Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Spaceflight, Inc.	)	
	)	
Authority to Deploy and Operate Sherpa-AC1 as a Non-Geostationary Orbit Free-Flying Deployment Vehicle and Radionavigation-Satellite Service	))))	File No. SAT-LOA-_______________

APPLICATION NARRATIVE

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APPLICATION NARRATIVE

I. INTRODUCTION AND OVERVIEW

Pursuant to Section 25.113(g) of the Commission's rules, Spaceflight, Inc. ("Spaceflight") requests authority to deploy and operate a non-geostationary orbit ("NGSO") free-flying deployment vehicle known as Sherpa-AC1. As further described in this narrative to Spaceflight's application ("Application"), Spaceflight's Sherpa missions provide a crucial bridge between traditional launch services and satellite services, deploying satellites into their desired orbit after the Sherpa is itself injected into orbit by a launch vehicle.

As the Commission has recognized, there are currently no standards specifically adopted for Sherpa-type operations that the Commission uses to evaluate such missions.[1] Rather, the Commission has reviewed them on a case-by-case basis and

[1] *Orbital Debris in the New Space Age*, Report and Order and Further Notice of Proposed Rulemaking, 35 FCC Rcd 4156 at 4191-4195 ¶¶77-81 (2020). Spaceflight notes in this regard that it has urged the Commission to initiate a rulemaking proceeding to develop licensing standards for deployment, rendezvous, and proximity services, (collectively, "On-Orbit Services"). *Amendment of Part 2 of the*

authorized them through grants of Special Temporary Authority ("STA").[2] As that experience has developed, the Commission staff has advised Spaceflight to seek regular Part 25 authorization for its continuing Sherpa missions. Spaceflight has followed that advice in this Application for the referenced mission.

As set forth below and in the attached exhibits, Spaceflight provides the same categories of information that the Commission has requested for Spaceflight's previous Sherpa mission STAs. Spaceflight also provides separate and detailed information regarding a Xona Space Systems ("Xona") Radionavigation-Satellite Service hosted payload on the Sherpa-AC1.[3]

Commission's Rules for Federal Earth Stations Communicating with Non-Federal Fixed Satellite Service Space Stations, and Federal Space Station Use of the 399.9-400.05 MHz Band, ET Docket No 13-115, RM-11341, Comments of Spaceflight, Inc. (filed Aug 11, 2021), Reply Comments of Spaceflight, Inc. (filed Sep 10, 2021). Spaceflight accepts that a grant of the Application would be subject to modification to bring it into conformity with the outcome of such a proceeding.

[2] *Spaceflight, Inc, Request for STA to deploy and operate Sherpa-FX2 and Sherpa-LTE1*, IBFS File No. SAT-STA-20210205-00017, DA#21-650, granted May 28, 2021; *Spaceflight, Inc, Request for STA to deploy and operate Sherpa FX1*, IBFS File No. SAT-STA-20200728-00089, DA# 20-1475, granted Dec 10, 2020; *Spaceflight, Inc, Request for STA to deploy and operate Upper and Lower Free Flyer vehicles for the SSO-A mission*, IBFS File No. Sherpa FX SAT-STA-20180523-00042, DA# 18-1074, granted Oct 12, 2018; *Spaceflight, Inc, Request for STA to operate a fixed earth station in North Pole, AK to communicate with the SHERPA spacecraft*, IBFS File No. SES-STA-20150824-00549, stamp grant Nov 22, 2016; Spaceflight, Inc, *Request for STA to operate a fixed earth station in Tukwila, WA to communicate with the SHERPA spacecraft*, IBFS File No. SES-STA-20150824-00550, stamp grant Nov 22, 2016; *Spaceflight, Inc, Request for STA to operate a fixed earth station in Wallops Island, VA to communicate with the SHERPA spacecraft*, IBFS File No. SES-STA-20150824-00551, stamp grant Nov 22, 2016; *Spaceflight, Inc, Request for STA to deploy and operate the SHERPA spacecraft*, IBFS File No. SAT-STA-20150821-00060, DA-16-1365, Oct 25, 2016.

[3] Spaceflight notes that a second Xona navigational payload to be employed by Xona together with the one that would be hosted on the AC1 vehicle is planned for a later Spaceflight mission. Because the design of that mission is still in the planning phase, it is not included as part of this Application.

II. GRANT OF THIS APPLICATION IS IN THE PUBLIC INTEREST

Spaceflight has been a leading global launch services provider since 2011 and is a pioneer in innovative orbital transit vehicles, most recently deploying a new orbital transfer vehicle called "Sherpa." Beginning with its landmark SSO-A mission in 2018 on a SpaceX Falcon 9, Spaceflight consistently has sought to provide new or expanded opportunities for customers of all types who seek affordable rideshare options to launch their spacecrafts into orbit. The SSO-A mission was the largest single rideshare mission from a U.S.-based launch vehicle to date, successfully deploying 64 spacecraft from 34 different organizations in a Sun-Synchronous Low-Earth Orbit. Since then, Spaceflight has continued to develop its equipment and vehicles to meet the demands of the marketplace and to enhance the launch industry's ability to take customers where and when they need to go while at the same time being cognizant of the need to minimize space debris.

Spaceflight's generation of new Sherpas, which began flying in 2021, provides customers with options to achieve orbital diversification by delivering them to orbits distinct from the injection orbit they would achieve from a traditional launch vehicle. The Sherpa offers customers the ability to separate from the launch vehicle and use attitude control and/or propulsion to reach various orbital altitudes or inclinations. This functionality enables a host of benefits for satellite and spacecraft customers, including flexible manifest changes, deployment to multiple altitudes and orbital planes, and rapid launch solutions. The Sherpas therefore can enable relatively lowcost access to space for academic, scientific, government and commercial stakeholders that otherwise could not effectively use traditional launch services.

As noted above, up until this point, Spaceflight's missions have been authorized by the Commission on a mission-by-mission STA basis. That approach has served Spaceflight, its customers, and the public interest well by allowing the development of Spaceflight's innovative services while Spaceflight and the Commission have gained experience in their implementation. Now that this experience has developed into a regularized process, the Commission has requested that Spaceflight take the next step in seeking a regular Part 25 authorization.

This particular Sherpa mission employs a new type of Sherpa vehicle, the Sherpa-AC. As described further below, this vehicle has an advantage over the Sherpa-FX vehicle that has been Spaceflight's mainstay to date by virtue of its ability to maintain operations and provide active attitude control for a mission that extends beyond the very limited time period of operation of the Sherpa-FX vehicle. That ability is necessary to support the operation of the Xona navigational payload that is hosted on this mission. The Sherpa-AC vehicle is similar to the Sherpa-LTE vehicle that was previously launched in June 2021, but without the modular electric propulsion system. The requirements of the Xona mission do not include propulsion; hence, Spaceflight will operate a Sherpa-AC instead of a Sherpa-LTE.

III. TECHNICAL DESCRIPTION

A. Mission Description and Orbit Information

Sherpa-AC1 will be placed in sun synchronous orbit (SSO) at an altitude between 525-575 km ± 25 km[4] at an inclination of 97.59 degrees. At that point, the Rapidly Reconfigurable Avionics (R2A)-Core (discussed below) will initiate a timed sequence of procedures to begin the deployment of spacecraft on Sherpa-AC1, referred to herein as the "Deployment Phase." The Deployment Phase is anticipated to last no more than 36 hours. The Sherpa-AC1 will then begin the "Hosted Payload Phase" of the mission that involves extended Sherpa operations and the operation of its hosted payloads, including the Xona navigational payload. The Hosted Payload Phase is anticipated to last no more than one year.

B. Overall Design of Sherpa-AC1

Sherpa-AC1 will be similar to Sherpa-LTE1, previously approved by the Commission under SES-STA-20200728-00089. Like Sherpa-LTE1, Sherpa-AC1 has an active attitude control system; however, unlike Sherpa-LTE1, Sherpa-AC1 has no

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[4] This range reflects flexibility given the launch provider will select a targeted altitude within 525-575 km and a margin for uncertainty in the actual orbital injection of ± 25km. Spaceflight will file a supplement to this Application once the targeted altitude is specified by the launch provider which will then result in a range of that targeted altitude ± 25km.

propulsion. Similar to previous missions (SSO-A,[5] Sherpa-FX1,[6] and Sherpa-FX2[7]), Sherpa-AC1 consists of several structural elements to mount both microsatellites and CubeSat dispensers. Spaceflight provides the launch capacity, structure, separation systems, and integration services for the customer spacecraft located on Sherpa-AC1.

Like Sherpa-FX1 and Sherpa-FX2, Sherpa-AC1 contains within its internal volume an R2A-Core system, including batteries, to command for this mission the deployment of up to seven (7) spacecraft into SSO.[8] In addition to the R2A-Core, Sherpa-AC1 will also contain a Makalu Command and Control System ("CCS") to provide active attitude control for hosted payloads on orbit. Makalu has flown on Sherpa-LTE1.

Sherpa-AC1 will be attached to a single port on a SpaceX-provided payload ring. Once a separation signal is received by Sherpa-AC1's separation system from SpaceX's Falcon 9 avionics, Sherpa-AC1 will separate. See Figure 1 for a rendering of the Sherpa-AC1 architecture.

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[5] *Spaceflight, Inc, Request for STA to deploy and operate Upper and Lower Free Flyer vehicles for the SSO-A mission*, IBFS File No. Sherpa FX SAT-STA-20180523-00042, DA# 18-1074, granted Oct 12, 2018.

[6] *Spaceflight, Inc, Request for STA to deploy and operate Sherpa FX1*, IBFS File No. SAT-STA-20200728-00089, DA# 20-1475, granted Dec 10, 2020.

[7] *Spaceflight, Inc, Request for STA to deploy and operate Sherpa-FX2 and Sherpa-LTE1*, IBFS File No. SAT-STA-20210205-00017, DA#21-650, granted May 28, 2021.

[8] Spaceflight notes that while the Sherpa-AC1 manifest may change before launch, Sherpa-AC1 will carry no more than seven (7) deployable spacecraft on this launch and all risk assessments and analyses of the Sherpa-AC1 spacecraft factor in the maximum number of spacecraft and highest possible launch mass. The mission analyses will be rerun with the final spacecraft configuration, and Spaceflight expects it to show improved results compared to those presented in the Application.

Figure 1: Physical architecture of Spaceflight's Sherpa-AC1 with customers on a SpaceX Falcon 9 rideshare mission.

After Sherpa-AC1's separation from the Falcon 9 launch vehicle and a subsequent delay in accordance with SpaceX requirements, Sherpa-AC1 will begin its Deployment Phase and the R2A-Core will initiate its own separation sequence to deploy customer spacecraft from Sherpa-AC1 and send telemetry back to Spaceflight. The R2A-Core also activates the Black Box Standard[9] S3 Black Box Radio (provided by NearSpace Launch and more fully described below); specifically, the L-band transmitter sends deployment confirmation telemetry to the Globalstar constellation for relay by commercial Globalstar data services to Spaceflight. Once the Deployment Phase is complete, the attitude control system ("ACS", which includes Makalu, 2-way RF communications, and a power system) will be commissioned, and the Hosted Payload

[9] The "Black Box Standard" S3 Black Box Radio is previously referred to as the "EyeStar" S3 Black Box Radio. This is strictly a name change from the manufacturer, the component itself remains the same.

Phase will commence. In addition to the separable payloads deployed as part of the Deployment Phase, Sherpa-AC1 will include hosted payloads that will not deploy and will complete their objectives as part of Sherpa-AC1's Hosted Payload Phase.

The R2A-Core is equipped with an S-band receiver, also contained within the Black Box Standard Radio, to allow a kill-command to be sent from a ground station operated by NearSpace Launch to deactivate the transmitter in the event of radio frequency interference. The R2A-Core will also have an on-board timer to cut off its transmissions several hours after the end of the planned deployment cycle. If all else fails, battery life is expected to be exhausted by 36 hours into the Sherpa-AC1 Mission.

The Hosted Payload Phase is anticipated to last less than one year. It involves pointing the hosted payload antenna at the ground during planned ground station passes several times per day for uplink and downlink of payload data and pointing of the solar panels at the sun for battery charging while downlinking stored data from the Makalu CCS. The Hosted Payload Phase will then transition to a data gathering mode where Sherpa-AC1 operates and downlinks via the Makalu CCS only. A more detailed technical description of the Sherpa-AC1 is attached as Exhibit 2, Technical Annex.

C. Hosted Payloads

Spaceflight will host two payloads on Sherpa-AC1. Both hosted payloads are permanently affixed to the Sherpa-AC1 spacecraft.

The first payload (TROOP-3) has a radio transmitter. The TROOP-3 payload is owned and operated by NearSpace Launch. TROOP-3 has two independent mechanical switches that are connected to the Sherpa-AC1 separation systems. Other than the mechanical interface of the payload to Sherpa-AC1, these switches are the only interface to Sherpa-AC1, and all power and radios are electrically independent from those belonging to Sherpa-AC1. There are payload-inhibit switches that prevent inadvertent activation of the payload with single fault tolerance. When the Sherpa-AC1 separates, the two switches will close, activating an onboard timer on the TROOP-3 payload. Thereafter, these switches have no further function. TROOP-3 will automatically begin transmitting a beacon after 30 minutes from the activation of the timer. Any RF transmissions from the TROOP-3 payload or from the ground will be licensed by NearSpace Launch, and NearSpace Launch must obtain the proper authorization as a prerequisite to integration on Sherpa-AC1.

The second payload, the Xona navigational payload, is owned and will be employed on a day-to-day basis by Xona. Power for its operation, however, is provided by the Sherpa-AC1, and Spaceflight has the ability to cease operation of the Xona navigational payload at any time by cutting power to it. Upon the advice of the Commission staff, Spaceflight is seeking to license the operation of the Xona navigational payload itself, rather than leaving it to Xona to license separately. A separate and detailed description of the Xona payload and its operations is set forth in Exhibit 3 hereto.

D. Frequency and Earth Station Parameters

The frequencies[10] and earth stations to be employed in connection with the Sherpa-AC1 mission are shown below[11]:

<table>
<tr><th></th><th colspan="2">Deployment Phase Comms (<36 Hours after Launch)</th><th colspan="8">Hosted Payload Comms (Up to 1 Year after Launch)</th><th colspan="2">Xona Payload Comms (Up to 1 Year after Launch)</th></tr>
<tr><th>Beam ID</th><th>LTX</th><th>SRX2</th><th>URX</th><th colspan="2">SRX</th><th>UTX</th><th colspan="2">STX</th><th>SRX3</th><th>XTX</th><th>LTX2</th><th>CTX</th></tr>
<tr><td>Description</td><td>L-band Uplink to Globalstar</td><td>S-band Kill Command</td><td>UHF Uplink</td><td colspan="2">S-Band Uplink (Two Types of Ground Antenna)</td><td>UHF Downlink</td><td colspan="2">S-Band Downlink (Two Types of Ground Antenna)</td><td>S-Band Uplink</td><td>X-Band Downlink</td><td>L-Band Downlink</td><td>C-Band Downlink</td></tr>
<tr><td>Center Frequency (MHz)</td><td>1616.25</td><td>2467.0</td><td>402.9</td><td colspan="2">2046
2048
2050
2053
2056
2075</td><td>400.5</td><td colspan="2">2207.5
2212.5
2217.5
2245
2250
2272.5
2287.5</td><td>2047.5
2054
2075</td><td>8062.5
8112.5
8162.5
8212.5
8262.5</td><td>1260</td><td>5020</td></tr>
<tr><td>Bandwidth</td><td>2.5 MHz</td><td>22 MHz</td><td>40 kHz</td><td colspan="2">300 kHz</td><td>40 kHz</td><td>300 kHz</td><td>1 MHz</td><td>5.0 MHz</td><td>50 MHz</td><td>10 MHz</td><td>20 MHz</td></tr>
<tr><td>Transmit Power</td><td>-5.0 dBW</td><td>20.0 dBW</td><td>15.8 dBW</td><td>18.0 dBW</td><td>3.2 dBW</td><td>5.0 dBW</td><td>-5.8 dBW</td><td>-0.8 dBW</td><td>10.7 dBW</td><td>4.9 dBW</td><td>13.9 dBW</td><td>14.0 dBW</td></tr>
</table>

[10] Spaceflight will also receive GPS L1 band signals at 1575.42 MHz used by on-board GPS location receivers. The Xona payload will also receive GPS L1 and Galileo E1 signals on 1575.42 MHz, GPS L2 band signals at 1227.60 MHz, and Galileo E5b band signals on 1176.45 MHz.

[11] Please note Schedule S houses representative center frequencies only. The values might change because of Spaceflight's coordination efforts. And Spaceflight's software defined radios permit this frequency agility within the requested frequency bands.

	Deployment Phase Comms (<36 Hours after Launch)		Hosted Payload Comms (Up to 1 Year after Launch)								Xona Payload Comms (Up to 1 Year after Launch)	
Beam ID	**LTX**	**SRX2**	**URX**	**SRX**		**UTX**	**STX**		**SRX3**	**XTX**	**LTX2**	**CTX**
Transmit Antenna Gain	5.0 dBi	27 dBi	21.1 dBi	27.5 dBi	42.3 dBi	2.1 dBi	5.5 dBi		42.3 dBi	13.1 dBi	5.6 dBi	5.2 dBi
EIRP	0 dBW (Space-to-Space)	47 dBW	36.9 dBW	45.5 dBW		7.1 dBW	-0.3 dBW	4.7 dBW	53.0 dBW	18.0 dBW	19.5 dBW	19.2 dBW
Polarization	RHCP	RHCP	Linear	RHCP		Linear	RHCP		RHCP	RHCP	RHCP	RHCP
Receive Antenna Gain	13.8-18.2 dBi	4.0 dBi	1.8 dBi	4.0 dBi		21.1 dBi	42.8 dBi		5.5 dBi	55.2 dBi	6.3 dBi	6.1 dBi
Receive Noise Temp.	330 K	330 K	330 K	330 K		500 K	292 K		330 K	270 K	359 K	359 K

U.S. Earth Station Location	Operator Name and Address	Coordinates	# Passes Per Day	Duty Cycle (12 min pass)	GS Rx (Beam ID)	GS Tx (Beam ID)
Santa Clara, CA	Astro Digital, 3171 Jay St. Santa Clara, CA 95054	37.38N 121.96W	2	1.70%	UHF (UTX)	UHF (URX)
Deadhorse, AK	RBC Signals, 2205 152nd Ave NE, Redmond, WA 98052	70.21N 148.41W	14	11.70%	UHF (UTX)	S-band (SRX)
Windham, NY	RBC Signals, 2205 152nd Ave NE, Redmond, WA 98052	42.34N 74.26W	7	5.80%	UHF (UTX)	None
Fairbanks, AK	RBC Signals, 2205 152nd Ave NE, Redmond, WA, 98052	64.86N 147.84W	7	5.80%	UHF (UTX)	None
Ohio	Not Provided	40.43N 82.9W	5	4.0%	X-band (XTX)	S-band (SRX, SRX3)
Hawaii	Not Provided	21.3N 157.86W	2	2.0%	X-band (XTX)	S-band (SRX, SRX3)

U.S. Earth Station Location	Operator Name and Address	Coordinates	# Passes Per Day	Duty Cycle (12 min pass)	GS Rx (Beam ID)	GS Tx (Beam ID)
Oregon	Not Provided	43.8N 120.55W	6	4.5%	X-band (XTX)	S-band (SRX, SRX3)
Upland, IN	NearSpaceLaunch 8702 E 825 S., Upland IN, 46989	40.43N 85.51W	7	0.01%	None	S-band (SRX2)
Tucson, AZ	Xona 11465 E Prospect Ln, Tuscon, AZ 85749	32.28N 110.75WW	2	1.7%	L-band (LTX2) C-band (CTX)	None
San Mateo, CA	Xona 161 South Blvd, San Mateo, CA 94402	37.56N 122.31W	2	1.7%	L-band (LTX2) C-band (CTX)	None
Boulder, CO	NIST 328 Broadway St, Boulder, CO 80302	40.00N 105.26W	5	4.0%	L-band (LTX2) C-band (CTX)	None

Foreign Earth Station Location	Operator Name and Address	Coordinates	# Passes Per Day	Duty Cycle (12 min pass)	GS Rx (Beam ID)	GS Tx (Beam ID)
Tromso, Norway	KSAT, Prestvannvegen 38, 9291 Tromsø, Norway	69.66N, 18.94E	12	10%	UHF (UTX)	UHF (URX) S-band (SRX)
Dublin, Ireland	Not Provided	53°24'25"N 6°13'32"W	4	10%	S-band (STX) X-band (XTX)	S-band (SRX, SRX3)
Vasteras, Sweden	Not Provided	59°38'56"N 16°35'00"E	4	10%	S-band (STX)X-band (XTX)	S-band (SRX, SRX3)
Cape Town, South Africa	Not Provided	34°01'39"S 18°43'08"E	4	10%	S-band (STX) X-band (XTX)	S-band (SRX, SRX3)
Zallaq, Bahrain	Not Provided	26°03'06"N 50°30'12"E	4	5%	S-band (STX) X-band (XTX)	S-band (SRX, SRX3)
Sydney, Australia	Not Provided	34°2'14"S 150°46'3"E	4	8%	S-band (STX) X-band (XTX)	S-band (SRX, SRX3)

Foreign Earth Station Location	Operator Name and Address	Coordinates	# Passes Per Day	Duty Cycle (12 min pass)	GS Rx (Beam ID)	GS Tx (Beam ID)
Punta Arenas, Chile	Not Provided	52°56'28"S 70°50'59"W	4	8%	S-band (STX) X-band (XTX)	S-band (SRX, SRX3)
Seoul, South Korea	Not Provided	37°18'20"N 127°8'18"E	4	5%	S-band (STX) X-band (XTX)	S-band (SRX, SRX3)
Calgary, AB, CA	University of Calgary 856 Campus Pl NW, Calgary, AB T2N 1N7, CA	51.08N 114.13W	9	7%	L-band (LTX2) C-band (CTX)	None
Fort Smith, NT, CA	University of Calgary 298 McDougal Rd, Fort Smith, NT X0E, CA	60.01N 111.90W	10	9%	L-band (LTX2) C-band (CTX)	None

IV. ORBITAL DEBRIS ASSESSMENT REPORT & RECONTACT ANALYSIS

An Orbital Debris Assessment Report ("ODAR") for Sherpa-AC1 is attached hereto as Exhibit 4. The analysis reflected in that report has been run on NASA Debris Assessment Software ("DAS") v3.1.2 and shows compliance with all NASA standards and Commission requirements. Among the findings:

(i) The targeted altitude, per SpaceX, for injection of the Sherpa-AC1 will be between 525 and 575 km, but the exact target within this range has yet to be designated by the launch provider, SpaceX. From that targeted altitude, SpaceX reserves an additional margin for uncertainty in the actual orbital injection of ± 25 km. Spaceflight believes based on feedback from SpaceX and previous missions that the most likely targeted altitude will be 525 km.

As shown in the table below, even at the very highest possible targeted altitude (575 km) and adding the greatest increase in altitude to account for the margin of uncertainty (25 km), for a total altitude of 600 km, in the Nominal Mission case, the post-mission life of the Sherpa-AC1 is calculated by DAS to be less than 25 years. If the targeted launch is lowered and/or the increase (if any) in altitude is less than reflected at the outer bounds of the margin of uncertainty, post-mission life is reduced.

Table 1: Predicted Orbital Lifetime

Altitude[12] (km)	**Orbital Life (years)**	
	Nominal Mission	**Failed Mission**
600 x 600	24.1	34.7
577 x 577	15.8	24.8
575 x 575	15.5	24.4
550 x 550	13.1	15.7
525 x 525	10.5	13.1

In the worst-case circumstance of a Failed Mission, post-mission lifetime for the Sherpa-AC1 is predicted by DAS to be 25 years or less up to an orbital injection altitude of 577 km, which is higher than the maximum targeted injection altitude. A post-mission life of greater than 25 years would only occur by the confluence of the following factors: i) the combination of the targeted orbital injection plus any margin used in the launch is greater than 577 km; and (ii) the Sherpa-AC1 suffers a Failed Mission.[13]

Spaceflight believes that this worst possible scenario is highly unlikely based upon the following. First, while it is a matter within the launch provider's control, Spaceflight does not anticipate a targeted launch altitude of 552 km or higher, below which, even using maximum margin, the insertion orbit would not exceed 577 km. Second, while there is allowed a margin of uncertainty of ± 25 km, historically the insertion accuracy for these missions has been much narrower and the actual insertion

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[12] Spaceflight will file a supplement to this Application once the targeted altitude is specified by the launch provider to update this table based upon that targeted altitude and the associated margin of uncertainty

[13] A "Failed Mission" refers to one or more deployments failing to occur. The analysis considers the worst-case scenario in which all planned deployments fail resulting in the worst-case orbital lifetime for a failed mission.

orbit is very close to the target. Third, while both of the above factors are within the province of the launch provider, with respect to the risk of a Failed Mission, Spaceflight has launched three Sherpa vehicles with this deployment technology (R2A-Core) prior to this filing and none of them have been Failed Missions. This includes 49 out of 49 successful deployments. At least one additional Sherpa using an R2A-Core for deployment is anticipated to be launched prior to Sherpa-AC1. Each R2A-Core goes through extensive Mission Simulation Tests prior to flight to ensure deployments will occur as planned.

(ii) DAS calculates Sherpa-AC1 and its separation systems and subcomponents (listed in further detail in the full DAS results in Exhibit 4) have a 1:52,400 risk of human casualty at what Spaceflight anticipates to be the most likely targeted injection altitude, 525 km. At the highest targeted injection altitudes, DAS calculates a somewhat higher risk; 1:48,500 at 575 km. Because of operation of DAS v3.1.2, and not because of any change in the Sherpa components surviving reentry, other potential injection altitudes within margin of error (±25 km) would also result in minor differences in the results, but would still be compliant with the NASA standard.

The Reaction Wheel Assembly components integral to Makalu CCS that do not demise are a required part of the Sherpa-AC1 architecture and in particular necessary to meet the Hosted Payload attitude control requirements of this mission, which could not be met with a Sherpa-FX. After investigation, Spaceflight determined that no viable alternatives for these components and/or functionality exist with better demise properties.

In addition to a standard ODAR showing that the Commission requires for satellite applications, the Commission has also required Spaceflight to provide a long term recontact probability analysis in connection with the spacecraft to be deployed as part of Spaceflight's Sherpa missions that have been granted through STAs. Following this approach, such a recontact analysis for the Sherpa-AC1 mission is attached hereto as Exhibit 5. That report shows an estimated risk of recontact of $1.21x10^{-4}$, assuming that vehicles with propulsion are capable of collision avoidance and $4.15x10^{-4}$ even if those spacecraft are not capable of collision avoidance.

V. FREQUENCY CONSIDERATIONS

The frequencies planned for use on Sherpa-AC1, the nature of their proposed use, and other relevant technical consideration are set forth below. Where indicated, waivers of the Commission rules are required to permit Spaceflight's operation on certain specified frequencies on a non-conforming use basis. Good cause for such waivers is demonstrated in Exhibit 7 hereto.

A. Coordination with Federal Systems

Spaceflight recognizes coordination is necessary in frequencies shared with U.S. Federal agencies. Spaceflight and its earth station partners will commence coordination immediately after submitting the Application and finalize coordination agreements before receiving FCC authorization.

Coordination should not prove challenging. For all requested frequencies except X-band and the frequencies to be employed by the Xona Hosted Payload, Spaceflight and its earth station partners previously completed coordination for similarly situated missions. For the requested X-band and frequencies to be employed by the Xona Hosted Payload, such use, as demonstrated below and in Exhibit 3, will pose minimal concern to Federal systems given the proposed limited use.

B. Band-by-Band Analysis

1. 400.15-401 MHz and 402-403 MHz

Spaceflight will transmit signals at 400.5 MHz and receive signals at 402.9 MHz for spacecraft primary beacons and command uplink. For the 400.5 MHz frequency, Spaceflight understands that its use would be permitted only on a secondary, non-interference basis. For the 402.9 MHz frequency, Spaceflight understands that it will need a waiver for the non-conforming use. For both frequencies, Spaceflight will not exceed the long-term interference criteria limits specified in Table 2 (Type C) of Recommendation ITU-R RS.1263-2 to protect National Oceanic and Atmospheric Administration ("NOAA") radiosonde operations in the United States and Possessions. Spaceflight will coordinate with federal agencies as to this frequency and other proposed ones, for which the use is consistent with past Spaceflight missions.

2. 1575.42 MHz, 1227.60 MHz, and 1176.45 MHz

Spaceflight will receive GPS L1 band signals at 1575.42 MHz used by on-board GPS location receivers. The Xona payload will also receive GPS L1 and Galileo E1 signals on 1575.42 MHz, GPS L2 band signals at 1227.60 MHz, and Galileo E5b band signals on 1176.45 MHz. The FCC has approved non-federal reception of the Galileo E1 and E5 bands.[14]

3. 1616.25 MHz

Spaceflight will establish a one-way link from its Sherpa to the Globalstar constellation (no longer than a 36-hour period) for telemetry monitoring during Sherpa's spacecraft deployment. In particular, the link will permit the Spaceflight technical crew to monitor the deployment of the small spacecraft onboard Sherpa and disseminate related data both to Spaceflight's customers and the Combined Space Operations Center.[15] Globalstar will use its own licensed network to downlink the telemetry and is responsible for securing FCC authority to receive signals from Sherpa. Spaceflight's use of this band will be coordinated with Globalstar, and operations will be conducted on a non-interference basis.

4. 2025-2110 MHz

Spaceflight will receive signals in 2025-2110 MHz for secondary command uplink. Spaceflight understands that it will need a waiver for the non-conforming use. Spaceflight seeks to use this band on a non-interference basis and will coordinate with

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[14] Waiver of Part 25 Licensing Requirements for Receive-Only Earth Stations Operating with the Galileo Radionavigation-Satellite Service, Order, 33 FCC Rcd 11322 ¶ 2 (2018).

[15] The associated avionics systems are set to beacon data to the Globalstar constellation from activation until cut off by a timer set to shut off transmissions once the deployments of all customer spacecraft are complete. The duty cycle for the L-band system is a transmission up to 10 seconds every 20 seconds (30 seconds of broadcast time per minute; a 50% duty cycle).

those users to ensure that Spaceflight's operations will not cause harmful interference. Spaceflight's limited, short-term operations, coupled with the use of software-defined radios, should facilitate coordination in any available segment of the band.

5. 2200-2290 MHz

Spaceflight will transmit imaging and video data in 2200-2290 MHz. Spaceflight understands that it will need a waiver for the non-conforming use. Transmissions shall not cause harmful interference to Federal stations operating consistent with the Table of Frequency Allocations. Subject to coordination, Spaceflight can operate its carrier in the portion of the 2200-2290 MHz band where traffic is lowest and Spaceflight's use is most compatible with incumbent government and commercial operators.

Spaceflight will require the use of only one 300-kilohertz or 1-megahertz channel anywhere in the band when in line of sight over one of seven earth stations not inside the United States or its territories (Dublin, Ireland; Sydney, Australia; Stockholm, Sweden; Capetown, South Africa; Zallaq, Bahrain; Seoul, South Korea; and Puntas Arenas, Chile). Initial research suggests one of the following center frequencies could support Spaceflight's mission: 2207.5 MHz, 2212.5 MHz, 2217.5 MHz, 2272.5 MHz, or 2287.5 MHz. Spaceflight's limited, short-term operations, coupled with the use of software-defined radios, should facilitate coordination in the identified center frequencies or any other segment of the 2200-2290 MHz band.

6. 8025-8400 MHz

Spaceflight will transmit image, video, and high-rate system performance data in 8025-8400 MHz. Spaceflight understands that it will need a waiver for the non-conforming use. Two key operational practices, coupled with satisfaction of related ITU protections (see subsection (C)), will ensure existing services in the band do not experience harmful interference.

Transmissions will occur only in short durations when in line of sight of a limited number of earth stations. For harmful interference to occur, satellites belonging to different systems would have to be visible to the limited number of earth stations receiving in short durations using the same frequencies at the exact same time. In such an unlikely event, the resulting inline interference will be avoided by coordinating the satellite transmissions so that Spaceflight will turn off its transmissions as needed so that they do not occur simultaneously with other satellites in authorized services.[16]

7. 2456-2478 MHz

Spaceflight will employ this band solely for the limited purpose of receiving a kill command from an Upland, Indiana earth station that is operated by NearSpace Launch to deactivate the Black Box Standard Radio, as described above, in the unlikely event that such deactivation will be required. Spaceflight understands that it will need a waiver for the non-conforming use.

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[16] For federal operators, Spaceflight will pre-coordinate the band. For non-federal operators, Spaceflight plans to engage Commercial Smallsat Spectrum Management Association membership and operational FCC authorization holders in the band to pre-coordinate the band.

If needed at all, the transmission of signals to the Sherpa-AC1 will be of exceedingly limited duration: the single uplinked kill command will last for only seconds. NearSpace Launch already holds an experimental authorization for operation of the referenced earth station in this band to communicate with a number of satellites.[17] Transmission in this band by NearSpace would be subject to the conditions of that experimental license, which by definition requires operation on a non-interference basis, and Commission authorization to add the Sherpa-AC1 as an additional point of communication.

8. Xona Hosted Payload Frequencies

The Xona Hosted Payload will employ L-band and C-band frequencies centered at 1260 MHz and 5020 MHz. A discussion of considerations associated with these frequencies can be found in Exhibit 3, at Attachment B.

C. Interference Showings

1. 2200-2900 MHz

The Commission's rules do not specify a PFD limit in the 2200–2290 MHz band; however, there are PFD limits specified in rule No. 21.16 of the International Telecommunication Union (ITU) Radio Regulations. The maximum PFD levels for the Sherpa transmissions were calculated for the 2200-2290 MHz band, and Figure 2 below illustrates the PFD values in comparison with the ITU PFD limits. This figure

[17] Grant, ELS File No. 0211-EX-CM-2020 (effective Nov. 16, 2020).

represents the maximum transmitted EIRP when the satellite is at the worst-case 500 km altitude. Spaceflight will attenuate the transmitted RF power accordingly to meet the PFD limits.

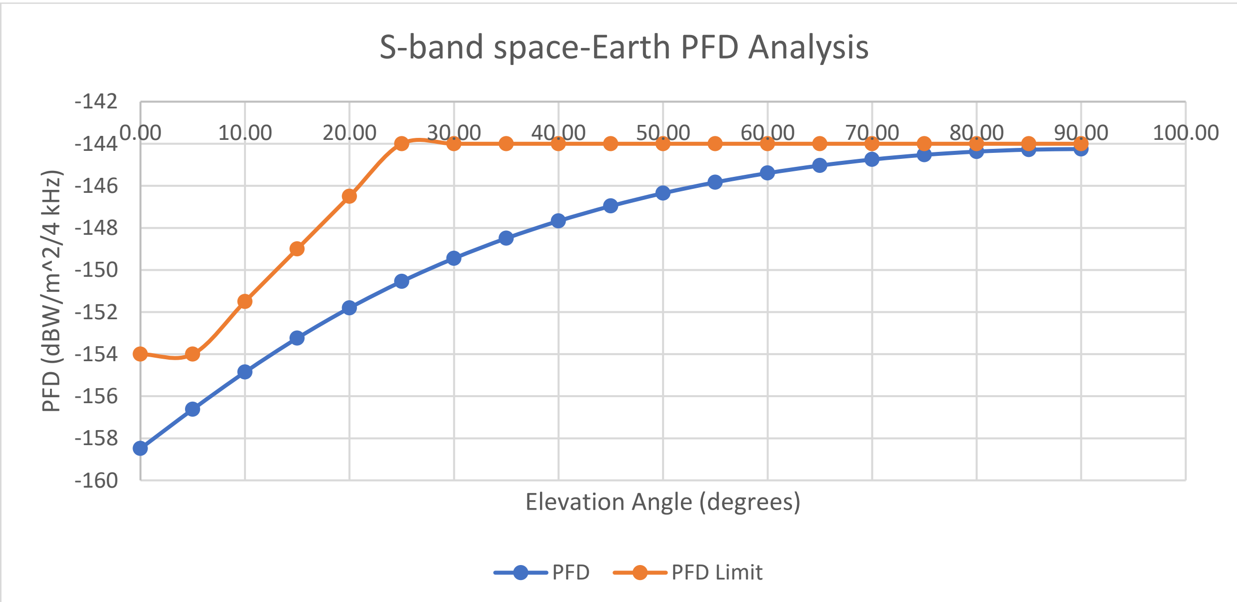

Figure 2: 2200-2290 MHz PFD analysis

2. *8025-8400 MHz*

As demonstrated below, Spaceflight will satisfy in-band PFD limits, adjacent-band power-spectral density limits, and internationally endorsed design guidelines applicable to existing EESS systems operating in the band.

PFD limits. The Commission's rules do not specify a PFD limit in the 8025-8400 MHz band; however, there are PFD limits specified in rule No. 21.16 of the ITU Radio Regulations. The maximum PFD levels for the Sherpa transmissions were calculated for the 8025-8400 MHz band, and Figure 3 below illustrates the PFD values in comparison with the ITU PFD limits. This figure represents the maximum transmitted EIRP when the satellite is at the worst-case 500 km altitude. Spaceflight meets the ITU requirement as demonstrated in the following chart.

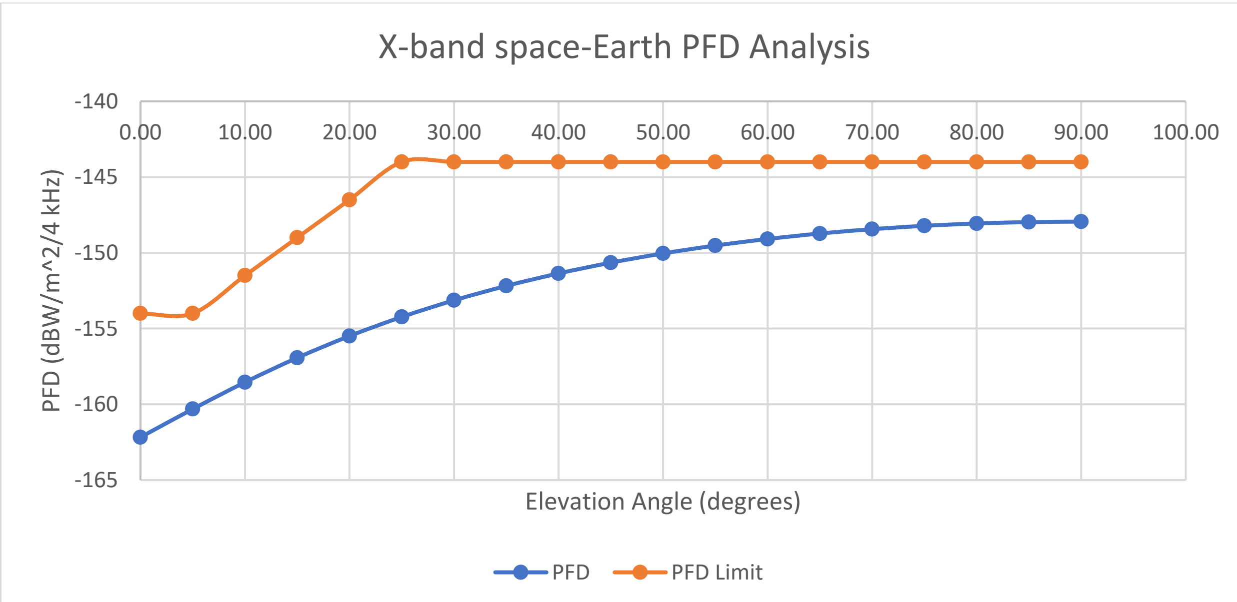

Figure 3: 8025-8400 MHz PFD analysis

Co-channel PFD at GSO arc. ITU Radio Regulations No. 22.5 specifies that in the 8025-8400 MHz band the maximum PFD produced at the GSO by any EESS space station shall not exceed -174 dbW/m^2/4 kHz. The calculation below shows that the PFD produced by the transmission from a Spaceflight spacecraft would not exceed that limit even in the worst hypothetical case.

Using the worst case (*i.e.*, highest altitude) orbit (600 km), the minimum distance to the geostationary orbit would be 35,186 km. At this orbital distance, for an antenna pointed toward the GSO arc having a maximum EIRP of 18 dBW in a fifty megahertz bandwidth, the maximum PFD at the GSO would be approximately -184.889 dBW/m^2/4 kHz.[18]

[18] This operation mode is atypical because the NGSO antenna will point toward earth in normal operation.

Adjacent-channel power spectral density ("PSD"). ITU-R Recommendation SA-1157 specifies a maximum allowable interference PSD level of -221 dB(W/Hz) to protect ground receivers in the deep-space research band operating in the 8400-8450 MHz frequencies. Spaceflight uses a combination of baseband digital filtering and hardware radio frequency filtering to achieve the ITU recommended protection for its out-of-band emissions in this frequency band.

ITU system-design guidelines for EESS operating in the band 8025-8400 MHz. Recommendation ITU-R SA.1810 includes various guidelines that EESS operators should follow to avoid potential difficulties in sharing the 8025-8400 MHz band. Spaceflight confirms that its system design in this band will satisfy the ITU guidelines.

VI. RESPONSIBILITIES OF OWNERS/OPERATORS OF SPACECRAFT TO BE DEPLOYED AND HOSTED PAYLOADS; CUSTOMER MANIFESTS

The current customer manifest for Sherpa-AC1 is attached as Exhibit 6. That manifest includes the identity of customers or, if different, operators and their authorizing administrations. Because the availability of customer spacecraft can change as the time of launch approaches, Spaceflight requests that it be granted authority to substitute non-separating mass module(s) for customer spacecraft that are not available.

The spacecraft to be deployed and the TROOP-3 hosted payload on Sherpa-AC1 are owned and to be operated by Spaceflight's customers or, in some cases, their operators. Each customer is expressly required under its agreement with Spaceflight to obtain and/or require its operator to obtain all licenses, authorization, clearances, and permits from their applicable administrations that may be necessary to operate its individual spacecraft or hosted payload. Further detail on the TROOP-3 hosted payload to be flown on Sherpa-AC1 is included in Exhibit 2, the Technical Annex, attached hereto.

The Xona navigational payload is a special case. As noted above, while it is owned and will be employed on a day-to-day basis by Xona, power for its operation comes from the Sherpa-AC1, and Spaceflight will have the ability to cease operation of the Xona navigational payload by cutting power to it. Upon the advice of the Commission staff, Spaceflight is therefore seeking to license the operation of the Xona navigational payload itself, rather than leaving it to Xona to license separately.

VII. OTHER MATTERS

A. Waiver Requests.

In addition to waivers for Spaceflight's non-conforming frequency uses, Spaceflight seeks waivers of the Commission's rules regarding surety bonds, modified processing round requirements, and, if deemed required, specific orbital information requirements in the Schedule S that are being submitted contemporaneously with this Application. Such waivers are addressed in Exhibit 7 hereto.

B. ITU Cost Recovery and SpaceCap

Spaceflight is preparing ITU filing information as required under Section 25.111(d) of the Commission's rules and will provide this information under separate cover. A signed declaration of unconditional acceptance of all consequent ITU cost-recovery responsibility is included here as Exhibit 9.

C. Notification of Intent to Commence Space Station Construction

Pursuant to Section 25.113(f) of the Commission's rules, Spaceflight hereby notifies the Commission of its intent to commence construction at its own risk of the satellite that is the subject of this Application.

D. NOAA Authorization

Sherpa-AC1 will have a camera onboard for the purposes of mission assurance and to confirm customer deployments. Spaceflight will file for and secure NOAA licensing.

VIII. LIST OF EXHIBITS

1. Application Narrative
    - Attachment A. Certification
2. Technical Annex
3. Xona Hosted Payload
    - Attachment A. Xona Hosted Payload Mission Description
    - Attachment B. Interference Analysis Result for Xona Alpha Mission
4. Sherpa-AC1 Orbital Debris Assessment Report (ODAR)
5. Sherpa-AC1 Long-Term Recontact Probability
6. SHERPA-AC1 Manifest
7. Waiver Requests
8. Ownership
9. ITU Cost Recovery Letter

IX. CONCLUSION

In view of the foregoing, grant of Spaceflight's Application is in the public interest, and it is respectfully requested that the Commission grant the Application expeditiously.

Respectfully submitted,

/s/ *Sasha Field*
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January 11, 2022

ATTACHMENT A

CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING ENGINEERING INFORMATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this application and associated attachments, that I am familiar with Part 25 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted in this Application and that it is complete and accurate to the best of my knowledge and belief.

/s/ *Philip Bracken*
Philip Bracken
Vice President of Engineering

Technical Annex

Figure 1: Spaceflight's Sherpa-AC1 Mission

Spaceflight, Inc ("Spaceflight") is planning to launch and deploy a Sherpa-AC on a Space Exploration Technologies Corporation ("SpaceX") Falcon 9 (the "Mission"). Sherpa-AC1 consists of **two (2) distinct missions**: (i) deploy customer spacecraft ("Deployment Phase"), and (ii) support a hosted payload at the Sherpa AC-1 injection orbit ("Hosted Payload Phase").

Sherpa-AC1 is scheduled to be launched by SpaceX on a Falcon 9 launch vehicle no earlier than June 2022. The Sherpa-AC1 will separate from the Falcon 9 upon receipt of a separation command from the launch vehicle once the launch vehicle reaches the destination orbit, targeted at 525-575 km, with a tolerance of ± 25 km (SpaceX will down-select a target altitude between 525 and 575 km and that altitude will have a ± 25 km tolerance). In addition to the Sherpa-AC1, the Falcon 9 will have multiple rings with SpaceX's own customers stacked above and/or below the ring to which Spaceflight's Sherpa-AC1 is attached.

Sherpa-AC1

Like previous missions, SSO-A[1], Sherpa-FX1[2], Sherpa-FX2[3], and Sherpa-LTE[4], Sherpa-AC1 consists of several structural elements to mount both microsatellites and CubeSat dispensers. Sherpa-AC1's primary mission ("Deployment Phase") is the anticipated deployment of seven customer spacecraft being carried by the vehicle. This Deployment Phase is anticipated to last for less than six (6) hours after launch. During this phase, the Sherpa-AC1 vehicle will deploy customer spacecraft in the same way as the Sherpa-FX1, Sherpa-FX2, and Sherpa-LTE1.

[1] SAT-STA-20180523-00042.
[2] SAT-STA-20200728-00089.
[3] SAT-STA-20210205-00017.
[4] SAT-STA-20210205-00017.

Sherpa-AC1 utilizes the R2A-Core system for its Deployment Phase to command the deployment of customer spacecraft into SSO. Sherpa-AC1 will also have one (1) camera onboard for the purpose of mission assurance and to confirm customer deployments. Spaceflight provides the launch capacity, structure, separation systems, and integration services for the customer spacecraft. Sherpa-AC1 will be attached to a single port on a SpaceX-provided payload ring. Once a separation signal is received by Sherpa-AC's separation system from SpaceX's Falcon 9 avionics, Sherpa-AC1 will separate. The internal volume of Sherpa-AC1 will contain the R2A-Core sequencer and batteries. After Sherpa-AC1's separation from Falcon 9 (and a subsequent delay in accordance with SpaceX requirements), once activated, the R2A-Core will initiate its own separation sequence to deploy customer spacecraft.

The R2A-Core also activates the Black Box Standard S3 Black Box Radio (provided by NearSpace Launch, and more fully described below) and, specifically, the L-band transmitter that sends deployment confirmation telemetry to the Globalstar constellation for relay by commercial Globalstar and NearSpace Launch data services to Spaceflight.

The Sherpa-AC1 Deployment Phase is anticipated to last less than six (6) hours, and all communications from R2A-Core will stop at or before 36 hours after launch. The R2A-Core is equipped with an S-band receiver contained within the Black Box Standard Radio to allow a kill-command to be sent from a ground station to deactivate the transmitter in the event of radio frequency interference. The R2A-Core will also have an on-board timer to cut off its transmissions several hours after the end of the planned deployment cycle. If all else fails, battery life is expected to be exhausted by 36 hours into the mission.

Sherpa-AC1 Xona Hosted Payload Mission

During the Hosted Payload Phase, a new subsystem will be enabled in addition to the previously-flown onboard computer with sensors and effectors to provide command and control over the Sherpa vehicle. This command and control will make use of traditional, flight-proven, small satellite control systems (reaction wheels, star trackers, magnetic torque rods, etc.) to detumble and stabilize the Sherpa vehicle in a known attitude and then point the vehicle toward the sun for solar panel charging

For the Hosted Payload Phase, Spaceflight will use flight-proven space-to-ground communications over UHF and S-band for command and health data TT&C. In addition, Sherpa-AC1 will include a new dual X-band[5] and S-band transceiver to test capabilities for greater situational awareness and higher data rates, as well as greater levels of encryption. The higher data rates will allow Spaceflight to deliver on-demand images and video of customer spacecraft separating from the Sherpa-AC1, while providing additional data uploads and downloads for the hosted payload customer and as a proof of concept for future operations. Communication frequency and earth station details for the Hosted Payload Phases of the Sherpa-AC1 mission are provide in Exhibit 1.

RF System Design – R2A-Core

The R2A-Core has an L-band transmitter, an S-band receiver, and a GPS L-band receiver. The L-band transmitter broadcasts through one simplex patch antenna to the Globalstar constellation using the Black Box Standard S3 Black Box Radio from NearSpace Launch, the same system that flew on the

Sherpa-FX1, Sherpa-FX2, and Sherpa-LTE1 missions. The Black Box Standard S3 Black Box Radio has an absolute temperature operating range between -40° C and 60° C. If found to be outside of that range for too long, the transmitter will stop working. The Black Box Standard S3 Black Box Radio unit transmits 99.00% of its radiated power within 1.8817 MHz of the specified 2.5 MHz bandwidth. The Black Box Standard S3 Black Box Radio also includes an integrated Novatel GPS receiver module that works in conjunction with a GPS patch antenna. Other radio property details are shown in Exhibit 1.

RF Concept of Operations

The L-band avionics systems are set to beacon data to the Globalstar constellation from activation until cut off by a timer set to shut off transmissions once the deployments of all customer spacecraft are complete. The duty cycle for the L-band system is a transmission up to 10 seconds every 20 seconds (30 seconds of broadcast time per minute; a 50% duty cycle). The L-band transmitter will continue to broadcast until the earliest of the following:

- Programmed stop (via R2A-Core's onboard mission sequence); or
- Kill command from NSL S-band ground transmitter (see below); or
- Battery depleted (no more than 36 hours after starting).

The Black Box Standard S3 Radio has an S-band uplink that can receive a kill command from the Near Space Launch ground station in Indiana. The Black Box Standard S3 Black Box Radio S-band receive antenna's sole purpose is to receive a kill command from the ground.