MPE Analysis For Earth Station

TeleBEEPER of New Mexico, Inc.

Site Location
4545 McLeod, Albuquerque, NM 87109
Latitude: 35 °08 ’15.9 "N
Longitude: 106 °35 ’40.4 "W

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Analysis of Non-Ionizing Radiation for TeleBEEPER 1.8m Earth Station System

This report analyzes the non-ionizing radiation levels for a 1.8-meter earth station system. The analysis and calculations performed in this report are in compliance 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 01-01. 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 the 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 30 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 transmit 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 MPE's.

Table 1 - FCC Limits for Maximum Permissible Exposure (MPE) Limits for Occupational (Controlled) Exposure

Band	Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time |E|, |H| or S (minutes)
1	0.3-3.0	614	1.63	(100)*	6
2	3.0-30	1842/f	4.89/f	$(900/f^2)$*	6
3	30-300	61.4	0.163	1	6
4	300-1500	--	--	f/300	6
5	1500-100,000	--	--	5	6

*f = frequency in MHz *Plane-wave equivalent power density*

Table 2 - FCC Limits for Maximum Permissible Exposure (MPE) Limits for General Population (Uncontrolled) Exposure

Band	Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time |E|, |H| or S (minutes)
1	0.3-1.34	614	1.63	(100)*	30
2	1.34-30	824/f	2.19/f	($180/f^2$)*	30
3	30-300	27.5	0.073	0.2	30
4	300-1500	--	--	f/1500	30
5	1500-100,000	--	--	1	30

f = frequency in MHz **Plane-wave equivalent power density*

TeleBEEPER parameters for its earth station is shown in Table 3 below

Table 3 - Earth Station Parameters

Antenna Diameter	D	1.8	meter
Sub-reflector Diameter	D_s	15.78	cm
Frequency	F	14250	MHz
Wavelength (300/F)	λ	0.021053	m
Transmit Power = 6.02 dBw	P_{Feed}	4	Watts
Antenna Gain	G	46.5	dBi
Antenna $Gain_{Numberic}$	$G_{Numeric}$	44668.36	
Effective Radiated Isotropic Power (108908.05) Watts	E_iRP	52.52	dB_iW
Pi	Π	3.141593	n/a
Antenna Efficiency	ή	0.7	n/a

Table 4 represents the power density calculations based on FCC Bulletin 65

Table 4 - Power Density Formulas and Calculation

I. Near Field:

R_{Near} = extent of the near-field (m)
D = diameter of the antenna main reflector (m) 1.8 m
λ = wavelength of the RF transmit frequency (m) 0.021053 m

$R_{Near} = (D)^2/4\lambda$ $R_{near} =$ **38.48 m**

S_{Near} = maximum on axix power density within near field (mW/cm^2)
ή = antenna aperture efficiency 0.7
P_{Feed} = maximum power into antenna feed flange (W) 4 W
D = diameter of the antenna main reflector (m) 1.8 m
Π = Pi 3.141593

$S_{Near} = \{(16\acute{\eta}P_{feed})/[\Pi(D)^2]\}/10$ $S_{near} =$ **0.440132 mW/cm^2**

II. Far Field

R_{Far} = distance to beginning of far field (m)
D = diameter of the antenna main reflector (m)
λ = wavelength of the RF transmit frequency (m)

$R_{Far} = [0.6(D)^2]/\lambda$ $R_{Far} =$ **92.34 m**

S_{Far} = maimum on-axis power density in the far field (mW/cm^2)
P_{Feed} = maximum power into antenna feed flange (W) 4 W
$G_{Numeric}$ = antenna main beam gain at RF transmit frequency (number) 44668.36
R_{Far} = distance to beginning of far field (m) 92.34 m

$S_{Far} = [(P_{Feed}\, G_{numeric})/4\Pi(R_{Far})^2]/10$ $S_{Far} =$ **0.166752 mW/cm^2**

III. Antenna Transition Region Power Density Calculation

S_{Tr} = maximum on-axis power density in transition region (mW/cm^2)
S_{Near} = maximum on-axis power density within near field (mW/cm^2)
R_{Near} = extent of the near-filed (m)
R_{Tra} = distance within transition region between near field and far field region

$R_{Tra} = R_{Far} - R_{Rear}$ $R_{tra} =$ **53.87**
$S_{Tr} = S_{Near}R_{Near}/R$ $S_{tra} =$ **0.31438 mW/cm^2**
$S_{Tr} < S_{near}$ **then it is OK**

IV. Antenna Feed-Flange (Or Sub reflector) Power Density Calculation

$S_{Feed-Sub}$ = max power density at antenna feed flange or sub-reflector surface (mW/cm^2)
P_{Feed} = maximum power into antenna feed flange (W) 4 W
$D_{Feed-Sub}$ = diameter of the antenna feed-flange or sub-reflector (cm) 15.78 cm

$S_{Feed-Sub} = 1000\{[4(P_{Feed})]/\{[\Pi(D_{Feed-Sub})^2]/4\}\}$ **81.81183 mW/cm^2**

V. Antenna Main Reflector Power Density Calculation

S_{Ant} = maximum power density in the antenna main reflector region (mW/cm^2)
P_{Feed} = maximum power into antenna feed flange (W) 4 W
D = diameter of the antenna main reflector (m) 1.8 m

$S_{Ant} = \{[4(P_{Feed})]/\{[\Pi D)^2/4\}\}/10$ **0.62876 mW/cm^2**

VI. Power Density Calculation between the Antenna Main Reflector and the Ground

S_{Ground} = maximum power density between the antenna main reflector and ground (mW/cm^2)
P_{Feed} = maximum power into antenna feed flange (W) 4 W
D = diameter of the antenna main reflector (m) 1.8 m

$S_{Ground} = \{P_{Feed}/\{[\Pi(D)^2]/4\}\}/10$ **0.15719 mW/cm^2**

The non-ionize RF radiation summary can be found in Tables 5 and 6

Table 5 - Summary of Expected Radiation levels for Uncontrolled Environment

Region	Calculated	Hazard Assessment
Diannce Near Field (R_{Near})	38.48 m	
Distance to the Far Field (R_{Far})	92.34 m	
Power Density Near Field	0.440132 mW/cm^2	Satisfies FCC MPE
Power Density Far Field	0.166752 mW/cm^2	Satisfies FCC MPE
Transition Region		
$R_{Near} < R_{Tra} < R_{far}$	RNear =38.475 < RTran =53.865 < RFar =92.34	
Power Density Transition Region	0.314380 mW/cm^2	Satisfies FCC MPE
Power Density Antenna Feed Flange	81.811828 mW/cm^2	Potential Hazard
Power Density Antenna Main ReflectorReflector Surface	0.628760 mW/cm^2	Satisfies FCC MPE
Power Density Between Reflector and the Ground Between Reflector	0.157190 mW/cm^2	Satisfies FCC MPE

Table 6 - Summary of Expected Radiation levels for Controlled Environment

Region	Calculated	Hazard Assessment
Diannce Near Field (R_{Near})	38.48 m	
Distance to the Far Field (R_{Far})	92.34 m	
Power Density Near Field	0.440132 mW/cm^2	Satisfies FCC MPE
Power Density Far Field	0.166752 mW/cm^2	Satisfies FCC MPE
Transition Region		
$R_{Near} < R_{Tra} < R_{far}$	RNear =38.475 < RTran =53.865 < RFar =92.34	
Power Density Transition Region	0.314380 mW/cm^2	Satisfies FCC MPE
Power Density Antenna Feed Flange	81.811828 mW/cm^2	Potential Hazard
Power Density Antenna Main ReflectorReflector Surface	0.628760 mW/cm^2	Satisfies FCC MPE
Power Density Between Reflector and the Ground Between Reflector	0.157190 mW/cm^2	Satisfies FCC MPE

The above analysis confirms the presence of potentially hazardous power flux densities at the TeleBEEPER terminal which will require physical and operational protections to manage General Population and Occupational exposure. The TeleBEEPER Antenna at the Albuquerque, NM facility will be located on a roof of an existing building where for RF safety, physical safety, and security purposes access to the antenna is controlled by TeleBEEPER.

The size of the access area on the roof will consider the RF hazards, moving antenna 'swept volume', and the surrounding terrain. In addition to fencing, the area will contain signage which clearly states the standard Radiation Hazard warning. TeleBEEPER will ensure antenna tracking geometry maintains angular limits and other occupied areas where the calculated General Population MPE levels may be exceeded.