ISAT US Inc.

Exhibit C – Radiation Hazard Analysis

1.0 Introduction.

The analyses and calculations performed in this Annex 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 specifies 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/cm^2. 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/cm^2. The Occupational MPE is a function of transmit frequency and is for an exposure period of six minutes or less.

2.0 Analysis for the Ka5000 earth station.

The analysis for the Ka5000 earth station antenna provided in this report determines 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.

Section 2.1 – Calculations for Ka5000

Input Parameter	Value	Units
Antenna Diameter	0.3	m
Antenna Transmit Gain	37	dBi
Transmit Frequency	30000	MHz
Antenna Feed Flange Diameter	0.813	cm
Power Input to the Antenna	10	Watts

Calculated Parameter	Value	Units
Antenna Surface Area	0.0707	m^2
Area of Antenna Flange	0.5191	cm^2
Antenna Efficiency	0.5643	real
Gain Factor	5011.8723	real
Wavelength	0.0100	m

Calculated Parameter	Value	Units
Near-Field Distance	2.25	m
Distance to Far-Field	5.4	m

Distance of Transition Range	2.25	m

Calculated Parameter	Value	Units
Power Density in the Near Field	31.9318	mW/cm^2
Power Density in the Far Field	13.6778	mW/cm^2
Power Density in the Transition Region	31.9318	mW/cm^2
Power Density at the Feed Flange	77055.1779	mW/cm^2
Power Density at Main Reflector	56.5901	mW/cm^2
Power Density between Reflector and Ground	14.1475	mW/cm^2

Section 2.2 – Summary and Discussion of Results

Region	Distance (m)	Calculated Power Density (mW/cm^2)	Limit Controlled Environment ≤ 5 mW/cm^2	Limit Uncontrolled Environment ≤ 1 mW/cm^2
Safe Range for Uncontrolled	≥ 20	1.0	meets limit	meets limit
Safe Range for Controlled	≥ 8.9	5.0	meets limit	meets limit
Near Field	2.25	31.9	exceeds limit	exceeds limit
Far Field	5.4	13.7	exceeds limit	exceeds limit
Transition Region	2.25	31.9	exceeds limit	exceeds limit
Feed Flange	N/A	77055	exceeds limit	exceeds limit
Main Reflector	N/A	57	exceeds limit	exceeds limit

The Ka5000 terminal proposed in this application is for commercial and government uses and intended to be operated by professional personnel. As summarized in the above table, the Ka5000 antenna does not meet the FCC's MPE levels for controlled or uncontrolled environments until separation distances of 20 m and 8.9 m respectively. However, given that the antenna will not operate below elevation angles of 5 degrees, its mounting location on the tail of the aircraft (approximately 8 meters from the ground), and that the terminal will be pointed upward toward the satellite, persons on the ground near the aircraft are highly unlikely to be exposed to the main beam of the antenna, and therefore the levels of power density will be significantly reduced from 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. Therefore, the levels of power density will be significantly reduced from those calculated. In addition, the antenna will be enclosed within a radome during operation. Therefore, the feed flange and main reflector, where the levels are highest, will not be physically accessible. When maintenance of the antenna is required, the trained technicians will turn off the transmit power before removing the radome and performing maintenance activities. Training of personnel with access to the antenna will include consideration of the operation mode of the antenna and information on how to prevent radiation exposure, including disabling the communications system.

Furthermore, the manuals for these terminals will provide warnings regarding potential for radiation hazard, including a diagram showing the regions around the terminal where the radiation levels could exceed the maximum radiation exposure limit specified in 47 CFR §1.1310 Table 1, Finally, a label will be attached to the surface of the terminal warning about the potential for radiation hazard, in accordance with §25.228(d).

The terminal is also 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.

In conclusion, the results show that the Ka5000 antenna, while in motion or in a controlled environment, and under the proper mitigation procedures, meets the guidelines specified in § 1.1310 of the Commission's Rules.

3.0 Analysis for the GetSAT Milli-EX earth station.

The analysis for the GetSAT Milli-EX antenna provided in this report determines the power flux density levels of the earth station in the 1) far-field, 2) near-field, 3) transition region, and 4) at the aperture surface.

Section 3.1 – Calculations for GetSAT Milli-EX

Input Parameter	Value	Units
Antenna Major Axis Dimension	0.48	m
Antenna Transmit Gain @ 30 GHz	38.2	dBi
Transmit Frequency	30000	MHz
Power Input to the Antenna	12	Watts
Antenna Surface Area	975.63	cm^2
Antenna Efficiency	0.58	real

Calculated Parameter	Value	Units
Gain Factor	6606.9345	real
Wavelength	0.0100	m

Calculated Parameter	Value	Units

Near-Field Distance	5.76	m
Distance to Far-Field	13.824	m
Distance of Transition Range	5.76	m

Calculated Parameter	Value	Units
Power Density in the Near Field	15.3850	mW/cm^2
Power Density in the Far Field	3.3014	mW/cm^2
Power Density in the Transition Region	15.3850	mW/cm^2
Power Density at Aperture Surface	49.1990	mW/cm^2

Section 3.2 – Summary and Discussion of Results

Region	Distance (m)	Calculated Power Density (mW/cm^2)	Limit Controlled Environment ≤ 5 mW/cm^2	Limit Uncontrolled Environment ≤ 1 mW/cm^2
Safe Range for Uncontrolled	≥ 25.11	1.0	meets limit	meets limit
Safe Range for Controlled	≥ 13.824	5.0	meets limit	meets limit
Near Field	5.76	15.385	exceeds limit	exceeds limit
Far Field	13.824	3.30	meets limit	exceeds limit
Transition Region	5.76	15.385	exceeds limit	exceeds limit
Aperture Surface	N/A	49.199	exceeds limit	exceeds limit

The analysis of the non-ionizing radiation levels presumes the maximum allowed input power to antenna of 12 W 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 12 W 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, which 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 Milli-EX terminal, as it utilizes a small, flat panel antenna that results in tighter beam-forming, concentrating the transmitted power in a smaller area around the main beam and 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 Milli-EX terminal is for commercial and government use and is 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 table above, the GetSAT Milli-EX terminal meets the FCC's MPE levels for controlled or uncontrolled environments beyond separation distances of about 13.9 m and 25.1 m, respectively. Based on these calculations, the GetSAT Milli-EX terminal 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 aperture surface. The terminal has the capability to exceed the FCC's MPE levels for uncontrolled environments in the near field, far field and transition regions and at the aperture surface. Since the antenna of each terminal will be enclosed within a radome, the aperture surface areas will not be accessible while the antenna is in operation. Training of personnel with access to the terminal will 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 terminal that will prevent radiation exposure. The antenna will be installed on aircraft, and only at locations not accessible by the general population near the aircraft. As the antenna will not operate below elevation angles of five degrees, and the terminal will be pointed upward toward the satellite, persons near the aircraft at ground level are unlikely to be exposed to the main beam of the antenna. Personnel will be trained to install and operate the terminal in a manner to ensure that any location where prolonged operation will occur is limited to locations such that areas where the limits for uncontrolled environments could be exceeded will be restricted to trained personnel. Furthermore, the manuals for this terminal 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, and a diagram showing the regions around the terminal where the radiation levels could exceed the maximum radiation exposure limit specified in 47 CFR §1.1310 Table 1, in accordance with the provisions of §25.228(d).

The terminal is also 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 terminal 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 terminal show that the GetSAT Milli-EX terminal, operating while in-motion, or when located in a controlled environment, and under the proper mitigation procedures, meet the guidelines specified in § 1.1310 of the Regulations.