Radiofrequency Radiation Hazard Study

prepared for

Hearst Stations Inc.

Fixed Satellite Service - Temporary Earth Station

On behalf of *Hearst Stations Inc.*, this statement provides the results of a Radiofrequency Radiation Hazard Study regarding the proposed modification of E070241, a transportable earth station. The proposed modification is to change the antenna and emissions. The transportable earth station will operate in the "Ku" band with a transmitter power output of 100 Watts and a Sat-Lite 1.45 meter diameter dish antenna.

In keeping with §1.1307(b) of the FCC's rules, the proposed operation has been evaluated for human exposure to radiofrequency energy using the procedures outlined in FCC OET Bulletin No. 65 ("OET 65"). The 1.45 meter dish antenna will be mounted on the top of a commercial-grade truck such that the distance from the ground to the center of the antenna is approximately 4 meters.

The following data have been used with the OET 65 equations for predicting RF fields for a parabolic aperture antenna:

Proposed Earth Station Parameters

Center Frequency of Operation	14.250 GHz
Wavelength at Center Frequency	0.02105 meters
Transmitter Power Output (Average)	100 Watts
Power At Antenna Input	87.1 Watts
Antenna Diameter	1.45 meters
Antenna Gain	43.3 dBi
Antenna Aperture Efficiency	0.650

At the range of the uplink transmit frequencies (14.0 – 14.5 GHz), according to FCC rule section §1.1310 the maximum permissible exposure ("MPE") limit for human exposure to RF electromagnetic field is 1.0 mW/cm^2 for general population / uncontrolled exposure and 5.0 mW/cm^2 for occupational / controlled exposure.

The following RF power density results were calculated using OET 65 procedures (see Appendix 1):

Maximum RF Power Density

Region	Calculated Power Density (mW/cm^2)	Conclusion
Far Field On-axis (begins at 59.9 m)	4.1	Exceeds Uncontrolled MPE Satisfies Controlled MPE
Transition Region On-Axis (25.0 to 59.9 m)	9.6	Exceeds Uncontrolled MPE Exceeds Controlled MPE
Near Field On-axis (ends at 25.0 m)	9.6	Exceeds Uncontrolled MPE Exceeds Controlled MPE
Off-axis Near Field (at one antenna diameter)	0.10	Satisfies Both MPE
Off-axis Far Field (59.9 m at 7° off axis)	0.041	Satisfies Both MPE

On-axis (in the main beam of the antenna, oriented towards the sky), the maximum near field power density is calculated to be 9.6 mW/cm^2. This exceeds the occupational / controlled and the general population / uncontrolled MPE limits. Such on-axis locations will be well elevated above ground and are not accessible by the general public. Off-axis, the maximum power density is 0.10 mW/cm^2 which does not exceed the general population / uncontrolled MPE.

The applicant proposes to comply with the FCC's MPE as described in the following. This antenna will be located on a vehicle rooftop 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 any hazardous areas are restricted while the unit is in operation.

The only access to the roof of the truck is a ladder that is not accessible by the general public. The distance from the ground to the center of the antenna is approximately 4 meters. Operational personnel shall choose transmitting locations such that no buildings, other obstacles, or human access will be situated in the areas that exceed the MPE limits. The earth station personnel will be trained to ensure that the antenna path is clear at all times while the transmitter is in operation.

The earth station's operational personnel will not ordinarily require access to the areas that exceed the MPE levels while the earth station is in operation. If access to the vehicle rooftop is necessary, personnel can easily limit their access to a distance of at least one antenna diameter away from the antenna and the main beam while the dish is in operation, as these areas comply with the general population / uncontrolled MPE limit. Authorized and trained personnel individuals that are covered by the occupational / controlled MPE limit may approach the antenna to a minimum distance of 0.28 meters from any part of the antenna, provided that they do not enter the area in front of the antenna's main reflector. To assure the compliance with safety limits, all emissions shall cease whenever personnel must access the area in front of the antenna or any areas within 0.28 meters of the antenna as those locations may exceed the occupational / controlled MPE limit. The mobile unit will be marked with warning signs to advise personnel to avoid the area around and in front of the reflector when the transmitter is operating.

Chesapeake RF Consultants, LLC August 30, 2018
207 Old Dominion Road Yorktown, VA 23692 703-650-9600

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APPENDIX 1
RF POWER DENSITY CALCULATIONS

NEAR FIELD REGION

Within the near-field region of a parabolic reflector antenna, the maximum value of RF power density occurs on-axis at a distance of R_{nf} (Extent of Near Field) as expressed by:

$$R_{nf} = D^2 / 4\lambda$$

where: R_{nf} = distance to beginning of near-field
D = antenna diameter
λ = wavelength

For this analysis, it is assumed that the maximum value of the RF power density exists throughout the entire length of the near-field region. For the proposed Ku-band satellite uplink earth station, the near field extends to a distance of:

$$R_{nf} = 24.97 \text{ meters}$$

The maximum value of on-axis RF power density that is possible within the near field region of the proposed Ku-band satellite earth station antenna can be expressed by the following equation:

$$S_{nf} = (16\ \eta\ P) / (\pi\ D^2)$$

where: S_{nf} = Maximum near-field power density
η = Aperture efficiency
P = Power fed to the antenna

For the Ku-band satellite earth station antenna, the maximum RF power density in the near field is calculated to not to exceed:

$$S_{nf} = 9.63 \text{ mW/cm}^2$$

OET 65 states that the "power density at that point *(one antenna diameter removed from the center of the main beam)* would be at least a factor of 100 (20 dB) less than the value

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calculated for the equivalent distance in the main beam." Accordingly, estimates of the off-axis RF power density in the near field region were made with this conservative presumption. For the proposed Ku-band satellite earth station, the General Population/Uncontrolled Exposure at a distance of at least 1.45 meters from the main beam, the near field maximum off-axis power density is no greater than:

$$S_{nf(oa)} = 0.096 \text{ mW/cm}^2$$

TRANSITION REGION

The RF power density in the transition region between the near field and the far field of a parabolic reflector antenna decreases inversely with distance from the antenna. The far field region (farthest extent of the transition region) can be approximated by the following equation:

$$R_{ff} = 0.6\, D^2 / \lambda$$

where: R_{ff} = distance to beginning of far-field

The beginning of the far field is calculated to be:

$$R_{ff} = 59.9 \text{ meters}$$

The maximum value of on-axis RF power density level in the transition region can be determined by the following relationship:

$$S_t = S_{nf}\, R_{nf} / R$$

where: S_t = Maximum power density for transition region
R = distance to point of interest

Assuming the point of interest is $R = R_{nf}$ = 24.97 meters where the maximum (upper bound) of the power density exists, the RF power density in the transition region is:

$S_{nf} = 9.63 \text{ mW/cm}^2$ (Maximum predicted density in the transition region)

The General Uncontrolled/Exposure area will be at least one antenna diameter distant from the Ku-band satellite earth station antenna and, according to OET 65, the off-axis power density can be conservatively assumed to be at least 20 dB below the maximum level from the center line axis of the antenna. Within the transition region, the maximum off-axis RF power density is less than the maximum value of:

$$S_{t\,(oa)} = 0.096 \text{ mW/cm}^2$$

FAR FIELD REGION

For the proposed Ku-band satellite earth station, the maximum possible value of on-axis RF power density in the far field region can be determined as follows:

$$S_{ff} = (P\,G) / (4\,\pi\,R^2)$$

where: S_{ff} = Power density (on axis)
G = Power gain relative to an isotropic radiator

For the Ku-band satellite earth station, the maximum RF power density at the end of the transition between the near field and the far field (R = 59.9 m) was calculated to not exceed:

$$S_{ff} = 4.13 \text{ mW/cm}^2$$

In compliance with the antenna meeting or exceeding performance specifications under §25.209(a)(2) of the FCC rules, the off-axis gain of the proposed antenna is 8 dBi (a power gain of 6.31) or less in any direction 7 degrees or more from the main lobe. The off-axis RF power density for the Ku-band satellite earth station can be conservatively calculated using the far field power, gain, and distance relationship as:

$$S_{ff(oa)} = (P\,G) / (4\,\pi\,R^2)$$

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Assuming a distance of 59.9 meters from the antenna (the far-field location nearest the antenna), the off-axis RF power density is calculated to be:

$$S_{ff(oa)} = 0.0012 \text{ mW/cm}^2$$

OFF-AXIS POWER DENSITY

The minimum distance required for authorized and trained personnel to approach the antenna from locations not in the main beam can be determined as follows:

$$S = (P\ G) / (4\ \pi\ R^2)$$

Solve for R (distance), where
P = 87.1 Watts
G = unity
$S = 5 \text{ mW/cm}^2$ (Occupational Limit)

R = 0.28 meters

Authorized and trained personnel individuals that are covered by the occupational / controlled MPE limit may approach the antenna to a minimum distance of 0.28 meters from any part of the antenna, provided that they do not enter the area in front of the antenna's main reflector.