

January 7, 2022

BY ELECTRONIC FILING

Karl A. Kensinger
Chief, Satellite Division
International Bureau
Federal Communications Commission
45 L Street, N.E.
Washington, DC 20554

Re: *Space Exploration Holdings, LLC*
IBFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105

Dear Mr. Kensinger:

On behalf of Space Exploration Holdings, LLC (“SpaceX”), we hereby respond to your letter dated December 23, 2021,¹ in which you have requested additional information with respect to the above referenced applications (collectively, “the Applications”) for SpaceX’s next-generation non-geostationary orbit (“NGSO”) satellite system operating in Ku-band, Ka-band, and E-band frequencies (the “Gen2 System”).² As a strong supporter of transparency for all operators, SpaceX appreciates this opportunity to provide yet more information to the Commission and the public about its system.

While many administrations prevent their licensees from providing the detailed information that SpaceX makes public,³ SpaceX supports the Commission’s transparent approach. Yet, as SpaceX has previously explained, asymmetric disclosures risk skewing public perception of space operations, potentially leading to misaligned policies that harm consumers, competition, and innovation while ignoring acute risks to space sustainability.⁴ In this case, no other applicant in the 2020 processing round, nor the 2016 processing round, has provided information to the

¹ Letter from Karl A. Kensinger to William M. Wiltshire, IBFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105 (Dec. 23, 2021).

² Application for Approval for Orbital Deployment and Operating Authority for the SpaceX Gen2 NGSO Satellite System, IBFS File No. SAT-LOA-20200526-00055 (May 26, 2020) (“Gen2 Application”); Amendment to Pending Application for the SpaceX Gen2 NGSO Satellite System, IBFS File No. SAT-AMD-20210818-00105 (Aug. 18, 2021) (“Amendment”).

³ See, e.g., Letter from Kumar Singarajah to Karl Kensinger, IBFS File Nos. SES-STA-20200117-00055, et al., at 1 (Nov. 25, 2020) (explaining that response on orbital debris mitigation issues was redacted because it “contains information that the United Kingdom Space Agency (‘UKSA’), which is the mission licensing authority, has requested remain confidential”).

⁴ For example, in response to a request from the National Science Foundation, the independent advisory group JASON strongly commended SpaceX for its recent modification to operate its satellites below 600 km, while simultaneously recommending against licensing operations at higher altitudes until “extremely stringent requirements on the post mission disposal probability have been demonstrated.” JASON, *The Impacts of Large Constellations of Satellites*, National Science Foundation 109 (Nov. 2020, updated Jan. 21, 2021), https://www.nsf.gov/news/special_reports/jasonreportconstellations/JSR-20-2H_The_Impacts_of_Large_Constellations_of_Satellites_508.pdf.

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extent that SpaceX routinely provides to the Commission, including in the responses below, even though several other applications in the 2020 processing round have been put out for comment or even granted a license. SpaceX reiterates that it cannot unilaterally maintain a sustainable orbital environment; no operator, and indeed no country, can. SpaceX therefore urges the Commission to seek the same sorts of information from other operators as it does from SpaceX, including those seeking market access to the United States.

SpaceX filed its Gen2 Application more than nineteen months ago, and its Amendment nearly five months ago, yet they were accepted for filing only two weeks ago. As SpaceX explained in its Amendment, it provided information about an alternative configuration for its Gen2 system to account for uncertainty in development, given the long lead times often required for Commission consideration of applications. SpaceX also made clear that it did not intend to operate both configurations and would inform the Commission about which configuration it would use as development became more certain. Much has changed in the intervening period, and SpaceX has exceeded its own expectations in the pace of developing both its Gen2 satellites and its Starship launch vehicle. Accordingly, SpaceX hereby notifies the Commission that it will pursue Configuration 1 and abandon Configuration 2 proposed in the Amendment.

As Chairwoman Rosenworcel recently noted, the Commission will “need to speed the processing of applications to keep pace with all the innovation headed our way.”⁵ SpaceX could not agree more and fully supports the Commission’s goal to speed deployment of quality broadband to otherwise unserved Americans, which is why SpaceX is doing its part to help expedite processing of its Applications. Despite the number and scope of the International Bureau’s information requests, SpaceX has responded within the specified fifteen-day period to avoid any further delay in consideration and ultimately the deployment of its Gen2 system to help connect more Americans.

Nonetheless, as even this docket has shown, SpaceX’s would-be competitors will resort to unprecedented regulatory maneuvering to slow the Commission’s work, in contravention of the Chairwoman’s important goals of speeding reviews and connecting the unserved. After first arguing that the public should be denied an opportunity to comment on SpaceX’s application and that the Commission must reject the application with no record support, the usual opponents will no doubt now request extensions of time to file comments in this proceeding. Yet SpaceX’s original application has been pending for more than a year and a half, and its minor amendment has been pending for nearly five months. Had these opponents spent this time evaluating those filings rather than engaging in a campaign to delay the Commission, they would have had more than enough time to develop their comments fully already. Moreover, these opponents have made abundantly clear that their primary concern was burdening their lawyers and lobbyists with having to oppose two slightly different configurations.⁶ By announcing that it will pursue Configuration

⁵ Statement of Chairwoman Jessica Rosenworcel, *Revising Spectrum Sharing Rules for Non-Geostationary Orbit, Fixed-Satellite Service Systems*, FCC 21-123 (rel. Dec. 15, 2021).

⁶ See, e.g., Letter from Mariah Dodson Shuman to Marlene H. Dortch, IBFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105, at 2 (Aug. 25, 2021) (arguing that two configurations “doubles the technical effort of every operator faced with the task of reviewing the interference and orbital debris concerns raised by

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1, SpaceX has now removed that burden from these lawyers and lobbyists, meaning no further extensions should be necessary. Accordingly, the Commission should look upon any extension requests with great skepticism and deny such requests in the absence of compelling circumstances that explain the failure to use the many months these Applications have been pending to prepare a timely submission.

Below we respond to each of the Bureau's specific requests for information in turn.

- 1. SpaceX describes this satellite system as its “next-generation Gen2 System” and states that its Gen2 system is meant to complement its first generation system. Please clarify the relationship between SpaceX’s first generation satellite system and the Gen2 system SpaceX proposes in this application and amendment. Does SpaceX plan to operate both systems simultaneously? Will SpaceX deploy replacement satellites for the first generation system in addition to deploying satellites in this Gen2 system, or will the Gen2 satellites be deployed in lieu of first generation system replacement satellites? Will a customer user terminal be able to access satellites from either system, or will there be separate customer user terminals for each system?***

SpaceX has launched more than 1,900 satellites of its first-generation system and is continuing to launch additional satellites to achieve full deployment of its authorized 4,408 satellite constellation. The Gen2 system will complement and augment that first generation system so that their combined capacity will be available to meet the growing needs of American consumers, including those in underserved and unserved areas. Just as terrestrial wireless networks meet customer demands by operating more than one generation of technology simultaneously, SpaceX plans to use both of its networks to provide superior service. SpaceX will continue to maintain its first-generation system, launching replacement satellites as appropriate to sustain the orbits in which it operates, even as it conducts the initial deployment of the Gen2 system. To be clear, operating both systems simultaneously does not mean that SpaceX will necessarily operate all of the satellites under its authorizations at all times in all areas.

A SpaceX customer user terminal will be able to receive service from satellites of either system.

- 2. Section 25.159 of the Commission’s rules states that applicants for one licensed-but-unbuilt NGSO-like satellite system in a particular frequency band will not be permitted to apply for another NGSO-like satellite system in that frequency band. SpaceX requests frequencies in its Gen2 system application that are the same as frequencies authorized for its first generation system. Please address the applicability of section 25.159, particularly with respect to those frequencies requested in this Gen2 application that overlap with those authorized in the first generation system, given that SpaceX has not yet completed***

SpaceX’s amendment”); Letter from Jennifer A. Manner to Marlene H. Dortch, IBFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105, Attachment at 1 (Dec. 9, 2021) (arguing that two configurations “would impose a burden on the satellite industry as both operators and the FCC would need to analyze the impacts of multiple constellations”).

deploying its first generation system, or reached the minimum 50% required by milestone rules. Please address the cadence of launches going forward with respect to the currently authorized system.

Section 25.159 prohibits an applicant with a licensed-but-unbuilt NGSO-like satellite system from applying for another NGSO-like satellite system in the same frequency band. While the rule itself does not specify the point at which deployment of an NGSO system is sufficient to move out of the “unbuilt” category, the Commission clarified the point at which the prohibition would no longer apply when it first adopted this rule. Specifically, the Commission stated that it would not accept “applications from entities with more than one pending application for an NGSO-like system, or ***more than one NGSO system where no satellites have been launched***, in any frequency band.”⁷ Accordingly, since SpaceX has launched at least one satellite authorized in its first-generation constellation—in fact, it has launched more than 1,900 such satellites—its system is no longer considered “unbuilt” for purposes of Section 25.159 and the prohibition on a new application no longer applies.

The Commission was prescient when implementing the rule in this way, as any other policy would be contrary to its approach to other broadband technologies—for instance, the Commission strives to prevent delays in upgrading terrestrial deployments by auctioning spectrum for 5G even while carriers are still deploying 4G networks—and would serve only to interrupt deployment of service for consumers, with no attendant benefit. Requiring a full deployment before allowing an operator to even apply to upgrade its system could lead to years of delay as the Commission would be unable to even begin to process the new application until after the older system had been completed. In the meantime, consumers would be denied the benefit of newer technologies as they wait for the Commission to process an application that could have been considered years earlier. In fact, the Commission’s clarification when adopting the rule has helped inform the common understating of it, as the majority of applicants in the 2020 processing round filed their applications without having completed deployment of their systems authorized in the 2016 processing round.

- SpaceX states that it will generally observe a minimum elevation angle as low as 25 degrees, although certain shells may use lower elevations in certain circumstances. In its original application, SpaceX states that satellites in the high inclination shells operating at altitudes of 360km and 373 km will observe a minimum elevation angle of five degrees for gateways located inside the Polar Regions. Given the amended orbital parameters, please indicate for each alternative orbital configuration which satellites would observe a minimum elevation angle below 25 degrees.***

For gateway links (E band and Ka band), a minimum elevation angle of 5 degrees will be observed when the gateway is located above 62 degrees latitude. For user links (Ku band), a

⁷ *Amendment of the Commission’s Space Station Licensing Rules and Policies*, 18 FCC Rcd. 10760, ¶ 233 (2003) (emphasis added).

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minimum elevation angle of 5 degrees will be observed when communicating with satellites in the 604 km and 614 km shells.

4. ***Please provide additional detail regarding SpaceX's launch plans for the Gen2 system. Specifically, for each of the alternative orbital configurations described in SpaceX's application, what is the anticipated order for launching into the various altitudes and orbital planes? Does SpaceX have any updates regarding the expected timing of launches for the Gen2 system, and does SpaceX have an estimated timeline in which it would plan to notify the Commission concerning which of the two configurations it plans to deploy?***

SpaceX filed its Gen2 Application more than nineteen months ago, and its Amendment nearly five months ago. As SpaceX informed Commission staff before filing its Amendment in August, SpaceX plans to have Gen2 satellites prepared for launch as soon as March 2022, pending regulatory approval. Although the situation was difficult to predict with certainty at the early dates SpaceX made these filings to account for extended Commission review time—which prompted filing of the two alternative configurations in the Amendment—SpaceX is now much further along in the process. SpaceX has now reached a point in the development of its Starship launch vehicle and Gen2 satellites that it can concentrate solely on Configuration 1 and no longer pursue Configuration 2. SpaceX confirms here that it still intends to begin launching the Gen2 system as early as March 2022, likely beginning with the 43 degree or 53 degree inclined planes.

5. ***In the amended legal narrative and technical attachment, SpaceX states it will conduct testing of its Gen2 satellites at low insertion altitudes before orbit-raising them to operational altitudes, consistent with the authorization for its first generation satellites. However, elsewhere in the technical attachment, SpaceX states the new configuration of satellites will allow for direct-to-station launches, and we note at least one public statement concerning direct injection of satellites into the operational altitude. Please clarify how SpaceX intends to deploy its Gen2 satellites.***

As noted above, SpaceX intends to proceed with Configuration 1 proposed in the Amendment. SpaceX's use of the term "direct to station" is not equivalent to "direct to operational altitude." Specifically, SpaceX uses the term "direct to station" to refer to the ability to bypass low altitude parking orbits for orbital precession to align the satellite planes. To be clear, SpaceX plans to continue to screen satellites at low altitude to confirm that each one is operating nominally, but because of the capabilities of Starship, it may be able to avoid using the parking orbit to align the planes. Nonetheless, SpaceX may send satellites directly to higher altitude in infrequent circumstances, such as when SpaceX satellites are included on rideshares of other satellites that require a higher insertion point.

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6. ***What is the expected reliability of SpaceX's Gen2 post-mission disposal systems? Does SpaceX expect the satellites will have reliability of systems necessary for post-mission disposal that is on-par with its first generation system to date?***

SpaceX continuously strives to improve the performance and capabilities of its satellites. SpaceX will continue to improve all aspects of those satellites, including the reliability of systems necessary for post-mission disposal. As such, it expects Gen2 post mission disposal reliability to meet or exceed that of the first generation. These improvements will be built upon the solid foundation SpaceX has already established, on which fewer than one half of one percent of active satellites became non-maneuverable in the past year.

7. ***Given the updated orbital parameters, please confirm whether the expected in-orbit lifetime of a fully-functional SpaceX Gen2 satellite will continue to be five to seven years?***

SpaceX confirms that the expected in-orbit lifetime of a fully-functional Gen2 satellite will continue to be five to seven years. SpaceX also expects to continue its practice of exercising an extremely conservative approach to replacing satellites whenever doing so will improve service for consumers or minimize the risk of non-maneuverable satellites.

8. ***Will SpaceX's Gen2 satellites employ an identical automated collision avoidance system as that used for its first generation system, or has SpaceX made improvements or otherwise altered the system? Please confirm whether SpaceX will observe a risk threshold of 0.001% as the trigger for a collision avoidance maneuver, as indicated in its original application.***

SpaceX continues to employ an iterative process to improve its satellites on an ongoing basis. Virtually all improvements to the Starlink collision avoidance system apply to all generations of SpaceX satellites. Two examples of recent improvements:

- Starlink now uses Conjunction Data Messages from two independent providers. This provides independent state confirmation and situational awareness, in the event that a single provider experiences interruptions for any reason.
- In addition to planning collision avoidance burns, SpaceX satellites preferentially orient themselves to minimize their cross section for conjunction events, which can further reduce collision probability by an order of magnitude.

SpaceX confirms that, as with its first-generation constellation, it will continue to observe a risk threshold of 0.001% (i.e., 1 in 100,000) as the trigger for a collision avoidance maneuver, which is significantly stricter than industry standards.

9. ***SpaceX indicates that it has "maintained an overall probability of collision with small debris (down to one millimeter in diameter) sufficient to prevent compliance with post-mission disposal maneuvers of less than 0.01 for an individual Gen2 space station during its mission lifetime." Please clarify this statement. What is the probability of collision***

with small debris per satellite, as calculated using the NASA Debris Assessment Software (DAS)? Of the two alternative orbital configurations described in SpaceX's amended application, which has a lower probability overall of collision with small debris?

An analysis of Configuration 1 using the most updated version of NASA's DAS software yields an overall probability of collision with small debris (down to one millimeter in diameter) sufficient to prevent compliance with post-mission disposal maneuvers of less than 0.004672 for an individual space station during its mission lifetime.

10. Please provide a description of how SpaceX's "internal software leveraging NASA's Debris Assessment Software" works. How does SpaceX's software differ from DAS? What are the input parameters? What is the casualty risk result obtained from simply using the NASA DAS, and how does this compare with the results of SpaceX's calculation? Please provide for reference a "standard" DAS analysis, including supporting material concerning input data, to the extent this would help to illustrate the differences.

SpaceX evaluates its system internally using several different tools, but provided figures in the Applications using only the standard DAS software with no internal code. Accordingly, the conclusion stated in the Amendment that Gen2 satellites will demise completely upon atmospheric re-entry reflects the results of the standard DAS analysis.

11. Does SpaceX plan to utilize spacers and/or stiffening rods as part of the deployment of the satellites requested in this application?

The orbital debris discussion of the Gen2 Application includes a complete discussion of SpaceX's intended use of rod assemblies in connection with launch of Gen2 satellites.⁸ While the deployment mechanism for the Starship launch vehicle is still being finalized, it may require tension rods.

12. Please indicate whether the application, as modified, includes all satellites for which SpaceX is pursuing regulatory approval for operations in the frequency bands included in the referenced IBFS files, whether from the FCC, other ITU Administrations, or other national licensing authorities. To the extent there are any such satellites not described in the application, please provide information concerning the deployment plans for those satellites, including the number of such satellites and whether they are intended as substitutes or replacements for the satellites request in this application, or additional deployments.

SpaceX filed its Gen2 Application in May 2020, expecting that this would give the Commission more than enough time to process and grant the application in time to support launch activities this spring. SpaceX agrees with Chairwoman Rosenworcel that the Commission should speed application review. During the subsequent nineteen months before the Commission accepted the application for filing, SpaceX has considered all options to ensure that it could

⁸ See Gen2 Application, Technical Attachment at 37.

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continue to provide high-quality broadband service to consumers in a timely manner. One of these options was to follow standard industry practice by submitting ITU filings through other administrations. SpaceX was one of the last remaining NGSO operators to have been licensed exclusively through the United States. While SpaceX fully supports the Chairwoman's goal of accelerating processing times, SpaceX will continue to explore ways to ensure it can provide the best possible service to customers across the United States and around the world, which may include continuing to follow the lead of most other NGSO operators and applying for licenses through administrations outside the United States.

SpaceX specifically submitted filings through Germany for 37,756 satellites to use E-band spectrum, and for 3,360 satellites to use Ku- and Ka-band spectrum. SpaceX does not yet have specific launch plans for these satellites and does not have launch authority for any of them.

In the interest of transparency, SpaceX looks forward to the Commission requesting similar details about launch plans from other licensees that have also submitted ITU filings through Germany or other administrations.

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Should you have any questions, please do not hesitate to contact me.

Sincerely,



William M. Wiltshire
Counsel to SpaceX