Speedcast Communications Inc.

Blanket ESV License Modification Application

I. 2.4m Radiation Hazard Report

II. 2.2m Radiation Hazard Report

Radiation Hazard Study

2.4m Ku-band Earth Station

This study analyzes the non-ionizing radiation levels for a 2.4m Ku-band earth station. This report is developed in accordance with the prediction methods contained in OET Bulletin No. 65, Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields, Edition 97-01.

Bulletin No. 65 specifies that there are two separate tiers of exposure limits that are depending on the area of exposure and/or the status of the individuals who are subject to the exposure -- the General Population/Uncontrolled Environment and the Controlled Environment, where the general population cannot access.

The maximum level of non-ionizing radiation to which individuals may be exposed is limited to a power density level of 5 milliwatts per square centimeter (5 mW/cm^2) averaged over any 6 minute period in a controlled environment, and the maximum level of non-ionizing radiation to which the general public is exposed is limited to a power density level of 1 milliwatt per square centimeter (1 mW/cm^2) averaged over any 30 minute period in a uncontrolled environment.

In the normal range of transmit powers for satellite antennas, the power densities at or around the antenna surface are expected to exceed safe levels. The purpose of this study is to determine the power flux density levels for the earth station under study as compared with the MPE limits. This comparison is done in each of the following regions:

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

Input Parameters

The following input parameters were used in the calculations:

Parameters:	Value	Unit	Symbol
Antenna Diameter	2.4	m	*D*
Antenna Transmit Gain	49.3	dBi	*G*
Transmit Frequency	14250	MHz	*f*
Antenna Feed Flange diameter	~7.5	cm	*d*
Power Input to the Antenna	238.8	W	*P*

Calculated Parameters:

The following values were calculated using the above input parameters and the corresponding formulas:

Parameter	Value	Unit	Symbol	Formula
Antenna Surface Area	4.524	m^2	A	$\pi D^2/4$
Area of Antenna Flange	~44.2	cm^2	a	$\pi d^2/4$
Antenna Efficiency	0.65		η	$G\lambda^2/(\pi^2 D^2)$
Gain Factor	85,114		g	$10^{G/10}$
Wavelength	0.021	m	λ	$300/f$

Behavior of EM Fields as a Function of Distance

The behavior of the characteristics of EM fields varies depending on the distance from the radiating antenna. These characteristics are analyzed in three primary regions: the near-field region, the far-field region and the transition region. Of interest also are the region between the antenna main reflector and the subreflector, the region of the main reflector area and the region between the main reflector and ground.

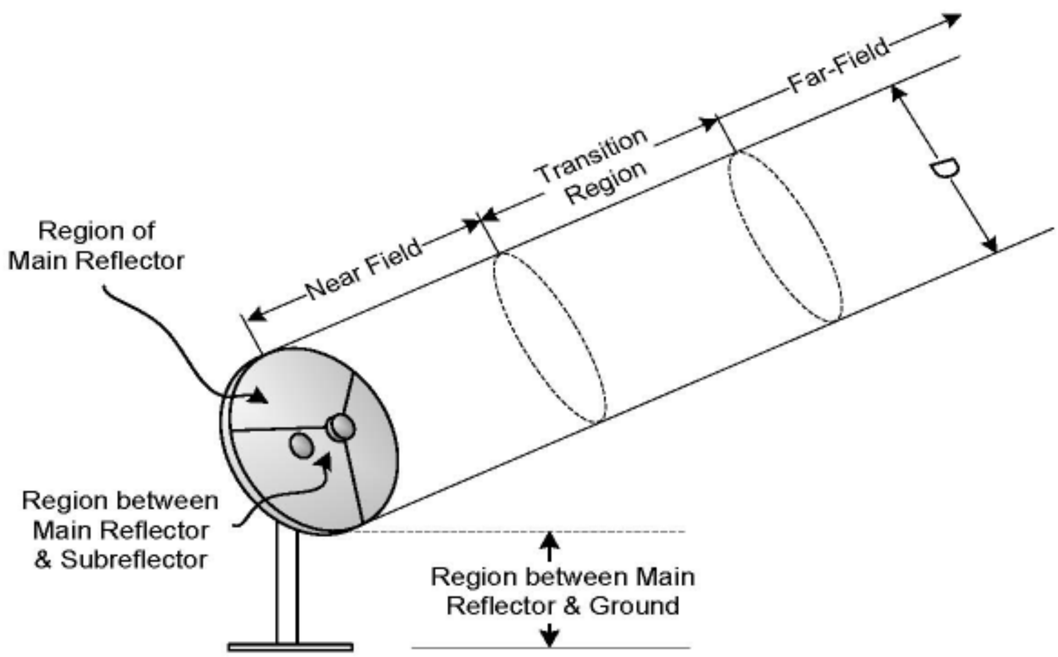

Figure 1. EM Fields as a Function of Distance

For parabolic aperture antennas with circular cross sections, such as the antenna under study, the near-field, farfield and transition region distances are calculated as follows:

Parameter	Value	Unit	Formula
Near-Field Distance	68.4	m	$R_{nf} = D^2/(4\lambda)$
Distance to Far-Field	164.2	m	$R_{ff} = 0.60D^2/(\lambda)$
Distance of Transition Region	68.4	m	$R_t = R_{nf}$

The distance in the transition region is between the near and far fields. Thus, $R_{nf} \leq R_t \leq R_{ff}$. However, the power density in the transition region will not exceed the power density in the near-field. Therefore, for purposes of the present analysis, the distance of the transition region can equate the distance to the near-field.

Power Flux Density Calculations

The power flux density is considered to be at a maximum through the entire length of the near-field. This region is contained within a cylindrical volume with a diameter, D, equal to the diameter of the antenna. In the transition region and the far-field, the power density decreases inversely with the square of the distance. The following equations are used to calculate power density in these regions.

Parameter	Value	Unit	Symbol	Formula
Power Density in the Near-Field	4.84	mW/cm^2	S_{nf}	$16.0\ \eta\ P/(\pi D^2)$
Power Density in the Far-Field	2.11	mW/cm^2	S_{ff}	$GP/(4\pi\ Rff^2)$
Power Density in the Transition Region	4.84	mW/cm^2	S_t	$S_{nf}\ R_{nf}/(R_t)$

The region between the main reflector and the subreflector is confined within a conical shape defined by the feed assembly. The most common feed assemblies are waveguide flanges. This energy is determined as follows:

Parameter	Value	Unit	Symbol	Formula
Power Density at the Feed Flange	_7618	mW/cm^2	S_{fa}	$4P / a$

The power density in the main reflector is determined similarly to the power density at the feed flange; except that the area of the reflector is used.

Parameter	Value	Unit	Symbol	Formula
Power Density at Main Reflector	7.44	mW/cm^2	$S_{surface}$	$4P / A$

The power density between the reflector and ground, assuming uniform illumination of the reflector surface, is calculated as follows:

Parameter	Value	Unit	Symbol	Formula
Power Density b/w Reflector and Ground	1.86	mW/cm^2	S_g	P / A

The below table summarizes the calculated power flux density values for each region. In a controlled environment, the only regions that exceed FCC limitations are shown below. These regions are only accessible by trained technicians who, as a matter of procedure, turn off transmit power before performing any work in these areas.

Power Density	Value	Unit	Controlled Environment
Far Field Calculation	4.84	mW/cm^2	Satisfies FCC MPE
Near Field Calculation	2.11	mW/cm^2	Satisfies FCC MPE
Transition Region	4.84	mW/cm^2	Satisfies FCC MPE
Region b/w feed iris and reflector	7618	mW/cm^2	Exceeds Limits
Main Reflector Region	7.44	mW/cm^2	Exceeds Limits
Region b/w Main Reflector & Ground	1.86	mW/cm^2	Satisfies FCC MPE

In conclusion, the results show that the antenna, in a controlled environment, may exist in the regions noted above and applicant will take the proper mitigation procedures to ensure it meets the guidelines specified in 47 C.F.R. § 1.1310.

The antenna will be covered with a radome which restricts access to the internal areas of the earth station (between the feed and the antenna surface) where power densities exceed the FCC limit.

The antenna will be installed at high elevation angles on cruise ships. The locations where these antennas are installed on cruise ships is restricted to public access. The earth station will be marked with the standard radiation hazard warnings, as well as the area in the vicinity of the earth station to inform the general population and cruise ship personnel not responsible for earth station maintenance or operations, who might be working or otherwise present in or near the path of the main beam.

The applicant will ensure that the main beam of the antenna will be pointed at least one diameter away from any building, or other obstacles in those areas that exceed the MPE limits. Since one diameter removed from the center of the main beam the levels are down at least 20 dB, or by a factor of 100, public safety will be ensured.

Finally, the earth station's operational personnel will not have access to areas that exceed the MPE limits while the earth station is in operation. The transmitter will be turned off during periods of maintenance so that the MPE standard of 5.0 mW/cm^2 will be complied with for those regions in close proximity to the main reflector, which could be occupied by operating personnel.

Radiation Hazard Study

2.2m Ka-band Earth Station

This study analyzes the non-ionizing radiation levels for a 2.2m Ka-band earth station. This report is developed in accordance with the prediction methods contained in OET Bulletin No. 65, Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields, Edition 97-01.

Bulletin No. 65 specifies that there are two separate tiers of exposure limits that are depending on the area of exposure and/or the status of the individuals who are subject to the exposure -- the General Population/Uncontrolled Environment and the Controlled Environment, where the general population cannot access.

The maximum level of non-ionizing radiation to which individuals may be exposed is limited to a power density level of 5 milliwatts per square centimeter (5 mW/cm^2) averaged over any 6 minute period in a controlled environment, and the maximum level of non-ionizing radiation to which the general public is exposed is limited to a power density level of 1 milliwatt per square centimeter (1 mW/cm^2) averaged over any 30 minute period in a uncontrolled environment.

In the normal range of transmit powers for satellite antennas, the power densities at or around the antenna surface are expected to exceed safe levels. The purpose of this study is to determine the power flux density levels for the earth station under study as compared with the MPE limits. This comparison is done in each of the following regions:

7. Far-field region
8. Near-field region
9. Transition region
10. The region between the feed and the antenna surface
11. The main reflector region
12. The region between the antenna edge and the ground

Input Parameters

The following input parameters were used in the calculations:

Parameters:	Value	Unit	Symbol
Antenna Diameter	2.2	m	*D*
Antenna Transmit Gain	53.54	dBi	*G*
Transmit Frequency	29650	MHz	*f*
Antenna Feed Flange diameter	~4	cm	*d*
Power Input to the Antenna	60	W	*P*

Calculated Parameters:

The following values were calculated using the above input parameters and the corresponding formulas:

Parameter	Value	Unit	Symbol	Formula
Antenna Surface Area	3.801	m^2	*A*	$\pi D^2/4$
Area of Antenna Flange	~12.6	cm^2	*a*	$\pi d^2/4$
Antenna Efficiency	0.65		η	$G\lambda^2/(\pi^2 D^2)$
Gain Factor	225,944		*g*	$10^{G/10}$
Wavelength	0.01	m	λ	$300/f$

Behavior of EM Fields as a Function of Distance

The behavior of the characteristics of EM fields varies depending on the distance from the radiating antenna. These characteristics are analyzed in three primary regions: the near-field region, the far-field region and the transition region. Of interest also are the region between the antenna main reflector and the subreflector, the region of the main reflector area and the region between the main reflector and ground.

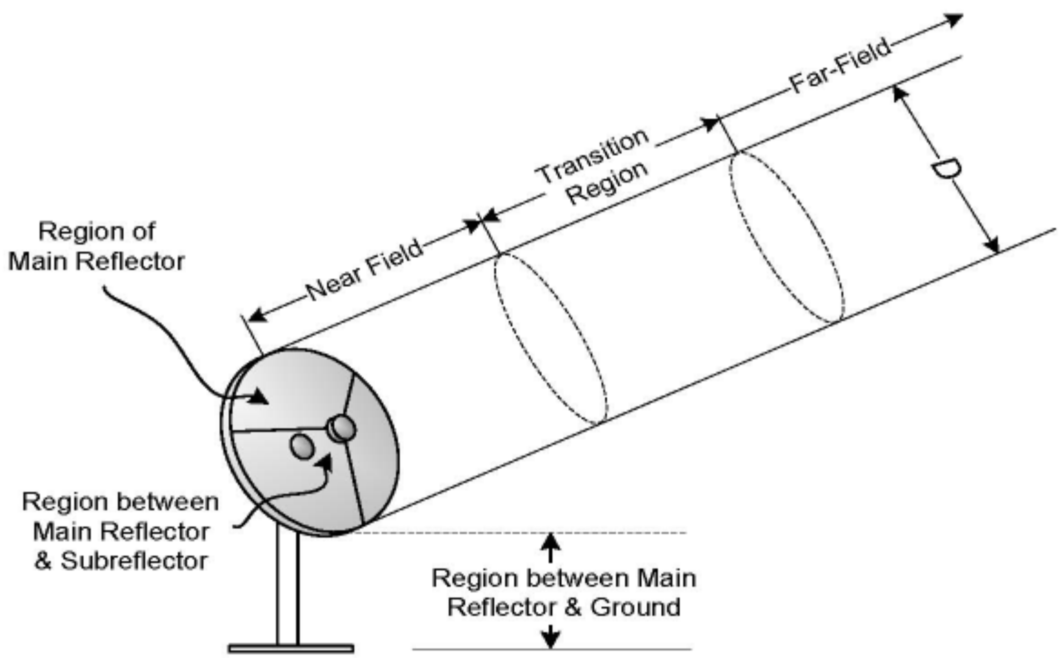

Figure 1. EM Fields as a Function of Distance

For parabolic aperture antennas with circular cross sections, such as the antenna under study, the near-field, farfield and transition region distances are calculated as follows:

Parameter	Value	Unit	Formula
Near-Field Distance	119.6	m	$R_{nf} = D^2/(4\lambda)$
Distance to Far-Field	287.0	m	$R_{ff} = 0.60D^2/(\lambda)$
Distance of Transition Region	119.6	m	$R_t = R_{nf}$

The distance in the transition region is between the near and far fields. Thus, $R_{nf} \leq R_t \leq R_{ff}$. However, the power density in the transition region will not exceed the power density in the near-field. Therefore, for purposes of the present analysis, the distance of the transition region can equate the distance to the near-field.

Power Flux Density Calculations

The power flux density is considered to be at a maximum through the entire length of the near-field. This region is contained within a cylindrical volume with a diameter, D, equal to the diameter of the antenna. In the transition region and the far-field, the power density decreases inversely with the square of the distance. The following equations are used to calculate power density in these regions.

Parameter	Value	Unit	Symbol	Formula
Power Density in the Near-Field	4.10	mW/cm^2	S_{nf}	$16.0\ \eta\ P/(\pi D^2)$
Power Density in the Far-Field	1.31	mW/cm^2	S_{ff}	$GP/(4\pi\ Rff^2)$
Power Density in the Transition Region	4.10	mW/cm^2	S_t	$S_{nf}\, R_{nf}/(R_t)$

The region between the main reflector and the subreflector is confined within a conical shape defined by the feed assembly. The most common feed assemblies are waveguide flanges. This energy is determined as follows:

Parameter	Value	Unit	Symbol	Formula
Power Density at the Feed Flange	_19,099	mW/cm^2	S_{fa}	$4P / a$

The power density in the main reflector is determined similarly to the power density at the feed flange; except that the area of the reflector is used.

Parameter	Value	Unit	Symbol	Formula
Power Density at Main Reflector	6.31	mW/cm^2	$S_{surface}$	$4P / A$

The power density between the reflector and ground, assuming uniform illumination of the reflector surface, is calculated as follows:

Parameter	Value	Unit	Symbol	Formula
Power Density b/w Reflector and Ground	1.58	mW/cm^2	S_g	P / A

The below table summarizes the calculated power flux density values for each region. In a controlled environment, the only regions that exceed FCC limitations are shown below. These regions are only accessible by trained technicians who, as a matter of procedure, turn off transmit power before performing any work in these areas.

Power Density	Value	Unit	Controlled Environment
Far Field Calculation	4.10	mW/cm^2	Satisfies FCC MPE
Near Field Calculation	1.31	mW/cm^2	Satisfies FCC MPE
Transition Region	4.10	mW/cm^2	Satisfies FCC MPE
Region b/w feed iris and reflector	19,099	mW/cm^2	Exceeds Limits
Main Reflector Region	6.31	mW/cm^2	Exceeds Limits
Region b/w Main Reflector & Ground	1.58	mW/cm^2	Satisfies FCC MPE

In conclusion, the results show that the antenna, in a controlled environment, may exist in the regions noted above and applicant will take the proper mitigation procedures to ensure it meets the guidelines specified in 47 C.F.R. § 1.1310.

The antenna will be covered with a radome which restricts access to the internal areas of the earth station (between the feed and the antenna surface) where power densities exceed the FCC limit.

The antenna will be installed at high elevation angles on cruise ships. The locations where these antennas are installed on cruise ships is restricted to public access. The earth station will be marked with the standard radiation hazard warnings, as well as the area in the vicinity of the earth station to inform the general population and cruise ship personnel not responsible for earth station maintenance or operations, who might be working or otherwise present in or near the path of the main beam.

The applicant will ensure that the main beam of the antenna will be pointed at least one diameter away from any building, or other obstacles in those areas that exceed the MPE limits. Since one diameter removed from the center of the main beam the levels are down at least 20 dB, or by a factor of 100, public safety will be ensured.

Finally, the earth station's operational personnel will not have access to areas that exceed the MPE limits while the earth station is in operation. The transmitter will be turned off during periods of maintenance so that the MPE standard of 5.0 mW/cm^2 will be complied with for those regions in close proximity to the main reflector, which could be occupied by operating personnel.