SPACEFLIGHT

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October 5, 2021

**FILED ELECTRONICALLY VIA IBFS**
Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
45 L Street, N.E.
Washington, DC 20554

Re: Spaceflight, Inc.;
Errata to Application for Special Temporary Authority ("STA") to deploy and operate Sherpa-LTC1, File No. SAT-STA-20210812-00098

Dear Ms. Dortch:

Spaceflight, Inc. ("Spaceflight"), responds to questions from the Commission regarding the above referenced application for special temporary authority for the Sherpa-LTC1 spacecraft. The questions are formatted in italics with Spaceflight's responses below.[1]

1. *The Spaceflight application describes use of S-band uplinks to Sherpa as part of the "Demonstration Mission," with bandwidths of 300 KHz and 5 MHz in the 2025-2110 MHz band, and an S-band downlink with a bandwidth of 500 KHz in the 2200-2290 MHz band, for purposes of tracking telemetry and command, including imagery confirming customer payloadseparation. Please address in greater detail the need for the uplink with a 5 MHz bandwidth.*

The 5 MHz uplink channel will allow Spaceflight to update Sherpa's flight software far more efficiently than can be achieved using the lower data-rate 300 kHz bandwidth that has been used for the Sherpa-LTE1 mission. Sherpa-LT vehicles are an incremental development and from the 300 kHz bandwidth used for Sherpa-LTE1 indicated a need for faster uploads to iterate, test, and, as needed, deliver patches to Sherpa-LT flight software during the mission life. Spaceflight estimates that a flight computer upload

[1] Footnotes contained in the questions have been deleted for clarity.

that might take a month on a 300 kHz channel could be completed in one or two passes, no more than a day, using a 5 MHz channel.

Uploads using this 5 MHz uplink are expected to be brief and infrequent. In Spaceflight's efforts to coordinate with government users of the band, no objections or concerns have been raised about the size of the channel.

2. *Spaceflight states that a transceiver capable of operating in X-band and S-band will be used solely in the S-Band to test capabilities for greater situational awareness and higher data rates, aswell as greater levels of encryption. Spaceflight states that the unit is designed to include both X-band and S-band elements, and that while it is "not practical physically to prevent the X-band from being capable of transmitting while keeping the S-band transmitter active. Nevertheless, Spaceflight will not seek authority to transmit in X-band and will not transmit for any purpose inX-band during the Mission." Please describe the steps Spaceflight will take to ensure that this transceiver will not operate in the X-band for any purpose at any time during the 180-day period.*

There are two system inhibitors in place to prevent the use of the X-band transmission capability. First, there is a hardware switch that is turned off in order to prevent power from flowing to the X-band transmitter. This switch can only be turned on by a directed optical transmission to the transmitter.

Second, the transmitter software must be configured to allow for transmission over the X-band system. The software will not be configured for X-band transmissions at the time of launch. Spaceflight's operator training program and script review process will ensure no scripts on board or uploaded to Sherpa will enable the X-Band transmission functions of the transceiver.

3. *Please specify Sherpa-LTC1's deorbit plan vis-a-vis protection of inhabitable spacecraft. This includes a description of operational strategies, if any, to avoid collision with the International Space Station (ISS), as well as the Chinese space station.*

Spaceflight plans to terminate Sherpa's mission ("safe the vehicle") at least 25-50 km above the orbits of inhabitable spacecraft. Spaceflight intends to end Sherpa's mission in an orbit which is as circular as we can obtain.

The Sherpa spacecraft is sufficiently large to be tracked by ground-based radars and be avoided like any other non-operational spacecraft as it gradually falls through the orbit of each inhabitable spacecraft.

As with its previous LTE1 mission, Spaceflight will coordinate the de-orbit path of the LTC1 with NASA in order to ensure that the Sherpa-LTC1 does not pose a threat of collision with the ISS. Representatives of Spaceflight have been added to the ISS program TLE short-and long-term forecasts and Spaceflight will also provide our planned maneuvers to the 18th Space Control Squadron for any major maneuvers so they can run a conjunction analyses.

4. *Spaceflight's Orbital Debris Assessment Report (ODAR) states in a single instance on page 6 that deorbit of the Sherpa-LTC1 will be accomplished in 6.9 years. The ODAR at pages 7 and20 state a figure of 9.2 years. Please address whether the 6.9 year figure was an error, or whether it was based on alternative assumptions.*

The 6.9 year figure is an error and Spaceflight regrets the mistake and confusion. The deorbit of Sherpa-LTC1 will be accomplished in 9.2 years.

5. *The ODAR states at page 14 that both primary and secondary batteries will deplete all charge within 36 hours. Please clarify whether this is describing the battery capability during the mission or only as part of end-of-life procedures for when the system is no longer connected tothe battery charge circuits.*

The referenced sentence referred to the batteries for the R2A Core. Sherpa LTC1 will use two redundant batteries to power the R2A-Core sequencer in order to conduct the first stage of its mission, which is functionally similar to the typical Sherpa-FX mission. The batteries both deplete within 36 hours of the beginning of the mission.

These batteries will remain depleted and non-functional as Sherpa-LTC1 continues its mission and descends to a lower orbit for the demonstration phase of the mission.

The Sherpa-LTC1 will rely on a four lithium-ion cell battery and another lithium-ion battery with two modules made up of seven cells each to provide power to its transmitters during the demonstration phase of its mission. Please note that this corrects information about these batteries that appeared in the original Sherpa-LTC1 ODAR.

6. *The ODAR Debris Assessment Report describes several materials that have a non-zero debris casualty area output risk. Please describe the material compositions of the OX Tank Assembly,fuel tank, pressurant tanks and thruster assembly. To what extent did Spaceflight implement adesign-to-demise approach during the spacecraft design stage? What if any alternative materialsor designs were considered?*

Spaceflight sought to develop a fully demisable design for the Sherpa-LTC1 and incorporated reentry analysis early in its product development program. However, design and timeline constraints prevented Spaceflight and its vendors from developing a fully demisable Spacecraft. Demisability remains a key consideration for Spaceflight and it will seek to develop more demisable Sherpa spacecraft as the program develops.

Below are more detailed responses to each component identified by the Commission:

- Fuel tanks and OX tank assembly: Material strength, propellant compatibility, and manufacturing supply chain concerns resulted in the selection of the chosen stainless steel alloys for these tanks. No viable option was found for demisable materials that met the minimum required strength and material compatibility requirements within the program schedule. Aluminum tanks were evaluated but Spaceflight and its vendors could not develop an aluminum tank that would fit on the Sherpa-LTC1 spacecraft and have the strength needed to house the tank's contents safely. Spaceflight will continue to develop aluminum tank solutions, which should have less mass and demise earlier than steel in the hopes of deploying demisable aluminum tanks on future Sherpa vehicles.

- Pressurant tanks: The pressurant tanks are 3D-printed Ti64. This material was chosen to minimize mass due to the strength-to-weight of titanium and the ability to source custom dimensions through additive manufacturing, so the tanks fit within the allowed space on Sherpa. Composite Overwrapped Pressure Vessels (COPV) have better demise characteristics than Ti64 but a COPV solution could not be developed within the time constraints of the Sherpa-LTC1 mission. A COPV tank may be an option for future missions if Spaceflight is able to source tanks of suitable dimensions in the future.

- Thruster assemblies: The thruster assemblies are a combination of SS-316L welded to C1-4 Niobium. These are bolted to a Ti64 mounting plate. These materials are necessary due to their ability to withstand the high temperatures of the propellant combustion.

7. *Starting on page 25 of the ODAR, the initial mass was entered into calculations as 400 kg. Please confirm the mass of the LTC1, the mass of solid propellant on board the LTC1 and themasses of the customer spacecraft on board as separate entries. If the combined values are not400 kg, please rerun the DAS analyses using the correct mass value and resubmit the results. Additionally, please indicate where the 400 kg value originated.*

The below table details the payload onboard the Sherpa-LTC1. The total mass of the Sherpa-LTC1 and the relevant customer spacecraft is 398.86 kg. There is approximately .25% of uncertainty in the mass of the customer spacecraft and Spaceflight has used the 400 kg value to account for and envelope that uncertainty.

| **Item** | **Mass (kg)** | **Notes** |
|---|---|---|
| Sherpa-LTC1 | 272.46 | includes 39 kg usable propellant and 3 kg of residuals (unusable propellant + GN2 pressurant) |
| Hawk 5A | 29.0 | MicroSat |
| Hawk 5B | 29.0 | MicroSat |
| Hawk 5C | 29.0 | MicroSat |
| Kleos KSF2a | 6.8 | 6U CubeSat |
| Kleos KSF2b | 6.8 | 6U CubeSat |
| Kleos KSF2c | 6.8 | 6U CubeSat |
| Kleos KSF2d | 6.8 | 6U CubeSat |
| LLITED | 5.0 | 2x 1.5U CubeSat (combined total mass) |
| SPiN1 & OreSat0 | 3.3 | 2x 1U CubeSat (combined total mass) |
| Spacemanic VZLUSAT-2 | 3.9 | 3U CubeSat |
| .25% Uncertainty | .99 | |
| **Total Mass** | **400** | |

8. *On page 9 of the ODAR the following tables with descriptions are included:*

***Total satellite mass at launch, including all propellants and fluids, potential mass growth anduncertainties:***

| | |
|---|---|
| *Sherpa-LTC1* | *362 kg* |

***Dry mass of satellites at launch, excluding solid rocket motor propellants, but including potential massgrowth and uncertainties:***

| | |
|---|---|
| *Sherpa-LTC1* | *360.4 kg* |

***Dry mass of satellites at end of mission, excluding solid rocket motor propellants:***

| | |
|---|---|
| *Sherpa-LTC1* | *258 kg* |

*Please identify if the customer spacecraft are considered as wet or dry masses, as well as identifying the reason why multiple satellites are indicated by the accompanying text.*

Unfortunately, these values are in error and Spaceflight regrets the confusion. The Sherpa-LTC1 wet mass at launch is 400 kg, including 39 kg usable propellant and 3 kg of residuals. The Sherpa-LTC1 dry mass (counting customer spacecraft as dry masses) at launch is 357 kg. The Sherpa-LTC1 dry mass at end of mission is 230.5 kg. As addressed further below, the Sherpa-LTC1 does not employ any solid rocket motor propellants.

Spaceflight also confirms that the above analysis refers to only a single spacecraft, the LTC1. Spaceflight regrets this error and apologizes for the confusion.

9. *Would the Sherpa-LTC1 contain any non-separating mass models in the event that any customerspacecraft are not integrated prior to launch? Please indicate whether Spaceflight would utilize such mass models and if so, please provide an updated ODAR analysis at the time of spacecraft integration.*

Yes, Spaceflight may implement non-separating mass models in the event that a mass model is deemed necessary for mass & balance. Spaceflight designs all mass models to demise according to DAS analysis. Spaceflight will provide updated ODAR analysis once Spaceflights knows for certain which non-separating mass models will be flown.

10. *Please describe in more detail the solid fuel chemical propulsion system planned for Sherpa-LTC1, including specifically identifying the propellant. Please provide the maximumparticulate size released from the system during the lifetime of operations.*

Sherpa-LTC1 does not contain any solid propellant and mistakenly omitted this information from its application. Spaceflight apologizes for the error. The Sherpa-LTC1 uses the following liquid fuels:

- 34.3 kg high-test peroxide (oxidizer) at 300 psi
- 6.5 kg isopropyl alcohol (fuel) at 300 psi
- 1.22 kg nitrogen gas (pressurant) at 6,000 psi

Sherpa-LTC1's propulsion system propellants are high-test peroxide (HT) and isopropyl alcohol (IPA). The pressurant is nitrogen gas and there is no risk of hazardous persistent liquid droplets. Both propellants have non-zero vapor pressure. All exhaust products should be molecular in nature and there will be no particulates upon release.

When HTP liquid is exposed to vacuum, it will immediately evaporate into small crystals. Once exposed to sunlight, the crystals will sublimate into vapor and disperse, therefore no droplets will remain. When liquid IPA is exposed to vacuum, it will immediately evaporate, but its freezing point is unlikely to be achieved in low Earth orbit, so it will remain a vapor and disperse and not form droplets or crystals. The gaseous nitrogen will remain gaseous and rapidly disperse. It will not refreeze in low Earth orbit.

Questions with respect to this matter should be referred to the undersigned.

Sincerely,

/s/ *Will Lewis*
Will Lewis
Sr. Manager, Regulatory