APPLICATION FOR BLANKET LICENSED EARTH STATIONS

I. OVERVIEW

In this application, Skylo Technologies Inc ("Skylo") seeks a blanket license authorizing operation of up to 1,000,000 earth stations that end-user customers will utilize to communicate through the Inmarsat 4-F3 satellite located at 97.6° W and the Skyterra 1 satellite located at 101.3° W. These earth stations will transmit in the 1.6265-1.6605 GHz band and receive in the 1.525-1.559 GHz band. The Commission's rules specifically contemplate blanket licensing for earth stations operating in these frequency bands[1]. Skylo seeks authority to deploy and operate these earth stations throughout the contiguous United States, Alaska, Hawaii, Puerto Rico, and the U.S. Virgin Islands. As a subset of these frequencies falls in the public safety bands, Skylo operations will conform to the Table of Frequency Allocations and not operate in the public safety bands.

Below, we show that grant of this application would serve the public interest. Then, we provide technical information to supplement the information provided on Form 312.

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[1] See 47 C.F.R. § 25.115(d).

II. GRANT OF THIS APPLICATION WOULD SERVE THE PUBLIC INTEREST

Skylo was founded by a team focused on bringing low cost, ubiquitous, narrow band connectivity to the 15B devices coming online globally by 2024, with a significant percentage of these being in areas that do not have cellular coverage. Granting this application would serve the public interest by helping to enable a low latency, 3GPP standards-based, narrow band deployment of the Internet of Things (NB-IoT) throughout the United States, territories and surrounding waters by authorizing Skylo mobile User Terminals (UT) that can bring millions of connected sensors and across a range of Industrial IoT applications to provide connectivity between these devices and user platforms.

The global growth in IoT demand is projected to grow to over 24 billion devices by the end of the decade. However, cellular coverage is predicted to geographically expand at a fraction of that, if at all. And, most broadband providers are focused on higher ARPU, higher density areas, where 5G deployments and fiber are prevalent. Skylo Technologies is focused on those solutions that have been traditionally analog, looking to bring digitization and the power of data to increase efficiency, yield, and reduce operational costs. We have a tried and tested end-to-end solution in key verticals, such as maritime, agriculture, and logistics, where simple tracking, messaging and sensor integration are providing valuable insights to users. For example:

1. Skylo Technologies can be used on fishing vessels, far outside of cellular or VHF radio coverage, helping to monitor and measure fish catch reporting, and providing a virtual tether to family back on land. This not only helps with sustainable catch reporting, but

also allows fleet owners complete visibility of their boats to ensure safe navigation in domestic waters with simple geofence solutions.

2. External sensors, such as soil pH can be integrated to measure the health of farmlands, helping to match the crop with soil. Additionally, by measuring soil moisture, we can match water levels, ensuring precise use of this precious resource. Tractor owners can monitor their equipment at all times and benefit from cloud-compute resources available to them at a fractional cost of legacy solutions. Skylo is a proud and active participant of the FCC Agriculture Task Force to support our nation's farmers.
3. Trucking is one of the backbones of the United States, with the U.S. having the most paved roads globally. However, there are still thousands of miles of roads that don't have cellular coverage - largely in rural and remote areas. With the increase in e-commerce and the need to match demand & supply in real-time, logistics companies require cost-effective & reliable data over 100% of the routes. Skylo is able to bring NB-IoT connectivity to the truck and connected sensors therein and the truckers, providing more than just visibility into location. Our cost-effective solution can provide a two-way, constant communication to drivers without the need for a large or complex install on their vehicle, alerting others in the event of a breakdown, or simply sending a message with important status updates. Integrating external sensors can help with the transport of vital temperature-regulated drugs, such as COVID vaccines.

Skylo is field proven and is providing a self-install, cost effective solution to provide connectivity to the billions of devices coming online by the end of the decade. Our users and the developer community for IoT are constantly building new use cases with our APIs, and leveraging our end to end, full stack solution, akin to the early days of the Internet. The Skylo Solution will deliver affordable 3GPP standards-based NB-IoT connectivity across the entirety of the US. This application seeks authority for an affordable, portable, end user terminal for ubiquitous connectivity. To this extent, Skylo recently renewed its experimental license through June 1, 2022 to continue testing the functionality of its device. The grant of a full commercial license will allow Skylo to connect rural communities in need of the Skylo Service. Accordingly, an expeditious grant of this application would greatly serve the public interest.

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Respectfully submitted,

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TECHNICAL ANNEX

In this Technical Annex, Skylo provides additional information on the proposed operations of its blanket-licensed earth stations to supplement the data provided in Schedule B to Form 312 filed with this narrative application.

A. Power and Gain Figures

The proposed user terminal is a flat, phased array capable of steering its beams toward the xxx satellites. The highest transmit power (10.0 W) occurs at maximum slant, while the lowest transmit power (3.16 W) occurs at boresight. The highest EIRP for all carriers is 10 dBw with a minimum 4 dBw to meet BER. Highest antenna gain is 8 dBi with the minimum required to meet BER at 2dBi. For purposes of Form 312 accompanying this application, In every case, Skylo has supplied the higher transmit power figures and lower gain figures in order to present worst-case conditions.

B. Frequencies to be used

The terminal uses 2 MHz of spectrum as defined in the application. The specific Mobile Satellite Service frequencies will be in the following ranges:

DIRECTION	FREQUENCY START (MHZ)	FREQUENCY STOP (MHZ)
Earth to Space	1626.5	1660.5
Space to Earth	1525	1559

C. Radiation Hazard Exhibit

RF Exposure Analysis of Skylo-1 Terminal

1. Introduction

This report analyzes the non-ionizing radiation levels of the 0.2M Skylo-1 earth station (ES) terminal.

The FCC's Office of Engineering Technology's (OET) Bulletin No. 65 specifies there are two separate tiers of exposure limits that are dependent upon the situation in which the exposure takes place and/or the status of the individuals who are subject to the exposure. The two tiers are General Population/Uncontrolled environment and an Occupational/Controlled environment. Because the environment is controlled and any potential exposure is of a transitory nature, the limits for Occupational/Controlled exposures are assumed to apply. Accordingly, this analysis discusses only the Maximum Permissible Exposure (MPE) limit for those types of exposures, which is a power density equal to 5 mW/cm^2 averaged over a six-minute period.

2. Earth Station Terminal Description

The ES terminal transmits bursts of information at designated times that are assigned to the terminal by the network. The length and carrier frequency of each transmission burst depend on the ES terminal's traffic requirements. In normal operation, the ES terminal transmits burst traffic to the network with a normal duty cycle of less than 2%.

The ES terminal is an M2M terminal which operates at low transmit power and very low duty cycle. It operates using the NB-IoT protocol, which is a solicit and respond protocol, meaning the ES terminal is not capable of transmitting unless it has been signaled by the base station or core network. The ES terminal is not commercially enabled to operate in continuous transmission modes. The ES terminal performs local watchdog monitoring and is able to self reset and heal operational failures, additionally the ES terminal can be remotely deactivated over its satellite connection.

3. Explanation of Analysis

The below analysis uses OET Bulletin 65 for continuous transmission. However, within Skylo's network, the terminals will transmit in short bursts of data periodically rather than continuous transmission.

4. Results & Conclusions

The ES terminals satisfy Commission requirements as the terminals do not exceed the MPE limit of 1 mW/cm^2 averaged over thirty-minute period when operated in the network as designed. In particular, a fail-safe feature greatly reduces the chance of human exposure between the feed and the reflector surface: a small blockage in this area is sufficient to cause transmissions to cease. If the down link (receive signal) is interrupted by an object in this area, the uplink (transmit signal) is shut down in less than 10 seconds and the receiver down link recovery time is 10 seconds. The uplink will remain off until the blockage is removed and the downlink recovery is complete. This feature, coupled with the terminal's non-continuous operation, ensures that the general population will not be exposed to harmful levels of radiation that exceed Commission standards.

The most likely duty cycle, 1%, meets the Occupational/Controlled MPE limit (5 mW/ cm^2 over 6-minute period) for each antenna.

This radiation hazard analysis demonstrates the Skylo ES terminals will not result in exposure levels exceeding the allowable radiation exposure limits.

5. Radiation Hazard Analysis

The following tables present the results from the radiation hazard analysis for the Skylo ES antenna. Yellow shaded values indicate calculated fields.

Table 1. Skylo-1 Antenna

Parameter	Unit	1% Duty Cycle (for normal operations)	2% Duty Cycle (for normal operations)
Diameter of antenna	m	0.2	0.2
Frequency	GHz	1.64	1.64
λ (wavelength)	m	0.183	0.183
Far Field length	m	0.131	0.131
Near Field length	m	0.0547	0.0547
Efficiency, η		0.133	0.133
Transmitter Gain	dBi	3	3
Max Transmitter power (at slant)	W	10.00	10.00
Min Transmitter power (at boresite)	W	3.16	3.16
Duty Cycle	%	1	2
Min Transmitter Gain (at slant)	dBi	3	3
Physical Area of the Aperture Antenna	m^2	0.023	0.023
Power Density in Far Field (Boresight Direction)	mW/cm^2	0.0865	0.173
Power Density in Near Field	mW/cm^2	0.125	0.249
Power Density at Antenna Surface	mW/cm^2	0.545	1.09
Power Density in Transition Region	mW/cm^2/R_t	0.00395	0.00791

Definition of terms

The terms are used in the formulas here are defined as follows:

$S_{surface}$ = maximum power density at the antenna surface
S_{nf} = maximum near-field power density
S_t = power density in the transition region
S_{ff} = power density (on axis)
R_{nf} = extent of near-field
R_{ff} = distance to the beginning of the far-field
R_t = distance to point of interest between near-field and far-field regions in cm
$P = 10\ W$ power fed to the antenna in Watts
$A = 0.04\ m^2$ physical area of the aperture antenna
$G = 3\ dBi$ antenna gain relative to an isotropic radiator
$D = 0.2\ m$ diameter of antenna in meters
$F = 1.64\ GHz$ frequency in GHz
$\lambda = 0.183\ m$ wavelength in meters
$\eta = 0.133$ aperture efficiency
$D_C = 0.01$ duty cycle of 1%

Antenna Surface. The maximum power density directly in front of an antenna (e.g., at the antenna surface) can be approximated by the following equation:

$S_{surface} = (4 * D_C * P) / A$
$= (4 * 0.01 * 10\ W) / 0.04\ m^2$
$= 0.316\ mW/cm^2$

Near Field Region. In the near-field or Fresnel region, of the main beam, the power density can reach a maximum before it begins to decrease with distance. The extent of the near field can be described by the following equation (**D** and λ in same units):

$R_{nf} = D^2 / (4 * \lambda)$
$= (0.2\ m)^2 / (4 * 0.183\ m)$
$= 0.0547\ m$

The magnitude of the on-axis (main beam) power density varies according to location in the near field. However, the maximum value of the near-field, on-axis, power density can be expressed by the following equation:

$S_{nf} = (16 * D_C * \eta * P) / (\pi * D^2)$
$= (16 * 0.01 * 0.133 * 10\ W) / (\pi * (0.2\ m)^2)$
$= 0.042\ mW/cm^2$

Transition Region. Power density in the transition region decreased inversely with distance from the antenna, while power density in the far field (Fraunhofer region) of the antenna decreased inversely with the square of the distance. The transition region will then be the region extending from R_{nf} to R_{ff}. If the location of interest falls within this transition region, the on-axis power density can be determined from the following equation:

$S_t = (S_{nf} * R_{nf}) / R_t$
$= (0.042\ mW/cm^2 * 5.47\ cm) / R_t\ (cm)$
$= (0.0023\ mW/cm) / R_t\ (cm)$ where R_t is the location of interest in centimeters

Far-Field Region. The power density in the far-field or Fraunhofer region of the antenna pattern decreased inversely as the square of the distance. The distance to the start of the far field can be calculated by the following equation:

$R_{ff} = (0.6 * D^2) / \lambda$
$= (0.6 * (0.2\ m)^2) / 0.183\ m$
$= 0.131\ m$

The power density at the start of the far-field region of the radiation pattern can be estimated by the equation:

$S_{ff} = (D_C * P * G) / (4 * \pi * R_{ff}^2)$
$= (0.01 * 10\ W * 2) / (4 * \pi * (0.131\ m)^2)$
$= 0.0292\ mW/cm^2$