. Far-field region
2. Near-field region
3. Transition region
4. The region between the feed and the antenna surface
5. The main reflector region
6. The region between the antenna edge and the ground

2. Configuration

The antenna under study is a Prodelin 1383 antenna. It has a diameter of 3.8 meters.

2.1 Input Parameters

The following input parameters were used in the calculations:

Parameter	Unit	Symbol	Value
Antenna Diameter	m	D	3.8
Antenna Transmit Gain	dBi	G_{ant}	53.2
Transmit Frequency	MHz	f	14250
Antenna Feed Flange Diameter	cm	d	18.0
Power input to Antenna	Watts	P	0.755

2.2 Calculated Parameters

Following are the calculated parameter values and their formulas using the above input parameters.

Parameter	Unit	Symbol	Value	Formula
Antenna Surface Area	m^2	A	11.34	$\pi D^2/4$
Antenna Flange Area	cm^2	a	254.34	$\pi d^2/4$
Antenna Efficiency		η	0.65	$G\lambda^2/(\pi^2 D^2)$
Gain Factor		G	208929.6	$10^{G/10}$
Wavelength	m	λ	0.0211	300/ f

2.3 Region Definition

The effect of exposure to RF radiation depends on the distance from the antenna radiating the energy. The primary are of interest is divided into three regions: Near Field, Far Field, and Transition Region. The limit of the Near Field (R_{nf}) and the beginning of the Far Field (R_{ff}) are calculated as follows

Near Field Distance (R_{nf}) = $D^2 / 4\lambda$

$(R_{nf}) = (3.8)^2 / 4(0.0211)$

$(R_{nf}) = 171.10$ m

$$\text{Far Field Distance } (R_{ff}) = 0.6(D)^2 / \lambda$$

$$(R_{ff}) = 0.6(3.8)^2 / 0.0211$$

$$(R_{ff}) = 410.62 \text{ m}$$

The distance between the end of the near field and the beginning of the far field is designated as the transition Region and is expressed as $R_{nf} \leq R_t \leq R_{ff.}$ In this case, the region between 171.1 m and 410.62 m is designated as the Transition Region. However, the power density in this region will not exceed the power in the Near Field region. As a result, for the following calculations the distance of the Transition Region will be equal to the Near Field distance.

$$\text{Transition Region } R_t = R_{nf}$$

$$(R_{nf}) = 171.10 \text{ m}$$

3. Field Strength

3.7 Near Field Strength

The Near Field Power Density is calculated as follows:

$$S_{nf} = 16.0\ \eta\ P/(\pi D^2)$$

$$S_{nf} = 16.0\ (0.65)\ (0.755) / (3.14)\ (3.8^2)$$

$$S_{nf} = 0.017 \text{ mW / cm}^2$$

This value satisfies the FCC MPE requirement for both the Uncontrolled Environment (1 mW/cm^2) and Controlled Environment (5 mW/cm^2).

3.8 Transition Region

The Power Density in the Transition Region is calculated as follows:

$$S_t = S_{nf}\ R_{nf} /(R)$$

The maximum power density in the transition Region is when R = Rnf, at which point

$$S_t = S_{nf} = 0.017 \text{ mW / cm}^2$$

This value satisfies the FCC MPE requirement for both the Uncontrolled Environment (1.0 mW/cm^2) and Controlled Environment (5.0 mW/cm^2).

3.9 Far Field Region

The Far Field Power Density is calculated as follows:

$$S_{ff}= PG/(4\pi\ R_{ff}^2)$$

$$S_{ff}= (0.755)\ (208929.6)\ /\ (4)(3.14)\ (410.62^2)$$

$$S_{ff}= 0.0074\ \text{mW / cm}^2$$

This value satisfies the FCC MPE requirement for both the Uncontrolled Environment (1.0 mW/cm^2) and Controlled Environment (5.0 mW/cm^2).

3.10 Region between Main Reflector and Subreflector

The region between the antenna's main reflector and subreflector is a conically shaped region defined by the feed assembly which is a waveguide flange. The power density of this region is calculated as follows:

$$S_{fa} = 4P\ /\ a$$

$$S_{fa} = 11.87\ \text{mW / cm}^2$$

This value exceeds the FCC MPE requirement for both the Uncontrolled Environment (1.0 mW/cm^2) and Controlled Environment (5.0 mW/cm^2).

3.11 Power Density at Main Reflector

The power density in the main reflector is calculated using the area of the main reflector instead of the feed waveguide flange.

$$S_{reflector} = 4P\ /\ A$$

$$S_{reflector} = 2.66\ \text{mW / cm}^2$$

This value exceeds the FCC MPE requirement for the Uncontrolled Environment (1.0 mW/cm^2) and satisfies the FCC MPE requirement for Controlled Environment (5.0 mW/cm^2).

3.12 Power Density between Main Reflector and Ground

The power density level between the antenna main reflector and the ground is calculated as follows:

$$S_g = P / A$$

$$S_g = 0.66 \text{ mW / cm}^2$$

This value satisfies the FCC MPE requirement for the Uncontrolled Environment (1.0 mW/cm^2) and satisfies Controlled Environment (5.0 mW/cm^2)

4. Power Density Summary

The values listed in the Power Density Summary table below show that the only region where the power density exceeds FCC limits for both Uncontrolled and Controlled Environments is the region between the Main Reflector and the Subreflector. In addition, the value of the Main Reflector region exceeds the FCC limit for Uncontrolled Environment.

These regions are not accessible to the general population since the antenna will be located in a restricted rooftop area controlled by building security personnel. Only network engineers and other authorized personnel will have access to the antenna location.

This antenna will only be accessible to trained network technicians. These technicians follow a strict set of procedures to work on the antennas that include turning the transmit power off before entering the radome.

Consequently, the analysis shows that the Seatel 6006 antenna, operating with an input power level of 0.755 watts at the waveguide flange, and with the proper mitigation procedures in place, complies with the guidelines specified in § 1.1310 of the FCC Regulations.

Power Density Region	Value (mW / cm^2)	Uncontrolled Environment (1 mW / cm^2)	Controlled Environment (5 mW / cm^2)
Far Field Region	.0074	Satisfies FCC MPE	Satisfies FCC MPE
Near Field Region	.017	Satisfies FCC MPE	Satisfies FCC MPE
Transition Region	.017	Satisfies FCC MPE	Satisfies FCC MPE
Main Reflector Region	2.66	Exceeds FCC MPE	Satisfies FCC MPE
Region between Main and Subreflectors	11.87	Exceeds FCC MPE	Exceeds FCC MPE
Region between Main Reflector and Ground	0.66	Satisfies FCC MPE	Satisfies FCC MPE