ISAT US Inc.

FCC Form 312 Exhibit C

Radiation Hazard Analysis

I. Introduction

This Exhibit analyzes the non-ionizing radiation levels for the three GetSat Terminal earth stations included in this application. The analysis and calculations performed in this Exhibit 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.

Bulletin No. 65 and the FCC R&O 96-326 specify two Maximum Permissible Exposure (MPE) 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. These are described below:

- General Population/Uncontrolled environment MPE limit is 1 mW/cm2. The General Population /Uncontrolled MPE is a function of transmit frequency and is for an exposure period of thirty minutes or less.
- Occupational/Controlled environment MPE limit is 5 mW/cm2. The Occupational MPE is a function of transmit frequency and is for an exposure period of six minutes or less.

The analysis determined the power flux density levels of the earth station in the 1) far-field, 2) near-field, 3) transition region, 4) region between the feed and main reflector surface, 5) at the main reflector surface, and 6) between the antenna edge and the ground. The analysis also examined the safe distance required to meet both the controlled and uncontrolled exposure limits. The summary of results and discussion is provided in Section 2 and the detailed analyses are provided in Section 3.

II. Summary of Results

The Tables below summarize the results for the proposed GetSat terminals. The analysis of the non-ionizing radiation levels, provided in Section 3, assumed the maximum allowed input power to antenna of 16W and a 100% duty cycle resulting in worst case radiation levels. In a significant number of deployments the terminal duty cycle would be below 100% and the actual power required would be lower than the 16W maximum resulting in lower radiation levels than those calculated. As with any directional antenna the maximum level of non-ionizing radiation is in the main beam of the antenna that is pointed to the satellite. As one moves around the antenna to the side lobes and back lobes the radiation levels decrease significantly. Thus, the maximum radiation level from an antenna occurs in a limited area in the direction the antenna is pointed to. This is especially true in the case of the GetSat terminals, as they utilize small, flat panel antennas that result in tighter beam-forming that concentrates the transmitted power in a smaller area around the main beam, resulting in higher calculated power density in the main beam but a sharp drop off in energy as one moves toward the side lobes.

The GetSat terminals are for commercial and government use and are not intended to be operated by the general public. The terminal is cost prohibitive for purchase by the general public, therefore it will only be operated by trained professional personnel. The antenna installers will be aware of the antenna's radiation environment and use measures best suited to maximize protection to anyone who may come into the proximity of the terminal.

As summarized in the tables below, the MilliSat-W and MilliSat-H antennas meet the FCC's MPE levels for controlled or uncontrolled environments beyond separation distances of about 21 m and 9.5 m, respectively. The MicroSat antenna meets the FCC's MPE levels for contolled or uncontrolled environments beyond separation distances of about 15.2 m and 6.8 m, respectively. Based on these calculations, the MilliSat-W antenna meets the FCC's MPE levels for controlled environments in the far field of the antenna and exceeds the levels in the near field and the transition region, as well as on the main reflector. The Millisat-H and MicroSat antennas exceed the FCC's MPE levels for controlled environments in the near field, far field, and transition region, as well as on the main reflector. Since the antenna of each terminal will be enclosed within a radome, the main reflector and feed flange areas will not be accessible while the antenna is in operation. Training of personnel with access to the terminal would include consideration of the operational modes of the antenna and information on how to prevent radiation exposure, including disabling the communications system. The terminal is not designed to be serviceable in the field. If maintenance of the antenna requiring removal of the radome is necessary, this typically will be done at the manufacturer's facility, by trained technicians who will turn off the transmit power before performing work in these areas.

Additionally, there are various safety features associated with the operation and installation of the terminals that will prevent radiation exposure. The antenna will be installed on vessels, and only at locations not accessible by the general population on the vessels. Given that the antenna will not operate below elevation angles of five degrees, and that the terminal will be pointed upward toward the satellite - persons on the vessel are unlikely to be exposed to the main beam of the antenna. Any areas where the limits for uncontrolled environments could be exceeded will be restricted to trained personnel. Furthermore, the manuals for these terminals will provide warnings regarding potential for radiation hazard, including a label attached to the surface of the terminal warning about the potential for radiation hazard.

The terminals also are designed to cease transmitting if the receive signal from the satellite is blocked, which could be caused by a person standing in front of the terminal or from other blockage. If the receive signal is blocked, the transmitter is shut down nearly instantaneously and will not resume operating until the signal from the satellite is reacquired. In fact there is a double shut down protection in the event that someone or something obstructs the RF path to the satellite. Not only does the terminal automatically turn off its Transmit capability if it loses the satellite Receive signal, i.e. the transmission path is compromised, but the radio frequency amplifier is additionally muted via its monitor and control so that no radio frequency can be transmitted. Especially given the small size of these flat panel antennas and their operational elevation angle, there is a high probability that any person passing close enough to the antenna to be exposed to its main beam would also block the RF path between the terminal and the satellite triggering the automatic shutdown mechanism. As a result of this automatic shutdown mechanism, the maximum continuous time that a person could be exposed to the main beam transmissions at any power level would be significantly less than one second before the antenna would cease transmitting.

Finally, the software interface for the terminals also includes the ability to set up three-dimensional blocking zones that will prevent the terminal from transmitting in certain set directions relative to the terminal's place of installation. This would allow the trained personnel installing and operating the terminal to ensure that the terminal will never transmit when it is pointed at areas where people are likely to be present.

In conclusion, the results of the analysis combined with the design and operational characteristics of the terminals show that the GetSat terminals, in a controlled environment, and under the proper mitigation procedures, meet the guidelines specified in § 1.1310 of the Regulations.

MilliSat-W Terminal

Region	Distance (m)	Calculated Power Density (mW/cm2)	Limit Controlled Environment ≤ 5 mW/cm2	Limit Uncontrolled Environment ≤ 1 mW/cm2
Safe Range for Uncontrolled	≥21.02	1.0	Meets Limit	Meets Limit
Safe Range for Controlled	≥9.40	5.0	Meets Limit	Exceeds Limit
Near Field	6.3	18.91	Exceeds Limit	Exceeds Limit
Far Field	15.0	1.96	Meets Limit	Exceeds Limit
Transition Region	6.3	18.91	Exceeds Limit	Exceeds Limit
Main Reflector	NA	94.81	Exceeds Limit	Exceeds Limit

MilliSat-H Terminal

Region	Distance (m)	Calculated Power Density (mW/cm2)	Limit Controlled Environment ≤ 5 mW/cm2	Limit Uncontrolled Environment ≤ 1 mW/cm2
Safe Range for Uncontrolled	≥21.26	1.0	Meets Limit	Meets Limit
Safe Range for Controlled	≥9.51	5.0	Meets Limit	Exceeds Limit
Near Field	1.8	64.83	Exceeds Limit	Exceeds Limit
Far Field	4.4	23.61	Exceeds Limit	Exceeds Limit
Transition Region	1.8	64.83	Exceeds Limit	Exceeds Limit
Main Reflector	NA	95.58	Exceeds Limit	Exceeds Limit

MicroSat Terminal

Region	Distance (m)	Calculated Power Density (mW/cm2)	Limit Controlled Environment ≤ 5 mW/cm2	Limit Uncontrolled Environment ≤ 1 mW/cm2
Safe Range for Uncontrolled	≥15.23	1.0	Meets Limit	Meets Limit
Safe Range for Controlled	≥6.81	5.0	Meets Limit	Exceeds Limit
Near Field	1.8	64.83	Exceeds Limit	Exceeds Limit

Far Field	4.4	12.11	Exceeds Limit	Exceeds Limit
Transition Region	1.8	64.83	Exceeds Limit	Exceeds Limit
Main Reflector	NA	191.16	Exceeds Limit	Exceeds Limit

III. Detailed Calculations

Millisat-W Terminal

Input Parameter	Value	Units	Symbol	
Antenna Major Axis Dimension	0.5	m	D	
Antenna Transmit Gain @30 GHz	35.4	dBi	G	
Transmit Frequency	30000	MHz	F	
Power Input to the Antenna	16	Watts	P	
Antenna Surface Area	675	cm^2	A	
Antenna Efficiency	0.58	Real	η	
Calculated Parameter	Value	Units	Symbol	Formula
Gain Factor	3467.37	Real	g	10^(G/10)
Wavelength	0.01	m	Λ	300/f
Antenna Field Distances				
Calculated Parameter	Value	Units	Symbol	Formula
Near-Field Distance	6.25	m	Rnf	$D^2/(4\lambda)$
Distance to Far-Field	15.00	m	Rff	$0.6D^2/\lambda$
Distance of Transition Range	6.25	m	Rt	Rt=Rnf
Power Density				
Calculated Parameter	Value	Units	Symbol	Formula
Power Density in the Near Field	18.91	mW/cm^2	Snf	$16\eta P/(\pi D^2)$
Power Density in the Far Field	1.96	mW/cm^2	Sff	$gP/(4\pi Rff^2)$
Power Density in the Transition Region	18.91	mW/cm^2	St	Snf*Rnf/Rt
Power Density at Aperture Surface	94.81	mW/cm^2	Ssurface	4P/A
Distance to 1 mW/cm^2	21.02	m		
Distance to 5 mW/cm^2	9.40	m		

Millisat-H Terminal

Input Parameter	Value	Units	Symbol	
Antenna Major Axis Dimension	0.27	m	D	
Antenna Transmit Gain @30 GHz	35.5	dBi	G	

Input Parameter	Value	Units	Symbol	
Transmit Frequency	30000	MHz	F	
Power Input to the Antenna	16	Watts	P	
Antenna Surface Area	669.6	cm²	A	
Antenna Efficiency	0.58	Real	η	
Calculated Parameter	Value	Units	Symbol	Formula
Gain Factor	3548.13	Real	g	10^(G/10)
Wavelength	0.01	m	Λ	300/f
Antenna Field Distances				
Calculated Parameter	Value	Units	Symbol	Formula
Near-Field Distance	1.82	m	Rnf	$D^2/(4\lambda)$
Distance to Far-Field	4.37	m	Rff	$0.6D^2/\lambda$
Distance of Transition Range	1.82	m	Rt	Rt=Rnf
Power Density				
Calculated Parameter	Value	Units	Symbol	Formula
Power Density in the Near Field	64.83	mW/cm^2	Snf	$16\eta P/(\pi D^2)$
Power Density in the Far Field	23.61	mW/cm^2	Sff	$gP/(4\pi Rff^2)$
Power Density in the Transition Region	64.83	mW/cm^2	St	Snf*Rnf/Rt
Power Density at Aperture Surface	95.58	mW/cm^2	Ssurface	4P/A
Distance to 1 mW/cm2	21.26	m		
Distance to 5 mW/cm2	9.51	m		

MicroSat

Input Parameter	Value	Units	Symbol	
Antenna Major Axis Dimension	0.27	m	D	
Antenna Transmit Gain @30 GHz	32.6	dBi	G	
Transmit Frequency	30000	MHz	F	
Power Input to the Antenna	16	Watts	P	334.8
Antenna Surface Area	334.8	cm²	A	0.03348
Antenna Efficiency	0.58	Real	η	
Calculated Parameter	Value	Units	Symbol	Formula
Gain Factor	1819.70	Real	g	10^(G/10)
Wavelength	0.01	m	Λ	300/f
Antenna Field Distances				

Calculated Parameter	Value	Units	Symbol	Formula
Near-Field Distance	1.82	m	Rnf	$D^2/(4\lambda)$
Distance to Far-Field	4.37	m	Rff	$0.6D^2/\lambda$
Distance of Transition Range	1.82	m	Rt	Rt=Rnf
Power Density				
Calculated Parameter	Value	Units	Symbol	Formula
Power Density in the Near Field	64.83	mW/cm^2	Snf	$16\eta P/(\pi D^2)$
Power Density in the Far Field	12.11	mW/cm^2	Sff	$gP/(4\pi Rff^2)$
Power Density in the Transition Region	64.83	mW/cm^2	St	Snf*Rnf/Rt
Power Density at Aperture Surface	191.16	mW/cm^2	Ssurface	4P/A
Distance to 1 mW/cm^2	15.23	m		
Distance to 5 mW/cm^2	6.81	m		