



December 21, 2022

**BY ELECTRONIC FILING**

Marlene H. Dortch  
Secretary  
Federal Communications Commission  
45 L Street, N.E.  
Washington, DC 20554

Re: *IBFS File No. SAT-AMD-20221216-00175, Callsign: S3069*

Dear Ms. Dortch:

Space Exploration Holdings, LLC (“SpaceX”) hereby provides supplemental information to the Commission regarding the above-captioned Amendment seeking U.S. space station authority for very-high frequency (“VHF”) beacons that SpaceX will operate as part of its second-generation non-geostationary orbit (“NGSO”) satellite system (the “Gen2 System”) during the launch and early operations phase (“LEOP”) and in the rare event of an on-orbit emergency.<sup>1</sup>

**A. German Payload License and ITU Filings**

As discussed in an earlier supplement to the Commission and in the Amendment, the proposed beacons were previously licensed for launch and operation through the German administration,<sup>2</sup> which has submitted the system for coordination with the International Telecommunication Union (“ITU”) under the name ASTROBIENE.<sup>3</sup>

- CR/C/5264 in BR IFIC 2925, including modifications in BR IFIC 2935 and under ITU processing no. D2021-37348; and,
- API/A submission under ITU processing no. D2021-37474.

These beacons have been authorized for mobile-satellite service (“MSS”). SpaceX has maintained that MSS designation for purposes of the Amendment even though it proposes only to use the beacons for back-up telemetry, tracking, and command (“TT&C”) functions on Gen2 satellites communicating with fixed Earth stations. Accordingly, SpaceX has no objection to a condition limiting its beacon operations in this way on the Gen2 satellites.

---

<sup>1</sup> See *Space Exploration Holdings, LLC*, FCC 22-91 (rel. Dec. 1, 2022).

<sup>2</sup> See Assignment of Orbit and Frequency Usage Rights, No. 223-3 SWARM ASTROBIENE 20220615 (issued Jun. 15, 2022).

<sup>3</sup> Dates of receipt on February 6, 2020, 4 March 2021, March 11, 2021, and December 8, 2020 at the ITU Radiocommunication Bureau.

## B. Other Related Applications

In addition to the instant Amendment, SpaceX and SpaceX affiliate Swarm Technologies, Inc. (“Swarm”), have filed nine additional applications related to the proposed use of these beacons, as summarized in Table 1 below.

Description		IBFS File No.	Call Sign	Date Filed
Space Station Amendment		SAT-AMD-20221216-00175	S3069	Dec. 16, 2022
Earth Station Modifications	Sussex, NJ	SES-MOD-20221216-01367	E190858	
	Wailuku, HI	SES-MOD-20221216-01364	E190859	
	Piti, Guam	SES-MOD-20221216-01365	E191406	
	Draper, UT	SES-MOD-20221216-01370	E210061	
Space Station Special Temporary Authority		SAT-STA-20221215-00174	None	Dec. 15, 2022
Earth Station Special Temporary Authority	Sussex, NJ	SES-STA-20221215-01372	E190858	
	Wailuku, HI	SES-STA-20221215-01361	E190859	
	Piti, Guam	SES-STA-20221215-01374	E191406	
	Draper, UT	SES-STA-20221215-01375	E210061	

**Table 1. Related VHF Beacon Applications**

## C. Beacon Number and Orbits

Due to limitations in the Schedule S software, SpaceX could not include in the Schedule S the full details on its request to operate 450 VHF beacons across three orbital ranges. Instead, the Schedule S associated with the Amendment lists a single satellite at each of the three orbital shells of the Gen2 system: 525 km altitude at 53 degree inclination, 530 km altitude at 43 degree inclination, and 535 km altitude at 33 degree inclination. SpaceX included this information to indicate that SpaceX would operate no more than 450 VHF beacons across those three shells. The actual deployment and operational altitudes of the Gen2 System will align with the deployment and operational altitudes of the VHF beacons as described herein. However, as stated in the Amendment, at no point would more than 450 beacons operate at one time across the entire Gen2 constellation (LEOP and on-station).

#### **D. VHF Beacon Power-Flux Density**

The VHF beacons are designed to limit out-of-band emissions to prevent interference with operations in adjacent bands, as well as with terrestrial, radio astronomy, and Federal government operations. The power flux density (“PFD”) at the Earth’s surface from the VHF downlink transmissions in the 137-138 MHz band will not exceed -125 dBW/m<sup>2</sup>/4kHz, and emissions into the 150.05-153 MHz radio astronomy service band will not exceed -259 dBW/m<sup>2</sup>/Hz. Furthermore, the spectrum mask for VHF Beacon emissions complies with the limits set forth in Section 25.202(f) of the Commission’s rules.

The VHF beacon downlink (space-to-Earth) operations will be conducted in the 137-138 MHz band. The ITU specifies that space stations transmitting in the 137-138 MHz band require coordination with terrestrial services only if the PFD produced by the space station exceeds -125 dBW/m<sup>2</sup>/4kHz at the Earth’s surface.<sup>4</sup> As shown in Table 2, transmissions from the VHF beacons will not exceed this threshold in any angle of arrival for any operational altitude down to 300 km, which includes altitudes at which Gen2 satellites may be initially inserted into orbit.

Maximum Power Flux Density (dBW/m <sup>2</sup> /BW)						
BW per:	0°-5°	5°-10°	10°-15°	15°-20°	20°-25°	25°-90°
4.0 kHz	-129.4	-129.3	-129.2	-129.0	-128.8	-125.9

**Table 2: Maximum PFD of the VHF Beacons at their minimum operational altitude (300 km)**

#### **E. VHF Beacon Transmission Bandwidth**

In this section, SpaceX provides additional details on the VHF beacon bandwidth addressing limitations in the Schedule S software. Specifically, because the Schedule S software automatically rounds up from 0.025 MHz to 0.03 MHz, the Schedule S associated with the Amendment lists bandwidths of 0.03 MHz.<sup>5</sup> In fact, during operations, the bandwidth of the VHF beacon transmission is 25 kHz (single-sided) and 50 kHz (double-sided). As a specific example, the VHF beacons will receive an uplink transmission on the 149.90-149.95 MHz band over the 50 kHz bandwidth channel with a center frequency of 149.925 MHz.

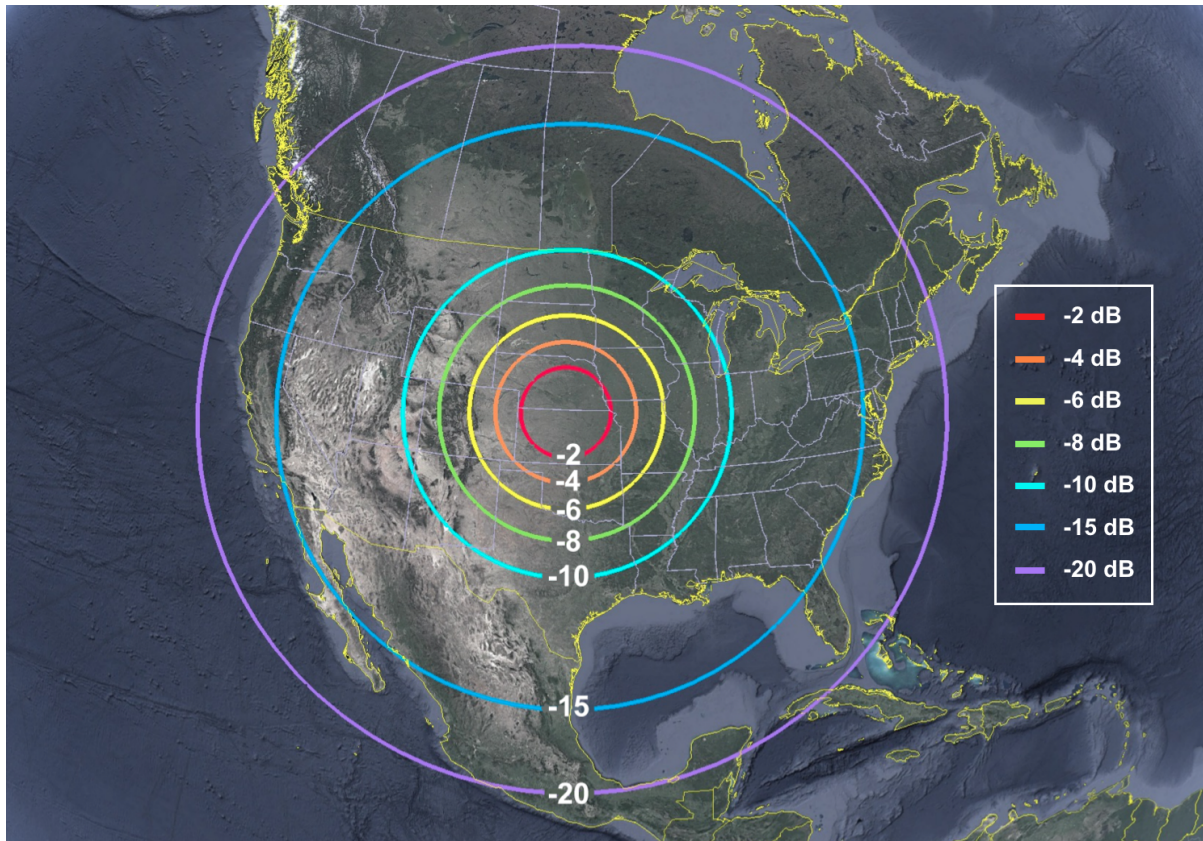
#### **F. VHF Beacon Antenna Gain Contour**

The antenna gain contours for the transmit beam for a VHF beacon are shown in Figure 1. The antenna gain contours are depicted on a projection of the Earth with the peak antenna gain for a VHF beacon pointed at nadir to a latitude and longitude within the proposed service area. The contours are plotted at -2, -4, -6, -8, -10, -15, and -20 dB relative to the peak antenna gain.

<sup>4</sup> See 47 C.F.R. §2.106 at International Footnote 5.208 and ITU Radio Regulations, Appendix 5, Annex 1 ¶ 1.1.1.

<sup>5</sup> This is consistent with the Schedule S presentation in the application granted for Swarm’s own authorization. See *Swarm Technologies, Inc.*, 34 FCC Rcd. 9469 (IB 2019).

Antenna gain contours for the omnidirectional transmit and receive antennas are also provided as attachments to the Schedule S filed with the Amendment. Those are provided in Exhibit A for ease of reference. Note that the antenna gain patterns are the same for uplink and for downlink.



**Figure 1. Antenna gain contours for a single VHF Beacon at its minimum operational altitude**

### **G. Upcoming Gen2 System Launch Plans**

SpaceX currently anticipates that it will begin launching Gen2 satellites on December 28, 2022. This launch will be followed by several additional launches in January and February 2023. In each of these launches, SpaceX expects to launch at least 10 Gen2 satellites equipped with VHF tracking beacons for use only during LEOP or in an emergency, and while SpaceX is seeking authorization for up to 450 satellites, it anticipates that the total number in operation at any one time will be significantly lower.

\* \* \*

SpaceX appreciates the Commission's attention to this matter and urges it to process the Amendment application expeditiously to enable SpaceX to operate safety-enhancing VHF beacons in the United States to support critical LEOP and emergency operations for its Gen2 constellation.

Sincerely,

*/s/ David Goldman*

David Goldman  
Senior Director, Satellite Policy

SPACE EXPLORATION TECHNOLOGIES CORP.  
1155 F Street, NW  
Suite 475  
Washington, DC 20004  
Tel: 202-649-2641  
Email: [David.Goldman@spacex.com](mailto:David.Goldman@spacex.com)

## EXHIBIT A: VHF Beacon Antenna Gain Contours (Transmit and Receive)

