SES-STA-20150824-00551 IB2015001559
Spaceflight, Inc.

Approved by OMB
3060–0678

APPLICATION FOR EARTH STATION SPECIAL TEMPORARY AUTHORITY

APPLICANT INFORMATIONEnter a description of this application to identify it on the main menu:
SHERPA earth station STA – Wallops

1. Applicant

Name:	Spaceflight, Inc.	**Phone Number:**	202–262–1825
DBA Name:		**Fax Number:**	
Street:	PO Box 1922	**E–Mail:**	IHornsby@SpaceflightIndustries.com
City:	Bellevnue	**State:**	WA
Country:	USA	**Zipcode:**	98009 –
Attention:	Ms Indra Hornsby		

GRANTED
International Bureau

File # SESSTA20150824-00551
Call Sign _____ Grant Date 11-22-16
(or other identifier)
Term Dates
From: 11-23-16 To: 5-24-17
Approved: Paul E Blais

GRANTED
International Bureau

File # SES-STA-20150824-00551
Call Sign _____ Grant Date 11-22-16
(or other identifier)
Term Dates
From: 11-23-16 To: 5-21-17
Approved: Paul Eldridge

Applicant: Spaceflights, Inc.
File No.: SES-STA-20150824-00551
Call Sign: None
Special Temporary Authority

Spaceflights, Inc., is granted special temporary authority, for 180 days from November 23, 2016 to May 21, 2017, to operate a fixed earth stations in Wallops Island, Virginia, to provide space operation communications to the SHERPA spacecraft as it deploys approximately 90 small spacecraft in low Earth orbit over the course of a twelve-hour operational period. Spaceflight Inc. seeks authority to use center frequencies 401.5 MHz (space-to-Earth) and 450.2 MHz (Earth-to-space) for space operation communications, under the following conditions;

1. Spaceflight, Inc. must coordinate with the local Society of Broadcast Engineers (SBE) coordinators for the uplink transmissions to the satellite for 450.1 MHz.

2. Operations on a non-interference basis only.

3. Operations on a non-protected basis only.

4. In the event that there is a report of interference, Spaceflight, Inc. must immediately terminate transmissions and notify the FCC in writing.

5. Spaceflight must ensure that radio-frequency operations with SHERPA will occur during times that will not interfere with Meteorological Satellite operations, in accordance with the conditions set forth in the SHERPA spacecraft grant of special temporary authority, IBFS File No. SAT-STA-20160821-00060.

6. Grant of this authorization is without prejudice to any determination that the Commission may make regarding any other pending or future Spaceflight Inc.'s applications.

7. Transmitter(s) must be turned off during antenna maintenance to ensure compliance with the FCC-specified safety guidelines for human exposure to radiofrequency radiation in the region between the antenna feed and the reflector. Appropriate measures must also be taken to restrict access to other regions in which the antennas' power flux-density levels exceed the specified guidelines.

8. Spaceflight, Inc. shall take extraordinary measures to ensure that the antenna does not create the potential for exposure of persons who may be within the immediate vicinity of radiofrequency radiation in excess of FCC safety guideline to prevent human exposure in excess of the FCC-specified safety limits. Warning signs, such as those discussed in the FCC's OET Bulletin 65, shall be posted informing members of the public to keep outside the exposure area that exceeds limit.

9. Any action taken or expense incurred as a result of operations pursuant to this special temporary authority is solely at Spaceflight, Inc.'s own risk.

2. Contact

Name:	Jonathan L. Wiener	**Phone Number:**	202-429-4900
Company:	Goldberg Godles Wiener & Wright LLP	**Fax Number:**	202-429-4912
Street:	1229 19th Street, NW	E-Mail:	jwiener@g2w2.com
City:	Washington	**State:**	DC
Country:	USA	**Zipcode:**	20036 -2413
Attention:		**Relationship:**	Legal Counsel

(If your application is related to an application filed with the Commission, enter either the file number or the IB Submission ID of the related application. Please enter only one.)
3. Reference File Number or Submission ID

4a. Is a fee submitted with this application?
◉ If Yes, complete and attach FCC Form 159. If No, indicate reason for fee exemption (see 47 C.F.R.Section 1.1114).
○ Governmental Entity ○ Noncommercial educational licensee
○ Other(please explain):

4b. Fee Classification CGX – Fixed Satellite Transmit/Receive Earth Station

5. Type Request

○ Use Prior to Grant ○ Change Station Location ◉ Other

6. Requested Use Prior Date
01/15/2016

7. CityWallops Island	8. Latitude (dd mm ss.s h) 37 51 18.0 N
9. State VA	10. Longitude (dd mm ss.s h) 75 30 47.0 W

11. Please supply any need attachments.

Attachment 1: Request for STA Attachment 2: Rad Haz Attachment 3:

12. Description. (If the complete description does not appear in this box, please go to the end of the form to view it in its entirety.)

Spaceflight Inc., pursuant to Section 25.120 of the Commission's Rules, hereby requests Special Temporary Authority to permit it to communicate with a spacecraft, known as SHERPA, and corresponding earth stations for a duration of up to twelve (12) hours to take place in a single occurrence between January 15, 2016 and April 15, 2016.

13. By checking Yes, the undersigned certifies that neither applicant nor any other party to the application is subject to a denial of Federal benefits that includes FCC benefits pursuant to Section 5301 of the Anti-Drug Act of 1988, 21 U.S.C. Section 862, because of a conviction for possession or distribution of a controlled substance. See 47 CFR 1.2002(b) for the meaning of "party to the application" for these purposes.

(●) Yes ( ) No

14. Name of Person Signing Indra Hornsby	15. Title of Person Signing General Counsel

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THE FOREGOING NOTICE IS REQUIRED BY THE PAPERWORK REDUCTION ACT OF 1995, PUBLIC LAW 104–13, OCTOBER 1, 1995, 44 U.S.C. SECTION 3507.

REQUESTS FOR SPECIAL TEMPORARY AUTHORITY

Spaceflight Inc. ("Spaceflight"), pursuant to Section 25.120 of the Commission's Rules, hereby requests Special Temporary Authority ("STA") to permit it to communicate with a spacecraft, known as SHERPA, and corresponding earth stations for a duration of up to twelve (12) hours to take place in a single occurrence between January 15, 2016 and April 15, 2016.[1]

As described in greater detail in the attached Technical Annex, SHERPA is a non-propulsive, free-flying spacecraft intended to deploy auxiliary spacecraft from each of five ports. SHERPA itself is proposed to be affixed to the payload on a Falcon 9 launch that is currently scheduled to occur within above-stated launch period. SHERPA will be placed in a sun synchronous elliptical orbit of 720 x 450 km, 97.4 degree inclination. After its deployment from the launch vehicle, SHERPA will initiate a sequence of procedures to begin the deployment of its own payload and the communication that is the subject of the instant requests will commence.

Spaceflight seeks authority to permit it to establish communications between SHERPA and three earth stations during the twelve-hour operational of the SHERPA payload.[2] The communications links, which will consist of two-way data transmissions, will permit the Spaceflight technical crew to track the launch and download status information from SHERPA. The proposed frequencies for communication to and from SHERPA are UHF frequencies authorized under the FCC's Table of Frequency Allocations for space operations.

The payload of SHERPA will consist of small spacecraft that are owned and to be operated by Spaceflight's customers. Each customer is expressly required under its agreement with Spaceflight to obtain all licenses, authorization, clearances, and permits that may be necessary to operate its individual spacecraft.

Spaceflight asserts that grant of the instant requests for Special Temporary Authority will be in the public interest. Such grant will permit Spaceflight to initiate a new and innovative deployment technology for small spacecraft, thereby providing a cost-efficient means for placing them into their designed orbits.

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[1] Recent developments in the spacecraft launch industry have resulted in a number of launch delays and uncertainties as to when future launches will occur. The timeframe set forth above reflects the current launch period assigned for the Spaceflight launch. Spaceflight has not yet been assigned an exact date of the SHERPA launch. Accordingly, Spaceflight is herein seeking STA to cover a period of three (3) months. However, as described herein, the actual communications for which STA is sought will occur over a period of only twelve (12) hours. Spaceflight will notify the Commission as its launch period is narrowed to a particular day as soon as that information is confirmed to it by the launch provider.

[2] Spaceflight is submitting concurrently unique applications for space station STA to cover the communications of SHERPA and earth station STA to cover the ground station locations.

Technical Annex: Spaceflight SHERPA Spacecraft Description

The Spaceflight SHERPA spacecraft is a non-propulsive, free-flying spacecraft intended to deploy auxiliary spacecraft from each of five ports. The spacecraft is primarily composed of commercial off the shelf (COTS) hardware, with the core structure being a custom ESPA Grande ring. Auxiliary satellites are integrated to each port using simple plates and separated using proven separation systems, such as the Planetary Systems Corporation (PSC) Motorized Lightband (MLB) and the Innovative Solutions in Space (ISIS) QuadPack. The configuration, shown in Figure 1, is intended to deploy three microsatellites using MLBs as well as several CubeSats and nanosatellites from twenty-one (21) QuadPack dispensers. Each QuadPack holds 12U worth of CubeSat payload. A CubeSat, based on the Cal Poly CubeSat standard, has nominal dimensions 10 x 10 x 10 cm. SHERPA runs flight software on COTS Andrews Space CORTEX avionics and it is equipped with its own power and power distribution system to deploy each auxiliary spacecraft in a pre-programmed sequence. The primary mission is satisfied by successful deployment of each auxiliary payload. The confirmation of successful payload deployment is given by the transmission of telemetry containing SHERPA state vectors taken upon each discrete deployment event.

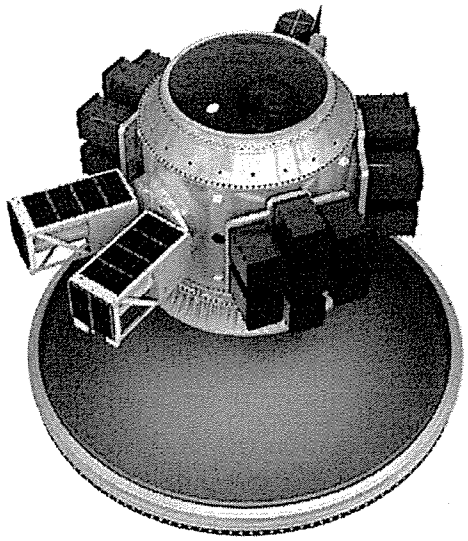

Figure 1. SHERPA Spacecraft shown integrated with the Payload Attach Fitting (below) and the Primary Payload Adapter (above)

The SHERPA mission itself is expected to last approximately twelve (12) hours. At launch, SHERPA is integrated beneath the primary payload. The primary payload is launched into 720 km circular sun synchronous orbit and then separated. The upper stage, with SHERPA attached, executes a maneuver to lower the perigee of the orbit to 450 km and change the inclination to 97.4 degrees. At this orbit, SHERPA is separated from the upper stage. The separation event activates the SHERPA spacecraft through the closing of separation switches, which will turn on for the first time. After initialization, SHERPA begins a pre-programmed sequence of deployments. No uplink is necessary to begin deployments. For each deployment event time, position, and velocity (determined via GPS receiver) are logged in the form of a state vector to be transmitted. Upon completion of deployments, SHERPA transmits the telemetry to a ground station. SHERPA's communication system utilizes an onboard UHF radio with 4 antenna.

SHERPA batteries are expected to last for duration less than 20 hours until they're expended. Ultimately, SHERPA de-orbits through orbital decay due to atmospheric drag approximately 20 years after launch.

Location	SHERPA (space segment)	North Pole, Alaska	Tukwila, Washington	NASA Wallops
Link direction	Downlink	Uplink	Uplink	Uplink
Antenna Manufacturer	Spaceflight Systems Inc	M2 Antenna Systems Inc	M2 Antenna Systems Inc	MIT Lincoln Labs
Antenna Model	n/a	450CP34	450CP34	n/a
Antenna Size	n/a	3.05-m boom length	3.05-m boom length	18.3-m diameter
Number of Antennas	1	1	1	1
Address, City, State	Mobile, LEO Orbit: 720 x 450 km, 97.4° inclination	1625 Richardson Highway, North Pole, Alaska	3415 S 116th St #123, Tukwila, WA	Building U-25, Mainland Road Wallops Island, VA 23337
Lat/Long coordinates in minutes,seconds	Mobile, LEO	64° 47' 37.0" N, 147° 32' 10.8" W	47° 29' 55.44" N, 122° 17' 23.64" W	37° 51' 18" N 75° 30' 47" W
Site Elevation AMSL	Mobile, LEO	144 m AMSL	15.9 m AMSL	12.6 m AMSL
Frequencies	401.5 MHz	450.2 MHz	450.2 MHz	450.2 MHz
Output Power (W)	2 W	5 W	5 W	8 W
ERP (W)	2.07 W	63 W	63 W	15,310 W
Frequency tolerance	*	*	*	*
Emissions (bandwidth of signal plus emission type)	825KG1D	27K6G1D	27K6G1D	27K6G1D
Modulating Signal	A single channel containing digital information	A single channel containing digital information	A single channel containing digital information	A single channel containing digital information

*In lieu of frequency tolerance, the occupied bandwidth of the emission shall not extend beyond the band limits set

Analysis of Non-Ionizing Radiation for a 18.3 Meter Dish Antenna Earth Station System

This report analyzes the non-ionizing radiation levels for a 18.3 meter earth station system. The analysis and calculations performed in this report comply with the methods described in the FCC Office of Engineering and Technology's General RF Exposure Guidance, 447498 D01 v05r02. The radiation safety limits used in the analysis are in conformance with Title 47 Chapter I, Subchapter A, Part 1, Subpart I, Section 1.1310. Section 1.1310 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 thirty 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, and between the antenna edge and the ground and to compare these levels to the specified MPEs.

Table 1. Limits for General Population/Uncontrolled Exposure (MPE)

Frequency Range (MHz)	Power Density (mW/cm^2)
0.3 - 1.34	100
1.34 - 30	180/Frequency(MHz)^2
30-300	0.2
300-1500	Frequency(MHz)/1500
1500-100,000	1

Table 2. Limits for Occupational/Controlled Exposure (MPE)

Frequency Range (MHz)	Power Density (mW/cm^2)
0.3-3.0	100
3.0-30	900/Frequency(MHz)^2
30-300	1
300-1500	Frequency(MHz)/300
1500-100,000	5

Table 3. Formulas and Parameters Used for Determining Power Flux Densities

Parameter	Symbol	Formula	Value	Units
Ant Largest Dimension	D	Input	18.29	m
Ant Equiv Surface Area	$A_{Surface}$	$\pi D^2/4$	262.7	m^2
Frequency	F	Input	450	MHz
Wavelength	λ	$300/F$	0.666667	m
Transmit Power	P	Input	8	W
Antenna Gain (dBi)	G_{es}	Input	35	dBi
Antenna Gain (factor)	G	$10^{Ges/10}$	3162.28	n/a
Pi	π	Constant	3.141592654	n/a
Antenna Efficiency	η	$G\lambda^2/(4\pi)/A_{surface}$	0.426	n/a

1. Far Field Distance Calculation

The distance to the beginning of the far field can be determined from the following equation:

Distance to the Far Field Region

$$R_{ff} = 0.60\ D^2/\lambda = 301.1\ \text{m} \quad (1)$$

The maximum main beam power density in the far field can be determined from the following equation:

On-Axis Power Density in the Far Field

$$S_{ff} = GP/(4\pi R_{ff}^2) = 0.022\ \text{W/m}^2 = 0.0022\ \text{mW/cm}^2 \quad (2)$$

2. Main Reflector Calculation

The power density $S_{surface}$ in the main reflector is determined as follows:

Main Reflector Surface Power Density

$$S_{surface} = 4P/A_{surface} = 0.122\ \text{W/m}^2 = 0.0122\ \text{mW/cm}^2 \quad (3)$$

3. Near Field Calculation

Power flux density is considered to be at a maximum value throughout the entire length of the defined Near Field region. The region is contained within a cylindrical volume having the same surface area as the antenna. Past the boundary of the Near Field region, the power density from the antenna decreases linearly with respect to increasing distance.

The distance to the end of the Near Field can be determined from the following equation:

Extent of the Near Field

$$R_{nf} = D^2/(4\lambda) = 125.4\ \text{m} \quad (4)$$

The maximum power density in the Near Field can be determined from the following equation:

Near Field Power Density

$$S_{nf} = 4\eta P/A_{surface} = 0.0518\ \text{W/m}^2 = 0.00518\ \text{mW/cm}^2 \quad (5)$$

4. Transition Region Calculation

The Transition region is located between the Near and Far Field regions. The power density begins to decrease linearly with increasing distance in the Transition region. While the power density decreases inversely with distance in the Transition region, the power density decreases inversely with the square of the distance in the Far Field region. The maximum power density in the Transition region will not exceed that calculated for the Near Field region. The power density calculated in Section 2 is the

highest power density the antenna can produce in any of the regions away from the antenna. The power density at a distance R_{tz} can be determined from the following equation:

Transition Region Power Density

$$S_{tz} = S_{nf}R_{nf}/R_{tz} = 0.00518\ \text{mW/cm}^2 \quad (6)$$

R_{tz} is calculated at a distance of 125.4 meters from the antenna, which is the worst case; it is the edge of the near-field boundary, R_{nf}.

5. Region between the Antenna and the Ground

Assuming uniform illumination of the antenna surface, the power density between the antenna and the ground can be determined from the following equation:

Power Density between Antenna and Ground

$$S_g = P/A_{surface} = 0.030\ \text{W/m}^2 = 0.0030\ \text{mW/cm}^2 \quad (7)$$

6. Summary of Calculations

Table 4. Summary of Expected Radiation Levels for Uncontrolled Environment

Region	Calculated Maximum Radiation Power Density Level (mW/cm^2)		Hazard Assessment
Far Field (R_{ff} = 301 m)	S_{ff}	0.0022	Satisfies FCC MPE
Main Reflector Surface	$S_{surface}$	0.012	Satisfies FCC MPE
Near Field (R_{nf} = 125 m)	S_{nf}	0.0052	Satisfies FCC MPE
Transition Region ($R_{nf} < R_{tz} < R_{ff}$)	S_{tz}	0.0052	Satisfies FCC MPE
Between Reflector and Ground	S_g	0.003	Satisfies FCC MPE

Table 5. Summary of Expected Radiation Levels for Controlled Environment

Region	Calculated Maximum Radiation Power Density Level (mW/cm^2)		Hazard Assessment
Far Field (R_{ff} = 301 m)	S_{ff}	0.0022	Satisfies FCC MPE
Main Reflector Surface	$S_{surface}$	0.012	Satisfies FCC MPE
Near Field (R_{nf} = 125 m)	S_{nf}	0.0052	Satisfies FCC MPE
Transition Region ($R_{nf} < R_{tz} < R_{ff}$)	S_{tz}	0.0052	Satisfies FCC MPE
Between Reflector and Ground	S_g	0.0030	Satisfies FCC MPE

It is the applicant's responsibility to ensure that the public and operational personnel are not exposed to harmful levels of radiation.

7. Conclusions

Based upon the above analysis, it is concluded that FCC RF Guidelines have not been exceeded in any of the zones in the Uncontrolled (Table 4) or the Controlled (Table 5) environments. The applicant proposes to comply with the Maximum Permissible Exposure (MPE) limits of 1.0 mW/cm^2 for the Uncontrolled Areas, and the MPE limits of 5.0 mW/cm^2 for the Controlled Areas.

The earth station dish antenna is mounted on a platform, and the applicant agrees that the antenna will be in an area secured from the public and worker personnel not familiar with the earth station system. Non-assigned worker personnel and the general public must be accompanied by knowledgeable earth station personnel when they enter the earth station secured area.

The applicant agrees to abide by the conditions specified in Condition 5208 provided below:

> *Condition 5208 - The licensee shall take all necessary measures to ensure that the antenna does not create potential exposure of humans to radiofrequency radiation in excess of the FCC exposure limits defined in 47 CFR 1.1307(b) and 1.1310 wherever such exposures might occur. Measures must be taken to ensure compliance with limits for both occupational/controlled exposure and for general population/uncontrolled exposure, as defined in these rule sections. Compliance can be accomplished in most cases by appropriate restrictions such as fencing.*
> *Requirements for restrictions can be determined by predictions based on calculations, modeling or by field measurements. The FCC's OET Bulletin 65 (available on-line at www.fcc.gov/oet/rfsafety) provides information on predicting exposure levels and on methods for ensuring compliance, including the use of warning and alerting signs and protective equipment for worker.*