ISAT US Inc.

FCC Form 312 Exhibit C

Radiation Hazard Analysis

I. Introduction

This Exhibit analyzes the non-ionizing radiation levels for the three Tampa Microwave 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, and 3) transition region. 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 Tampa terminals. The analysis of the non-ionizing radiation levels, provided in Section 3, assumed the maximum allowed input power to antenna of 4W 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 4W 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 Tampa terminals, as they utilize small, dish antennas that result in a very narrow 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 Tampa 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 Tampa 65 antenna meets the FCC's MPE levels for uncontrolled or controlled environments beyond separation distances of about 32.14 m and 14.37 m, respectively. The Tampa 95 antenna meets the FCC's MPE levels for uncontrolled or controlled environments beyond separation distances of about 45.45 m and 20.32m, respectively. The Tampa 130 antenna meets the FCC's MPE levels for uncontrolled or controlled environments beyond separation distances of about 84.44 m and 37.76 m, respectively. Based on these calculations, the Tampa 65 antenna meets the FCC's MPE levels for controlled environments in the near field, far field and the transition region of the antenna and exceeds the MPE levels for uncontrolled environments in the near field, far field and the transition region of the antenna. The Tampa 95 antenna meets the FCC's MPE levels for controlled environments in the near field, far field, and transition region, and meets the MPE levels for uncontrolled environments in the far field region and exceeds the MPE levels for uncontrolled environments in the near field and transition regions. The Tampa 130 antenna meets the FCC's MPE levels for both controlled and uncontrolled environments in the near field, far field and the transition regions of the antenna. 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.

Additionally, there are various safety features associated with the operation and installation of the terminals that will prevent radiation exposure. For example, the terminals 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 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.

The antenna will be operated only at locations not accessible by the general population. 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 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.

In conclusion, the results of the analysis combined with the design and operational characteristics of the terminals show that the Tampa terminals, when deployed, and used under the proper mitigation procedures, meet the guidelines specified in § 1.1310 of the Regulations.

Tampa 65 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	≥32.14	1.0	Meets Limit	Meets Limit
Safe Range for Controlled	≥14.37	5.0	Meets Limit	Exceeds Limit
Near Field	10.56	2.80	Meets Limit	Exceeds Limit
Far Field	25.35	1.61	Meets Limit	Exceeds Limit
Transition Region	10.56	2.80	Meets Limit	Exceeds Limit

Tampa 95 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	≥45.45	1.0	Meets Limit	Meets Limit
Safe Range for Controlled	≥20.32	5.0	Meets Limit	Exceeds Limit
Near Field	22.56	1.31	Meets Limit	Exceeds Limit
Far Field	54.15	0.70	Meets Limit	Meets Limit
Transition Region	22.56	1.31	Meets Limit	Exceeds Limit

Tampa 130 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	≥84.44	1.0	Meets Limit	Meets Limit
Safe Range for Controlled	≥37.76	5.0	Meets Limit	Exceeds Limit
Near Field	42.25	0.70	Meets Limit	Meets Limit
Far Field	101.40	0.69	Meets Limit	Meets Limit
Transition Region	42.25	0.70	Meets Limit	Meets Limit

III. Detailed Calculations

Tampa 65 Terminal

Input Parameter	Value	Units	Symbol
Antenna Major Axis Dimension	0.65	m	D
Antenna Transmit Gain @30 GHz	45.11	dBi	G
Transmit Frequency	30000	MHz	F
Power Input to the Antenna	4	Watts	P
Antenna Efficiency	0.58	Real	η

Calculated Parameter	Value	Units	Symbol	Formula
Gain Factor	32433.96	Real	g	10^(G/10)
Wavelength	0.01	m	λ	300/f

Antenna Field Distances

Calculated Parameter	Value	Units	Symbol	Formula
Near-Field Distance	10.56	m	Rnf	$D^2/(4\lambda)$
Distance to Far-Field	25.35	m	Rff	$0.6D^2/\lambda$
Distance of Transition Range	10.56	m	Rt	Rt=Rnf

Power Density

Calculated Parameter	Value	Units	Symbol	Formula
Power Density in the Near Field	2.80	mW/cm^2	Snf	$16\eta P/(\pi D^2)$
Power Density in the Far Field	1.61	mW/cm^2	Sff	$gP/(4\pi Rff^2)$
Power Density in the Transition Region	2.80	mW/cm^2	St	Snf*Rnf/Rt

Distance to 1 mW/cm^2	32.14	m
Distance to 5 mW/cm^2	14.37	m

Tampa 95 Terminal

Input Parameter	Value	Units	Symbol
Antenna Major Axis Dimension	0.95	m	D
Antenna Transmit Gain @30 GHz	48.12	dBi	G
Transmit Frequency	30000	MHz	F
Power Input to the Antenna	4	Watts	P
Antenna Efficiency	0.58	Real	η

Calculated Parameter	Value	Units	Symbol	Formula
Gain Factor	64863.44	Real	g	10^(G/10)
Wavelength	0.01	m	λ	300/f

Antenna Field Distances

Calculated Parameter	Value	Units	Symbol	Formula
Near-Field Distance	22.56	m	Rnf	$D^2/(4\lambda)$
Distance to Far-Field	54.15	m	Rff	$0.6D^2/\lambda$
Distance of Transition Range	22.56	m	Rt	Rt=Rnf

Power Density

Calculated Parameter	Value	Units	Symbol	Formula
Power Density in the Near Field	1.31	mW/cm^2	Snf	$16\eta P/(\pi D^2)$
Power Density in the Far Field	0.70	mW/cm^2	Sff	$gP/(4\pi Rff^2)$
Power Density in the Transition Region	1.31	mW/cm^2	St	Snf*Rnf/Rt

Distance to 1 mW/cm2	45.45	m
Distance to 5 mW/cm2	20.32	m

Tampa 130 Terminal

Input Parameter	Value	Units	Symbol	
Antenna Major Axis Dimension	1.3	m	D	
Antenna Transmit Gain @30 GHz	53.5	dBi	G	
Transmit Frequency	30000	MHz	F	
Power Input to the Antenna	4	Watts	P	334.8
Antenna Efficiency	0.58	Real	η	

Calculated Parameter	Value	Units	Symbol	Formula
Gain Factor	223872.11	Real	g	10^(G/10)
Wavelength	0.01	m	λ	300/f

Antenna Field Distances

Calculated Parameter	Value	Units	Symbol	Formula
Near-Field Distance	42.25	m	Rnf	$D^2/(4\lambda)$
Distance to Far-Field	101.40	m	Rff	$0.6D^2/\lambda$
Distance of Transition Range	42.25	m	Rt	Rt=Rnf

Power Density

Calculated Parameter	Value	Units	Symbol	Formula
Power Density in the Near Field	0.70	mW/cm^2	Snf	$16\eta P/(\pi D^2)$
Power Density in the Far Field	0.69	mW/cm^2	Sff	$gP/(4\pi Rff^2)$
Power Density in the Transition Region	0.70	mW/cm^2	St	Snf*Rnf/Rt

Distance to 1 mW/cm^2	84.44	m
Distance to 5 mW/cm^2	37.76	m