Technical Narrative in Support of
FCC File No.: SES−LIC−INTR2023−02565

The applicant filed the above referenced application with the Federal Communications Commission on June 6, 2023. Upon review, the Commission has determined that the information contained in the application must be supplemented to allow further review for the application be granted. Specifically, the Commission is requesting the following information to be modified by filing the instant supplemental statement:

- Updated Radiation Hazard Report which is provided in Appendix A
- Frequency Coordination section entries E56 through E60 are hereby amended as follows:
    - E56. Earth Station Azimuth Angle Eastern Limit: 0.0
    - E57. Antenna Elevation Angle Eastern Limit: 5.0
    - E58. Earth Station Azimuth Angle Western Limit: 360.0
    - E59. Antenna Elevation Angle Western Limit: 5.0
    - E60. Maximum EIRP Density toward the Horizon (dbW/4kHz): 13.37

Appendix A – Radiation Hazard Report

This report analyzes the non-ionizing radiation levels for a 1.8-meter mobile earth station system. The analysis and calculations performed in this report comply with the methods described in the FCC Office of Engineering and Technology Bulletin, No. 65 first published in 1985 and revised in 1997 in Edition 97-01. The radiation safety limits used in the analysis are in conformance with the FCC R&O 96-326. Bulletin No. 65 and the FCC R&O specifies that there are two separate tiers of exposure limits that are dependent on the situation in which the exposure takes place and/or the status of the individuals who are subject to exposure. The Maximum Permissible Exposure (MPE) limits for persons in a General Population / Uncontrolled environment are shown in Table 1. The General Population/Uncontrolled MPE is a function of transmit frequency and is for an exposure period of thirty minutes or less. The MPE limits for persons in an Occupational / Controlled environment are shown in Table 2. The occupational MPE is a function of transmitting frequency and is for an exposure period of six minutes or less. The purpose of the analysis described in this report is to determine the power flux density levels of the earth station in the far-field, near-field, transition region, between the sub reflector or feed and main reflector surface, at the main reflector surface, and between the antenna edge and the ground and to compare these levels to the specified MPEs.

Table 1. Limits for General Population/Uncontrolled Exposure (MPE)

Frequency Range (MHz)	Power Density (mW/cm^2)
30-300	0.2
300-1500	Frequency (MHz)*(0.8/1200)
1500-100,000	1.0

Table 2. Limits for Occupational/Controlled Exposure (MPE)

Frequency Range (MHz)	Power Density (mW/cm^2)
30-300	1.0
300-1500	Frequency (MHz)*(4.0/1200)
1500-100,000	5.0

Table 3. Formulas and Parameters Used for Determining Power Flux Densities

Parameter	Symbol	Formula	Value	Units
Antenna Diameter	D	Input	1.8	m
Antenna Surface Area	$A_{Surface}$	$\pi D^2/4$	2.5447	m^2
Sub Reflector Diameter	D_{sr}	Input	7.3025	cm
Area of Subreflector	A_{sr}	$\pi D_{sr}^2/4$	41.8825	cm^2
Frequency	F	Input	14.25	GHz
Wavelength	λ	300/F	0.0211	m
Transmit Power	P	Input	180	W
Antenna Gain (dBi)	G_{es}	Input	46.7	dBi
Antenna Gain (factor)	G	$10^{Ges/10}$	46773.5141	n/a
Pi	π	Constant	3.141592654	n/a
Antenna Efficiency	η	$G \lambda^2/(\pi^2 D^2)$	0.6483	n/a

1. Far Field Distance Calculations

The distance to the beginning of the far field can be determined from the following equation:

Distance to the Far Field Region	$R_{ff} = 0.60D^2/\lambda$ $R_{ff} = 92.3$ m	(1)

The maximum main beam power density in the far field can be determined from the following equation:

On-Axis Power Density in the Far Field	$S_{ff} = GP/(4\pi R_{ff}^2)$ $S_{ff} = 78.5747$ W/m^2 $S_{ff} = 7.8575$ mW/cm^2	(2)

2. Near Field Distance Calculations

Power flux density is considered to be at a maximum value throughout the entire length of the defined Near Field region. The region is contained within a cylindrical volume having the same diameter as the antenna. Past the boundary of the Near Field region, the power density from the antenna decreases linearly with respect to increasing distance.

The distance to the end of the Near Field can be determined from the following equation:

Extent of the Near Field	$R_{nf} = D^2/(4\lambda)$ $R_{nf} = 38.4750$ m	(3)

The maximum power density in the Near Field can be determined from the following equation:

Near Field Power Density	$S_{nf} = 16P/(\pi\eta D^2)$ $S_{nf} = 436.4451$ W/m^2 $S_{nf} = 43.6445$ mW/cm^2	(4)

3. Transition Region Calculations

The Transition region is located between the Near and Far Field regions. The power density begins to decrease linearly with increasing distance in the Transition region. While the power density decreases inversely with distance in the Transition region, the power density decreases inversely with the square of the distance in the Far Field region. The maximum power density in the Transition region will not exceed that calculated for the Near Field region. The power density calculated in Section 1 is the highest power density the antenna can produce in any of the regions away from the antenna. The power density at a distance R_t can be determined from the following equation:

Transition Region Power Density	$S_t = S_{nf} R_{nf}/R_t$ $S_t = 43.6445$ mW/cm^2	(5)

4. Distance to Safe Region Calculation

Since the power density decreases inversely with the square of the distance in the Far Field region, the distance to the On-axis Power Density of 5 mW/cm^2 for occupational controlled exposure and 1 mW/cm^2 for general population uncontrolled exposure be determined from the following equations:

Distance to ANSI 5 mW/cm^2	$D_{safe(controlled)} = R_{ff}((S_{ff}/5)^{0.5})$ $D_{safe(controlled)} = 115.7567$ m	(6)
Distance to ANSI 1 mW/cm^2	$D_{safe(uncontrolled)} = R_{ff}((S_{ff}/1)^{0.5})$ $D_{safe(uncontrolled)} = 258.8400$ m	(7)

5. Region between the Main Reflector and the Subreflector

Transmissions from the feed assembly are directed toward the subreflector surface, and are reflected back toward the main reflector. The most common feed assemblies are waveguide flanges, horns or subreflectors. The energy between the subreflector and the reflector surfaces can be calculated by determining the power density at the subreflector surface. This can be determined from the following equation:

Power Density at the Subreflector	$S_{sr} = 4000\ P\ /\ A_{sr}$ $S_{sr} = 17190.9$ mW/cm^2	(8)

6. Main Reflector Region

The power density in the main reflector is determined in the same manner as the power density at the subreflector. The area is now the area of the main reflector aperture and can be determined from the following equation:

Power Density at the Main Reflector Surface	$S_{surface} = 4P/A_{surface}$ $S_{surface} = 282.9421$ W/m^2 $S_{surface} = 28.2942$ mW/cm^2	(9)

7. Off-axis Evaluation

For off-axis calculations in the Near Field and in the Transition region, it can be assumed that, if the point of interest is at least one antenna diameter removed from the center of the main beam, the power density at that point would be at least a factor of 100 (20dB) less than the value calculated for the equivalent distance in the main beam. For off-axis calculations in the Far Field, the calculated main-beam power density can be multiplied by the appropriate relative power density factor obtained from the antenna gain pattern. Since the proposed antenna meets or exceeds the performance specifications under Part 25.209 of the FCC rules, the off-axis gain for this antenna is equal to or greater than 10dBi less than the on-axis gain in any direction of 48 degrees or more removed from the centerline of the main beam.
The distance to the end of the Near Field can be determined from the following equation:

Near Field Off-axis Power Density

$$S_{nf(off)} = 0.01\ S_{nf} \tag{10}$$
$$S_{nf(off)} = 0.4364\ \text{mW/cm}^2$$

Far Field Off-axis Power Density

$$S_{ff(off)} = 0.1\ S_{ff} \tag{11}$$
$$S_{ff(off)} = 0.7857\ \text{mW/cm}^2$$

8. Summary of Calculations

Table 4. Summary of Expected Radiation levels for Uncontrolled Environment

Region	Calculated Maximum Radiation Power Density Level		Hazard Assessment
Far Field (R_{ff} = 92.3 m)	S_{ff}	7.8575 mW/cm^2	Potential Hazard
Near Field (R_{nf} = 38.4750 m)	S_{nf}	43.6445 mW/cm^2	Potential Hazard
Transition Region ($R_{nf} < R_t < R_{ff}$)	S_t	43.6445 mW/cm^2	Potential Hazard
On-axis Safe Distance Region	$D_{safe(uncontrolled)}$	258.8400 m	
Between Main Reflector and Subreflector	S_{sr}	17190.9 mW/cm^2	Potential Hazard
Main Reflector	$S_{surface}$	28.2942 mW/cm^2	Potential Hazard
Far Field Off-axis Region	$S_{ff(off)}$	0.7857 mW/cm^2	Not a Hazard
Near Field Off-axis Region	$S_{nf(off)}$	0.4364 mW/cm^2	Not a Hazard

Table 5. Summary of Expected Radiation levels for Controlled Environment

Region	Calculated Maximum Radiation Power Density Level		Hazard Assessment
Far Field (R_{ff} = 92.3 m)	S_{ff}	7.8575 mW/cm^2	Potential Hazard
Near Field (R_{nf} = 38.4750 m)	S_{nf}	43.6445 mW/cm^2	Potential Hazard
Transition Region ($R_{nf} < R_t < R_{ff}$)	S_t	43.6445 mW/cm^2	Potential Hazard
On-Axis Safe Distance Region	$D_{safe(Controlled)}$	115.7567 m	
Between Main Reflector and Subreflector	S_{sr}	17190.9 mW/cm^2	Potential Hazard
Main Reflector	$S_{surface}$	28.2942 mW/cm^2	Potential Hazard
Far Field Off-axis Region	$S_{ff(off)}$	0.7857 mW/cm^2	Not a Hazard
Near Field Off-axis Region	$S_{nf(off)}$	0.4364 mW/cm^2	Not a Hazard

It is the applicant's responsibility to ensure that the public and operational personnel are not exposed to harmful levels of radiation.

Based on this analysis it is concluded that the FCC RF Guidelines have been exceeded in the specific regions of Tables 4 and 5. The applicant proposes to comply with the Maximum Permissible Exposure (MPE) limits of 1 mW/cm2 for the Uncontrolled areas and the MPE limits of 5 mW/cm2 for the Controlled areas by one or more of the following methods:

Means of Compliance - Uncontrolled Areas

The antenna is located on top of a truck. The bottom lip of the dish will be 3.50 meters above ground level. The general public will not have access to areas within ½ diameters from the edge of the antenna. Since one diameter removed from the main beam of the antenna or ½ diameters removed from the edge of the antenna the RF levels are reduced by a factor of 100 or 20 dB. None of the areas exceeding the MPE levels will be accessible by the general public.

Means of Compliance - Controlled Areas

The earth station's operational personnel will not have access to the areas that exceed the MPE levels while the earth station is in operation. The transmitters will be turned off during antenna maintenance.

Means of Compliance – Safety in General

This antenna system is located on a mobile unit and conditions will vary from operating site to operating site. Because of this, the licensee will establish procedures for the operational personnel to verify that the antenna is not pointing in the direction of populated areas, and that access to hazardous areas are restricted while the unit is in operation.

In addition, the transmit power used in these calculations is greater than that which will typically be utilized by the earth station. During normal operation, the typical power level would generally not exceed more than 50 to 75 percent of the indicated transmitter power. Maximum transmit power would generally only occur in conditions of extreme inclement weather.