SPACEX

May 29, 2026

VIA ELECTRONIC FILING

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

Re: *ICFS File No. SAT-LOA-20260108-00016*

Dear Ms. Dortch:

SpaceX supplements the record for its pending application with the following clarifications at the Commission's request.

1. SpaceX has requested authority for radiofrequency operations in the 18.8-19.3 GHz (space-to-Earth) and 28.6-29.1 GHz (Earth-to-space) bands as "backup communications" for telemetry, tracking, and command (TT&C). SpaceX states that its system will "primarily rely upon optical inter-satellite links, which may connect among or between those satellites and satellites in SpaceX's first- and second-generation Starlink system." We seek clarification as to how the radiofrequency will be used in the system. Given the backup use of the radiofrequency, how many space stations does SpaceX expect will be operating at any one time? In the event where optical intersatellite links are unavailable, how would SpaceX ensure safe control and operation of its constellation while protecting other Ka-band operators from harmful interference?

SpaceX requested authorization to use the non-geostationary orbit ("NGSO") primary portion of the Ka-band for Fixed-Satellite Service ("FSS") backup communications, including telemetry, tracking, and command ("TT&C") and other critical backup operations, on a non-interference, unprotected basis.[1] SpaceX will not operate these Ka-band antennas for continuous use, but rather will use them only in the rare event an issue arises with the primary optical inter-satellite links or laser equipment on a given satellite—i.e., the Ka-band links are cold backup only. Because SpaceX will only transmit in the Ka-band to address an issue with its optical intersatellite links, the nominal number of space stations transmitting via radiofrequency at any one time is zero. Critically, use of these frequencies will occur only when satellites are not operating nominally, so any restrictions on their use above normal Commission and international rules could risk losing satellites and increasing risk to space sustainability.

In the event SpaceX does require use of radiofrequencies, SpaceX will rely on the Ka-band for safe control and operation of the satellite and other critical backup operations. On these

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[1] *See* Application for Launch and Operating Authority for the SpaceX Orbital Data Center System, ICFS File No. SAT-LOA-20260108-00016, Narrative at 6, Technical Attachment at A-2, Schedule S at Section S2 (filed Jan. 30, 2026).

occasions, SpaceX will take several steps to protect other co-primary NGSO and terrestrial Ka-band users from harmful interference. For example, SpaceX will conduct its Ka-band operations using high-gain, directional beams with low sidelobes to reduce the risk of in-line events with other NGSO operators. Moreover, SpaceX will primarily conduct these operations using its existing network of earth stations, which operate pursuant to applicable coordination and spectrum sharing requirements to protect other authorized spectrum users. SpaceX will also comply with applicable backstop NGSO-NGSO sharing limits to protect other NGSO systems authorized through processing rounds. And SpaceX will meet applicable PFD limits to protect terrestrial users on the ground.

2. In order to render the application suitable for further processing, provide the following information and documentation: The necessary waiver request for SpaceX's proposed operations of TT&C-only in the 18.8-19.3 GHz and 28.6-29.1 GHz bands, which are only allocated to the Fixed-Satellite Service.

SpaceX's proposed backup radiofrequency communications constitute FSS operations within a band allocated for FSS, and therefore do not require a waiver of the Commission's rules.[2] The Commission and ITU Radio Regulations define FSS as a "radiocommunication service between earth stations at given positions, when one or more satellites are used,"[3] irrespective of the content of those radiocommunications. Here, SpaceX's backup communications would include TT&C, but may also include limited transmissions of non-TT&C content from the computing hardware on the satellite to terrestrial systems—e.g., downlinking AI inference results for end users before disposing of a satellite.

The Commission routinely grants NGSO operators authority to conduct TT&C operations in FSS bands without requiring a waiver, as demonstrated by numerous prior NGSO systems[4] that have relied on the explicit permission in 47 CFR § 25.202(g) and the domestic allocation table. Because SpaceX's proposed use falls within these established rules and definitions, a waiver is not necessary when the existing framework already provides the requested flexibility for backup communications and TT&C operations.

3. SpaceX states that it will operate "up to one million satellites" at "altitudes between 500 km and 2,000 km and at 30 degree and sun synchronous inclinations" and "within narrow orbital shells spanning up to 50 km." SpaceX provided a representative orbital configuration in its consolidated opposition and response. SpaceX describes four separate satellite groups at altitudes ranging from 686 km to 1,002 km. Is this the specific orbital configuration for which SpaceX seeks authorization, or does SpaceX seek greater flexibility in its deployment and operations? Please provide the following information:

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2 *See id.*

3 47 C.F.R. § 25.103; ITU Radio Regs. 1.21.

4 *See, e.g., Space Exploration Holdings, LLC*, 37 FCC Rcd. 14882, ¶¶ 42, 53 (2022) (authorizing Gen2 system to perform TT&C in the 12.15-12.25 GHz and 18.55-18.6 GHz bands); *Space Exploration Holdings, LLC*, 39 FCC Rcd. 2159, ¶¶ 7–8 (SB 2024) (authorizing TT&C in E-band FSS spectrum).

a. The nominal operating altitudes for all of SpaceX's proposed orbital shells.
b. The number of orbital planes and number of satellites in each plane for each operational altitude, or if greater flexibility is requested, the maximum number of planes and maximum number of satellites per plane for each operational altitude, as well as the nature of the flexibility in operations requested. Please provide this information in a spreadsheet.

The configuration SpaceX provided in its consolidated opposition and response is only representative and may not be the specific operational configuration for the system.[5] To supplement the record, SpaceX provides an updated orbital configuration below:

Group	Altitude Range (km)	Inclination Range (deg)	Number of Shells	Planes Per Shell	Satellites Per Plane	Maximum Satellites per Group
1	550-568	26-32	10	30	333	99,900
2	565-585	97.7	10	2	4,999	99,980
3	686 - 718	30	25	30	333	249,750
4	707 - 744	97.2	22	2	5,565	244,860
5	946 - 978	30	25	30	333	249,750
6	967 - 1002	99.4	22	2	5,770	253,880
TOTAL						1,000,000

Table 1: Orbital Configuration

SpaceX also seeks flexibility in altitude and inclination tolerances for its nominal altitudes that align with those of the ITU under Resolution 8 of the Radio Regulations.[6]

4. The application is missing certain orbital debris information required by the Commission's rules. Please clarify when SpaceX intends to submit the missing information and indicate whether SpaceX seeks a grant of authority conditioned upon providing and receiving approval of an updated orbital debris showing. The missing information includes:

SpaceX requests authorization for the full constellation of one million satellites subject to the Commission's orbital debris rules and evolving space sustainability best practices. SpaceX will launch and operate its satellites beginning with the orbital shells at nominal altitudes below 600 km and provides a high-fidelity analysis of small and large object collision risk for those shells. SpaceX will supplement the record with additional orbital debris information for satellites operating above 600 km prior to their deployment to better reflect its compliance at that time. SpaceX seeks approval of the entire fleet conditioned on filing a supplement in the record

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5 *See* Consolidated Opposition to Petitions and Response to Comments of Space Exploration Holdings, LLC, ICFS File No. SAT-LOA-20260108-00016, at 5-6 (Mar. 16, 2026).

6 *See* ITU Radio Regs., Res. 8 (WRC-23).

confirming that satellites operating above 600 km will meet all applicable orbital debris mitigation rules and thresholds.

a. The NASA DAS logs showing a small object collision risk probability of less than 0.01.

Rather than provide a lower-fidelity analysis using NASA's Debris Assessment Software ("DAS"), SpaceX performs a higher-fidelity small debris collision risk assessment using the European Space Agency's Debris Risk Assessment and Mitigation Analysis ("DRAMA") tool. Such submission is consistent with the Commission's rules that require applicants to state whether "the space station operator has assessed and limited the probability that the space station(s) will become a source of debris by collision with small debris or meteoroids that would cause loss of control and prevent disposal," indicating "whether this probability for an individual space station is 0.01 (1 in 100) or less, as calculated using the NASA Debris Assessment Software or a higher fidelity assessment tool." [7] To provide a higher fidelity small object collision risk probability than NASA's DAS allows, SpaceX uses ESA's DRAMA to assess the collision probability of small debris rendering a satellite unable to complete planned disposal. SpaceX is applying a design criterion for its satellites that will keep the individual satellite small debris collision probability below 1e-4 over the design life of the satellite, which is two orders of magnitude below the Commission's requirement.

To complete its small debris risk analysis, SpaceX thoroughly assesses its satellite design and identifies components without sufficient redundancy (e.g., battery assemblies and propulsion system) that, if disabled by a small debris strike, would render the satellite incapable of completing planned disposal. SpaceX then develops a high-fidelity, multi-faceted component input for DRAMA using CAD drawings to ensure each component's size, thickness, density, orientation and position relative to other components, structure, and shields are accurately modeled. Each component is discretized into multiple flat sub-surfaces to account for differences in surface normal direction, relative shielding angles, tank/surface curvature, surrounding structure and neighboring components that could act as shields.

All flat subsurfaces are then added to DRAMA's MASTER-based Impact Flux and Damage Assessment ("MIDAS") tool for the collision/perforation assessment using debris and micrometeorite flux generated using DRAMA's Meteroid and Space debris Terrestrial Environment Reference ("MASTER") model—note that while NASA's DAS only assesses against debris smaller than 10 cm for Requirement 4.5-2, SpaceX included micrometeorite flux in DRAMA to ensure the assessment is complete and conservative. The derived flux is used to compute a collision probability and probability of tank leakage across the satellite's design life.

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[7] 47 C.F.R. § 25.114(d)(14)(ii). Note that the rule does not require submission of DAS logs assessing small object collision risk, and the Commission has not required other applicants to provide such logs. For example, although the Commission specifically required Amazon to modify its original NGSO authorization by submitting an orbital debris mitigation plan, that plan was approved without submission of any DAS logs. *See Kuiper Systems LLC*, 38 FCC Rcd. 1112 (IB 2023); Technical Appendix, ICFS File No. SAT-MOD-20211207-00186 (filed Dec. 7, 2021) (submitting no DAS logs); Letter from Karl A. Kensinger to C. Andrew Keisner, ICFS File No. SAT-MOD-20211207-00186 (May 19, 2022) (follow-up request for information does not include DAS logs).

The overall vehicle small debris risk probability is the cumulative probability computed from the set of component probabilities, each of which is in turn computed as the cumulative probability for each flat sub-surface.

b. The NASA DAS logs showing a casualty risk of less than 0.0001.

SpaceX designs its satellites to ensure that no components reenter with higher than 15 Joules of energy, therefore the casualty risk is considered zero.[8]

c. The quantity of fuel including how much fuel will be reserved for disposal maneuvers for each satellite.

SpaceX will reserve at least 50 m/s of delta-V to expedite disposal and conduct collision avoidance operations during disposal. Furthermore, for disposal, SpaceX reserves enough maneuvering capability to conduct approximately 60 collision avoidance maneuvers. This collision avoidance reserve vastly exceeds the expected number of maneuvers necessary during deorbit from these altitudes. For reference, in 2025 on-orbit SpaceX satellites performed an average of roughly 40 maneuvers over the course of a full year, which is approximately 9 months longer than the time required for a satellite to deorbit from SpaceX's operational altitudes.

d. Additional information on SpaceX's post-mission disposal plans, including additional explanation on what circumstances under which SpaceX will choose high altitude Earth orbits or heliocentric orbits for satellite disposal as compared with disposal via atmospheric reentry. If SpaceX is not planning to dispose of satellites operating below 2,000 km through atmospheric reentry, provide a waiver request of 25.114(d)(14)(vii)(D)(1*).*

SpaceX plans to dispose of all satellites operating below 600 km through controlled atmospheric reentry in compliance with all applicable orbital debris mitigation rules, guidelines, and best practices. For all satellites operating above 600 km, SpaceX will tailor disposal plans to the specific orbital parameters and mission profiles of the satellites.

SpaceX seeks flexibility to use a disposal method other than atmospheric reentry for satellites operating between 600 km and 2000 km. For satellites between 600 km and 2000 km that SpaceX disposes through atmospheric re-entry, SpaceX will comply with 47 C.F.R. § 25.114(d)(14)(vii)(D)(1). For satellites operating between 600 km and 2000 km that SpaceX does not dispose through atmospheric re-entry, SpaceX requests a waiver of that rule. Pursuant to Section 1.3 of the Commission's rules, the Commission may waive its rules "if special circumstances warrant a deviation from the general rule and such deviation would better serve the public interest than would strict adherence to the general rule," including "more effective

[8] Here again, the Commission has not required other applicants to provide DAS logs related to casualty risk. *See* footnote 6, *supra*.

implementation of overall policy."[9] Providing SpaceX with flexibility to dispose satellites operating above 600 km altitude into Earth disposal orbits or heliocentric orbits would serve the public interest because such methods may be more reliable and sustainable than passive atmospheric reentry. In these circumstances, disposal into other orbits would more successfully achieve the Commission's objective to ensure the prompt removal of satellites from operational orbital regimes and thereby protect the long-term sustainability and usability of low-Earth orbit. As such, granting a waiver would not undermine the purpose of the rule, but rather would better achieve that objective. Accordingly, good cause exists to grant SpaceX's requested waiver.

In addition to the information requested above and to further supplement the record, SpaceX provides the following large debris collision probability analysis using NASA's DAS software in compliance with the Commission's requirements for satellites nominally operating below 600 km altitude. SpaceX conducted hypervelocity testing confirming that impacts to the Starlink solar array design result in minimal debris generation. The arrays consist primarily of lightweight, flexible thin-film photovoltaic materials and supporting substrates that would likely fragment into negligible pieces upon impact. In contrast, the satellite bus contains dense structural components, electronics, batteries, and propulsion elements whose disruption would be far more likely to produce debris capable of creating secondary collision risks. Focusing the DAS analysis on the bus therefore provides a conservative and representative evaluation of high-consequence collision scenarios while avoiding overstatement of debris-generation risk from lower-consequence impacts with the arrays. Accordingly, SpaceX conducted its DAS analysis assessment using the cross-sectional area of the satellite bus, excluding the solar arrays, and incorporates the satellite's area-to-mass ratio.

Altitude (km)	Inclination (deg)	Area-to-Mass (m2/kg)	Total Area (m2)	Bus & Radiator Area (m2)	Mass (kg)	Passive Decay Time (yrs)	Passive Decay Collision Probability
550	30	0.1333	800	100	3000	1.2	2.66E-04
568	30	0.1333	800	100	3000	1.6	3.21E-04
565	97.7	0.1333	800	100	3000	1.5	4.39E-04
585	97.7	0.1333	800	100	3000	1.9	7.00E-04

[9] *GE American Communications, Inc.*, Order and Authorization, 16 FCC Rcd. 11038, ¶ 9 (IB 2001) (quoting *WAIT Radio v. FCC*, 418 F.2d 1153, 1159 (D.C. Cir. 1969)).

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Please feel free to contact us with any questions regarding these statements.

Sincerely,

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