

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	ICFS File Nos.:
)	
Space Exploration Holdings, LLC	)	SAT-LOA-20200526-00055
	)	SAT-AMD-20210818-00105
Request for Deployment and Operating Authority	)	SAT-AMD-20221216-00175
for the SpaceX Gen2 NGSO Satellite System	)	SAT-AMD-20241017-00228
	)	Call Sign: S2992/3069
)	
Application for Authority for Modification of the	)	SAT-MOD-20230207-00021
SpaceX NGSO Satellite System to Add a Direct to	)	SAT-AMD-20240322-00061
Cellular System	)	Call Sign: S3069
)	
Application for Modification of the SpaceX V-band	)	SAT-MOD-20240423-00089
Satellite System	)	Call Sign: S2992/3069
)	
Space Bureau and Wireless Telecommunications	)	GN Docket No. 23-135
Bureau Seek Comment on Filings of SpaceX and)	
T-Mobile Requesting to Establish Supplemental)	
Coverage from Space)	
)	
)	

ORDER AND AUTHORIZATION

Adopted: November 26, 2024

Released: November 26, 2024

By the Chief, Space Bureau:

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I. INTRODUCTION

1. In this Order and Authorization (Order), we grant in part and defer in part, with conditions, the application, as amended, of Space Exploration Holdings, LLC (SpaceX) to construct, deploy, and operate a constellation of second generation non-geostationary orbit (NGSO) fixed-satellite service (FSS) satellites, known as its Gen2 Starlink constellation (SpaceX Gen2 Application, as amended).¹ We also grant in part and defer in part, with conditions, SpaceX’s modification application, as amended, to provide Supplemental Coverage from Space (SCS) within the United States and to operate on certain frequency bands for the purpose of performing direct-to-cellular (direct-to-cell)² operations outside the United States using its previously authorized 7,500 Gen2 Starlink satellites (SpaceX SCS Modification Application and SpaceX SCS Modification Amendment)³ and grant SpaceX’s modification application to operate using V-band frequencies at altitudes ranging from 340 km to 360 km (SpaceX V-band Modification Application).⁴

2. Specifically, we authorize SpaceX to operate its previously authorized 7,500 Gen2 Starlink satellites at the previously proposed altitudes of 340 km, 345 km, 350 km, and 360 km. SpaceX is authorized to communicate with these satellites in the previously authorized Ku-, Ka-, E-, and V-band frequencies,⁵ in conformance with the technical specifications SpaceX has provided to the Commission,⁶

¹ See Space Exploration Holdings, LLC, Application for Orbital Deployment and Operating Authority for the SpaceX Gen2 NGSO Satellite System, ICFS File No. SAT-LOA-20200526-00055 (filed May 26, 2020) (SpaceX Gen2 Application); Space Exploration Holdings, LLC, Amendment to Pending Application for the SpaceX Gen2 NGSO Satellite System, ICFS File No. SAT-AMD-20210818-00105 (dated Aug. 18, 2021) (SpaceX Gen2 Amendment); Space Exploration Holdings, LLC, Amendment to Pending Application for the SpaceX Gen2 NGSO Satellite System, ICFS File No. SAT-AMD-20221216-00175 (filed Dec. 16, 2022) (SpaceX Gen2 Beacon Amendment).

² SpaceX and other parties often use the term “direct-to-cell” to mean communications directly from satellites to mobile devices such as cellular phones.

³ See Space Exploration Holdings, LLC, Application for Modification of the Authorization for the SpaceX Gen2 NGSO Satellite System to Add a Direct to Cellular System, ICFS File No. SAT-MOD-20230207-00021 (filed Feb. 7, 2023) (SpaceX SCS Modification); Space Exploration Holdings, LLC, Amendment to Application for Modification of the Authorization for the SpaceX Gen2 NGSO Satellite System to Add a Direct-to-Cellular System, ICFS File No. SAT-AMD-20240322-00061 (filed Mar. 22, 2024) (SpaceX SCS Modification Amendment).

⁴ See Space Exploration Holdings, LLC, Request for Modification of the Authorization for the SpaceX V-band NGSO Satellite System, ICFS File No. SAT-MOD-20240423-00089 (filed Apr. 23, 2024) (SpaceX Second V-band Modification Application).

⁵ See *Space Exploration Holdings, LLC, Request for Orbital Deployment and Operating Authority for the SpaceX Gen2 NGSO Satellite System, Order and Authorization*, 37 FCC Rcd 14882 (2022) (*SpaceX Gen2 First Partial Grant*); *Space Exploration Holdings, LLC, Application for Modification of Authorization of the SpaceX V-band NGSO Satellite System, Grant Stamp*, ICFS File No. SAT-MOD-20230322-00062 (SB, SPPD, granted-in-part/dismissed-in-part Oct. 13, 2023) (*SpaceX First V-band Modification Grant*); *Space Exploration Holdings, LLC, Request for Orbital Deployment and Operating Authority for the SpaceX Gen2 NGSO Satellite System, Order and Authorization*, DA 24-222 (SB rel. Mar. 8, 2024) (*SpaceX E-Band Partial Grant*).

⁶ See SpaceX Gen2 Application, Narrative and Technical Attachment, and SpaceX Second V-band Modification Application, Narrative and Technical Attachment.

the conditions previously placed on its authorizations,⁷ and the conditions we adopt today. SpaceX is also authorized to conduct operations using its very high frequency (VHF) beacons at altitudes of 340 km, 345 km, 350 km, and 360 km, again, subject to conditions placed on its prior authorizations⁸ and adopted today. Based on a recommendation from the National Aeronautics and Space Administration (NASA), SpaceX's deployment and operations at altitudes below 400 km are conditioned on successful physical coordination with NASA to ensure protection of the International Space Station (ISS), ISS visiting vehicles, and launch windows for NASA science missions. SpaceX may only deploy and operate at altitudes below 400 km the total number of satellites for which it has completed physical coordination with NASA under the parties' Space Act Agreement.⁹ Additionally, for all 7,500 satellites in its authorized Gen2 system, SpaceX is authorized to conduct operations in the PCS G Block in the 1910-1915 MHz (Earth-to-space) and 1990-1995 MHz (space-to-Earth) bands for SCS pursuant to a lease arrangement with T-Mobile USA, Inc. and its subsidiaries (collectively, T-Mobile),¹⁰ consistent with the rules adopted in *Single Network Future: Supplemental Coverage from Space, Space Innovation Report and Order (SCS R&O)* and subject to conditions adopted today.¹¹ We also authorize SpaceX to operate all of its previously-authorized 7,500 Gen2 satellites in certain sub-bands within the 1429-2690 MHz band for MSS outside the United States for the purpose of direct-to-cell operations, subject to conditions. We defer consideration of SpaceX's request for a waiver of the aggregate out-of-band power flux-density (PFD) limit of -120 dBW/m²/MHz on SCS operations.¹² This Order also continues to defer SpaceX's request to deploy additional Gen2 Starlink satellites beyond the total 7,500 satellites previously authorized, that is, we continue to defer consideration of the remaining 22,488 satellites, including all satellites proposed to operate in the 340 km, 345 km, 350 km, and 360 km orbital shells beyond the 7,500 satellites authorized today.

3. As part of this authorization, we address comments raised in the record of the Gen2 application, as amended, that we deferred in our first partial grant of the Gen2 Starlink constellation.¹³ In

⁷ See generally *SpaceX Gen2 First Partial Grant*, *SpaceX First V-band Modification Grant*, *SpaceX E-band Partial Grant*.

⁸ *Space Exploration Holdings, LLC, Request for Orbital Deployment and Operating Authority for the SpaceX Gen2 NGSO Satellite System*, Order and Authorization, DA 24-1160 (SB rel. Nov. 20, 2024) (*SpaceX Gen2 Beacon Order*); see also, *SpaceX Gen2 First Partial Grant*, *SpaceX First V-band Modification Grant*, *SpaceX E-band Partial Grant*.

⁹ See Letter from Lauren E. Morgan, NASA Representative to the Commercial Transportation Interagency Group Space Operation Mission Directorate, Launch Services Office, to Marlene H. Dortch, Secretary, FCC, ICFS File Nos. SAT-LOA-20200526-00055, SAT-AMD-20210818-00105, SAT-AMD-20221216-00175, SAT-MOD-20230207-00021, SAT-AMD-20240322-00061, SAT-MOD-20240423-00089, SAT-STA-20240522-00108, GN Docket No. 23-135 (filed Nov. 19, 2024) (NASA November 19, 2024 Letter); see also Letter from Jennifer A. Manner, Senior Advisor, Space and Satellite Policy, Office of Spectrum Management, NTIA, to Marlene H. Dortch, Secretary, FCC, ICFS File Nos. SAT-LOA-20200526-00055, SAT-AMD-20210818-00105, SAT-AMD-20221216-00175, SAT-MOD-20230207-00021, SAT-AMD-20240322-00061, SAT-MOD-20240423-00089, SAT-STA-20240522-00108, GN Docket No. 23-135 (dated Nov. 19, 2024) (NTIA November 19, 2024 Letter).

¹⁰ ULS File Nos. 0010303032, 0010303084, 0010303124, and 0010303146 (filed Dec. 6, 2022, and amended on Feb. 7, 2023 and Sept. 23, 2024; granted on Nov. 26, 2024).

¹¹ *Single Network Future: Supplemental Coverage from Space, Space Innovation*, Report and Order and Further Notice of Proposed Rulemaking, FCC 24-28 (Mar. 15, 2024) (*SCS R&O*).

¹² See *SpaceX Exploration Technologies Corp.*, to Marlene H. Dortch, Secretary, FCC, GN Docket Nos. 23-65, 23-135; ICFS File No. SAT-MOD-20230207-00021; ULS File Nos. 0010303032, 0010303084, 0010303124, and 0010303146 at 1-2 (dated June 6, 2024) (*SpaceX June 6, 2024 Letter*).

¹³ See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14883, 14897-97, 14922, 14923, 14932-33, 14937, paras. 2, 18-19, 76, 79, 100-101, 112; see also Letter from Kathy Smith, Chief Counsel, National Telecommunications and Information Administration, to Marlene H. Dortch, Secretary, FCC, ICFS File No. SAT-AMD-20210818-00105 (dated Feb. 8, 2022) (NTIA Letter); Letter from Kathy Smith, Chief Counsel, National Telecommunications and

(continued....)

connection with this partial grant of SpaceX's SCS modification application, as amended, we address the Petition to Dismiss or Deny filed by DISH Network Corporation (DISH); DISH's Petition for Reconsideration of our December 2023 partial grant of the SpaceX's SCS Modification Application; the Petitions to Deny filed by EchoStar Corporation (EchoStar), and AT&T Services, Inc. (AT&T), the informal objection filed by Omnispace, LLC (Omnispace), the Oppositions filed by the National Radio Astronomy Observatory (NRAO), Omnispace, and Verizon, and the various comments and letters filed regarding this application.¹⁴ We also dismiss EchoStar's Petition for a Protective Order as moot.¹⁵

4. Authorization to permit SpaceX to operate up to 7,500 Gen2 satellites in lower altitude shells will enable SpaceX to begin providing lower-latency satellite service to support growing demand in rural and remote areas that lack terrestrial wireless service options.¹⁶ This partial grant also strikes the right balance between allowing SpaceX's operations at lower altitudes to provide low-latency satellite service and permitting the Commission to continue to monitor SpaceX's constellation and evaluate issues

(Continued from previous page)

Information Administration, to Marlene H. Dortch, Secretary, FCC, ICFS File No. SAT-AMD-20210818-00105 (dated Mar. 10, 2022) (NTIA March 10, 2022 Letter); Petition of Viasat, Inc., ICFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105 (filed Feb. 8, 2022) (Viasat Petition); Reply of Viasat, Inc., ICFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105 (filed Mar. 8, 2022) (Viasat Reply); Petition to Dismiss or Deny in Part of DISH Network Corporation, ICFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105 (filed Feb. 8, 2022) (DISH Gen2 Petition); Comments of Kepler Communications, Inc., ICFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105 (filed Jan. 24, 2021) (Kepler Comments); Letter from Darren McKnight, LeoLabs, to Karl A. Kensinger, Chief, Satellite Division, FCC, ICFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105, IB Docket No. 18-313 (dated March 29, 2022) (LeoLabs March 29, 2022 Letter); Letter from Professor Andy Lawrence, Institute for Astronomy, University of Edinburgh, to Marlene H. Dortch, Secretary, FCC, ICFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105 (dated Sept. 18, 2022) (Andy Lawrence September 18, 2022 Letter); Letter from Jarrett S. Taubman, Vice President and Deputy Chief, Government Affairs, Viasat, Inc., to Marlene H. Dortch, Secretary, FCC, ICFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105 (dated Oct. 4, 2022) (Viasat October 4, 2022 Letter).

¹⁴ Petition to Dismiss or Deny of DISH Network Corporation, GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 (filed May 18, 2023) (DISH SCS Petition); Opposition of the National Radio Astronomy Observatory, GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 (filed May 4, 2023) (NRAO May 4, 2023 Opposition); Opposition of Omnispace LLC, GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 (filed May 18, 2023) (Omnispace May 18, 2023 Opposition); Petition for Reconsideration of DISH, GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 (filed Jan. 2, 2024) (DISH SCS Petition for Reconsideration) (seeking reconsideration of the Space Bureau's partial grant of SpaceX's request to operate in the 1910-1915 MHz and 1990-1995 MHz bands); Petition to Deny Amended Waiver Request and Issue Protective Order of EchoStar, GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 (filed May Aug. 12, 2024) (EchoStar Petition); Petition to Deny of AT&T, GN Docket No. 23-135, ICFS File Nos. SAT-MOD-20230207-00021, SAT-AMD-20240322-00061 (filed Aug. 12, 2024) (AT&T Petition); Opposition of Verizon, GN Docket No. 23-135, ICFS File Nos. SAT-MOD-20230207-00021, SAT-AMD-20240322-00061 (filed Aug. 12, 2024) (Verizon August 12, 2024 Opposition). Although Omnispace's August 12, 2024 pleading was titled "Petition to Deny," we will consider it an informal objection because it lacks an affidavit required by our rules. 47 CFR § 25.154(a)(4), (b)(1). See Informal Objection of Omnispace, GN Docket No. 23-135, ICFS File Nos. SAT-MOD-20230207-00021, SAT-AMD-20240322-00061 (filed Aug. 12, 2024) (Omnispace Informal Objection).

¹⁵ Request for Protective Order of EchoStar Corporation, ICFS File Nos. SAT-LOA-20200526-00055, SAT-AMD-20210818-00105, SAT-AMD-20221216-00175, SAT-MOD-20240423-00089, SAT-MOD-20230207-00021, SAT-AMD-20240322-00061, GN Docket No. 23-135 (filed Jun. 28, 2024) (EchoStar June 28, 2024 Request for Protective Order).

¹⁶ See Letter from David Goldman, Vice President of Satellite Policy, Space Exploration Holdings LLC, to Marlene H. Dortch, Secretary, FCC, ICFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105 (dated Feb. 20, 2024) (SpaceX February 20, 2024 Letter).

previously raised on the record.¹⁷ Additionally, our action today supports the Commission's goal of promoting innovative and efficient use of spectrum resources through SpaceX's provision of SCS in the United States as well as through SpaceX's capability to perform direct-to-cell operations outside the United States. Finally, we find that this action will facilitate SpaceX's operations for its Gen2 system, which the Commission previously found would bring improved broadband connectivity to unserved and underserved areas of the United States.¹⁸

II. BACKGROUND

5. *Original Gen2 Starlink Applications.* On May 26, 2020, SpaceX filed its application¹⁹ as part of the processing round initiated for the 10.7-12.7 GHz, 12.75-13.25 GHz, 13.85-14.5 GHz, 17.7-18.6 GHz, 18.8-20.2 GHz, and 27.5-30 GHz bands by NGSO FSS systems (the 2020 Ku/Ka-band Processing Round).²⁰ The application requests up to 29,988 Gen2 Starlink satellites operating between 340 km and 614 km.²¹ On August 18, 2021, SpaceX initially amended its application to modify the configuration of the Gen2 Starlink satellites.²² Approximately two thirds of the satellites (19,440) would be deployed in shells centered at altitudes from 340 km to 360 km (below the International Space Station (ISS)), approximately one third (10,080) would be deployed in shells centered at altitudes from 525 km to 535 km, and 468 satellites would be deployed into retrograde inclinations in shells centered at altitudes of 604 km and 614 km.²³ The International Bureau, Satellite Division²⁴ found the SpaceX application, as amended, acceptable for filing and placed it on public notice on December 23, 2021.²⁵ A large number of parties filed in response to the SpaceX application, including government agencies, satellite operators,

¹⁷ See generally, *SpaceX Gen2 First Partial Grant*.

¹⁸ See *id.* at 14899, para. 21.

¹⁹ See SpaceX Gen2 Application.

²⁰ See *Cut-Off Established for Additional NGSO FSS Applications or Petitions for Operations in the 10.7-12.7 GHz, 12.75-13.25 GHz, 13.8-14.5 GHz, 17.7-18.6 GHz, 18.8-20.2 GHz, And 27.5-30 GHz Bands, Satellite Policy Branch Information*, Report No. SPB-279, DA 20-325 (rel. Mar. 24, 2020) (2020 Ku/Ka-band Processing Round Public Notice).

²¹ See SpaceX Gen2 Amendment, Narrative at 5.

²² See SpaceX Gen2 Amendment.

²³ See *id.*, Narrative at 5. We note that SpaceX has recently filed two applications, one to modify the orbital parameters, operational characteristics, and frequency use of the previously authorized 7,500 Gen2 satellites, and one to amend the orbital configuration, operational characteristics, and frequency use of the deferred portion of its Gen2 application, as amended. See ICFS File Nos. SAT-MOD-20241011-00224 and SAT-AMD-20241017-00228. These applications remain pending, and this authorization is without prejudice to any potential future action in connection with these applications.

²⁴ On January 4, 2023, the Commission adopted an Order that established the Space Bureau to handle the policy and licensing matters related to satellite communications and other in-space activities formerly handled by the International Bureau, which the Order eliminated. See *Establishment of the Space Bureau and the Office of International Affairs and Reorganization of the Consumer and Governmental Affairs Bureau and the Office of the Managing Director*, MD Docket No. 23-12, Order, 38 FCC Rcd 608, paras. 1-2 (2023). The Space Bureau officially launched on April 11, 2023. See Press Release, FCC, FCC Space Bureau & Office of International Affairs to Launch Next Week (April 7, 2023), <https://docs.fcc.gov/public/attachments/DOC-392418A1.pdf>. All references in this document to the International Bureau and the Satellite Division refer to filings made with, or actions taken by, the International Bureau prior to the establishment of the Space Bureau.

²⁵ *Satellite Policy Branch Information, Space Station Applications Accepted for Filing*, Report No. SAT-01598 (Dec. 23, 2021).

environmental groups, astronomers, students, and members of the general public.²⁶

6. *SpaceX Gen2 Authorizations.* On November 29, 2022, the Commission granted in part and deferred in part SpaceX's application, as amended, authorizing SpaceX to construct, deploy, and operate up to 7,500 Gen2 Starlink satellites, communicating in the Ku- and Ka-bands,²⁷ subject to a number of conditions.²⁸ The Commission deferred action on the remaining satellites requested by SpaceX, and also deferred action on SpaceX's request to operate in orbital shells in the 340 km, 345 km, 350 km, and 360 km altitude range.²⁹ In the *SpaceX Gen2 First Partial Grant*, the Commission granted certain waiver requests, authorized SpaceX to conduct communications during orbit-raising and deorbit of its satellites for launch and early-orbit phase (LEOP) operations, and granted authority for "testing communications equipment performance during the orbit-raising process."³⁰ Two parties appealed the *SpaceX Gen2 First Partial Grant* to the D.C. Circuit Court of Appeals, raising issues related to interference into other satellite systems and environmental review.³¹ In July 2024, the D.C. Circuit upheld the *SpaceX Gen2 First Partial Grant*.³² Two additional parties have submitted petitions for reconsideration of the *SpaceX Gen2 First Partial Grant* to the Commission, both of which remain pending.³³

7. The Space Bureau, Satellite Programs and Policy Division later granted, with conditions, SpaceX's request for modification of its Gen2 license to authorize SpaceX to operate in the V-band, 37.5-40.0 GHz (space-to-Earth), 40.0-42.0 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space), and 50.4-51.4 GHz (Earth-to-space), using its Gen2 satellites (*SpaceX First V-band Modification Grant*).³⁴ In a further partial grant, the Space Bureau authorized SpaceX to operate using E-band frequencies in the 71.0-76.0 GHz (space-to-Earth) and the 81.0-86.0 GHz (Earth-to-space) bands on its 7,500 authorized Gen2 satellites (*SpaceX E-band Partial Grant*).³⁵ On November 20, 2024, the Space Bureau authorized SpaceX to operate very high frequency (VHF) beacons on up to 450 of its Gen2 Starlink satellites for purposes of backup telemetry, tracking, and command (TT&C) during orbit raising operations and in the

²⁶ See, e.g., *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14887-88, 14889-93, paras. 6, 9, n.35, n.51, n.52, n.54, n.55, n.56, n.57, n.58, n.59, n.60, n.61 (describing the record before the Commission adopted the *SpaceX Gen2 First Partial Grant*).

²⁷ Specifically, the Commission granted SpaceX authority to operate in the Ku-band in the 10.7-12.75 GHz (space-to-Earth), 12.75-13.25 GHz (Earth-to-space), and 14.0-14.5 GHz (Earth-to-space) bands and in the Ka-band in the 17.8-18.6 GHz (space-to-Earth), 18.8-19.3 GHz (space-to-Earth), 19.7-20.2 GHz (space-to-Earth), 27.5 GHz (Earth-to-space), and 29.5-30.0 GHz (Earth-to-space) bands. See *id.* at 14911, para. 42; 14915, para. 53.

²⁸ See generally *SpaceX Gen2 First Partial Grant*.

²⁹ See *id.* at 14897, para. 19.

³⁰ See *id.* at 14927-28, paras. 90-91.

³¹ *International Dark-Sky Association v. FCC*, No. 22-1337 (D.C. Cir. filed Dec. 29, 2022), *Dish Network Corp. v. FCC*, No. 23-1001 (D.C. Cir. filed Jan. 3, 2023).

³² See *International Dark-Sky Association, Inc., v. FCC*, 106 F.4th 1206 (D.C. Cir. 2024).

³³ See Petition for Reconsideration of LeoLabs, Inc., ICFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105 (filed Dec. 30, 2022); Petition for Clarification of Viasat, Inc., ICFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105 (filed Jan. 3, 2023).

³⁴ See *SpaceX First V-band Modification Grant*. SpaceX was originally authorized to operate up to 7,500 satellites as part of a separate V-band constellation, but later committed to instead deploying the V-band capabilities on its Gen2 satellites. See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14883, 14896, paras. 2, 19. SpaceX has submitted a further modification application related to its V-band capabilities, requesting modification of the bond and milestone conditions applicable to its V-band operations. See ICFS File No. SAT-MOD-20240813-00183. This modification request remains pending.

³⁵ *SpaceX E-Band Partial Grant*.

event of an anomaly once the satellites reached their operational altitudes.³⁶

8. *SCS-Related Requests and NPRM.* On February 7, 2023, SpaceX filed an application requesting modification of its U.S. license for its Gen2 Starlink satellites (1) to deploy antennas capable of communicating with mobile devices in the 1429-2690 MHz range outside of the United States; and (2) to operate in the 1910-1915 MHz and 1990-1995 MHz bands within the United States to communicate with commercial, off-the-shelf mobile devices pursuant to a long-term spectrum manager lease arrangement with T-Mobile (SpaceX SCS Application).³⁷ SpaceX sought to support these operations with feeder links utilizing frequencies in the Ka-band and E-band for gateway operations.³⁸ SpaceX and T-Mobile filed a long-term spectrum manager lease notification informing the Commission of an arrangement whereby SpaceX satellites would provide SCS to T-Mobile's terrestrial network on Personal Communications Service (PCS) G Block spectrum, *i.e.* the 1910-1915 MHz and 1990-1995 MHz bands, licensed to T-Mobile.³⁹

9. On March 17, 2023, the Commission released a Notice of Proposed Rulemaking seeking comment on establishing an SCS framework through which satellite operators collaborating with terrestrial service providers would be able to obtain Commission authorization to operate space stations on currently licensed, flexible-use spectrum allocated to terrestrial services, thus expanding coverage to the terrestrial licensee's subscribers, especially in remote, unserved, and underserved areas.⁴⁰

10. On April 18, 2023, the Space Bureau and Wireless Telecommunications Bureau (WTB) jointly placed the SpaceX SCS Modification Application and T-Mobile's lease notification on public notice.⁴¹ DISH filed a Petition to Dismiss or Deny, Omnispace and the NRAO filed Oppositions, and several parties filed comments.⁴²

11. On December 1, 2023, the Satellite Programs and Policy Division issued a limited grant-in-part of the SpaceX SCS Modification Application (*SpaceX SCS Modification Partial Grant*) authorizing SpaceX to deploy Gen2 Starlink satellites with the capability to operate in certain frequencies in the 1429 MHz to 2690 MHz range and also operate these satellites on frequencies within the 1910-1915 MHz (Earth-to-space) and 1990-1995 MHz (space-to-Earth) frequency bands for limited on-orbit check out of the antennas immediately following deployment of each satellite for a period of 10 days or

³⁶ *SpaceX Gen2 Beacon Order.*

³⁷ See SpaceX SCS Modification, Technical Annex at 1, 13. Previously, on December 6, 2022, SpaceX filed a petition for a declaratory ruling granting market access to operate its Gen2 Starlink satellites in the United States in the 1910-1915 MHz and 1990-1995 MHz bands to communicate with commercial, off-the-shelf mobile devices that are intended to communicate with terrestrial networks. See ICFS File No. SAT-PPL-20221206-00170. SpaceX received a license for the requested operations through the German Administration, which had submitted the system for coordination with the ITU. See ICFS File No. SAT-PPL-20221206-00170, Petition at 1. SpaceX subsequently withdrew this request.

³⁸ See SpaceX SCS Modification, Narrative at 9.

³⁹ See ULS File Nos. 0010303032, 0010303084, 0010303124, and 0010303146 (filed Dec. 6, 2022 and amended on Feb. 7, 2023 and Sept. 23, 2024; granted on Nov. 26, 2024).

⁴⁰ *Single Network Future: Supplemental Coverage from Space, Space Innovation*, GN Docket No. 23-65, IB Docket No. 22-271, Notice of Proposed Rulemaking, 38 FCC Rcd 2790 (2023).

⁴¹ *Space Bureau and Wireless Telecommunications Bureau Seek Comment on Filings of SpaceX and T-Mobile Requesting to Establish Supplemental Coverage from Space; Space Exploration Holdings, LLC Application Accepted for Filing*, GN Docket No. 23-135, Public Notice, 38 FCC Rcd 3434 (SB/WTB 2023).

⁴² See *e.g.*, DISH SCS Petition; Omnispace May 18, 2024 Opposition; NRAO May 4, 2023 Opposition.

less, to ensure initial functionality of the satellite antenna.⁴³ This grant did not include authorization of other testing or commercial operations.⁴⁴ Following this partial grant, DISH filed a Petition for Reconsideration.⁴⁵ SpaceX then sought special temporary authority (STA) under the Commission's part 5 experimental licensing framework in order to test with antennas capable of performing SCS in the United States and direct-to-cell operations outside the United States.⁴⁶ The Office of Engineering and Technology has granted SpaceX several experimental STAs for this type of testing.⁴⁷ SpaceX has also requested and received from the Satellite Programs and Policy Division two limited part 25 STAs to provide SCS in areas of the United States affected by Hurricanes Helene and Milton.⁴⁸

12. *300 km Altitude Requests and SCS Application Amendment.* On February 20, 2024, SpaceX filed a letter in the docket for its Gen2 application, as amended, requesting to “leverage the shells included in its application in the 340 km-360 km range as an option within its authorized first tranche of 7,500 satellites.”⁴⁹ On March 22, 2024, SpaceX amended its SCS modification application to include its

⁴³ See *Space Exploration Holdings, LLC, Application for Modification of the Authorization for the SpaceX Gen2 NGSO Satellite System*, Grant Stamp, ICFS File No. SAT-MOD-20230207-00021 (granted-in-part/deferred-in-part Dec. 1, 2023) (*SpaceX SCS Modification Partial Grant*), petition for reconsideration pending.

⁴⁴ See *id.* at condition 6.

⁴⁵ See generally DISH SCS Petition for Reconsideration.

⁴⁶ See ELS File Nos. 1279-EX-CN-2023 (granted Sept. 26, 2023); 2479-EX-ST-2023 (granted Dec. 20, 2023); 0519-EX-ST-2024 (granted Mar. 29, 2024); 0934-EX-ST-2024 (granted June 21, 2024; re-issued Oct. 2, 2024); 1210-EX-ST-2024 (granted Jul. 9, 2024; re-issued Sept. 20, 2024); 1287-EX-ST-2024 (granted Sept. 26, 2024); 1209-EX-ST-2024 (granted Oct. 7, 2024); 0661-EX-ST-2024 (filed Apr. 8, 2024); 1798-EX-ST-2024 (granted Nov. 8, 2024; re-issued Nov. 18, 2024); 2103-EX-ST-2024 (filed Nov. 8, 2024).

⁴⁷ See ELS File Nos. 1279-EX-CN-2023 (granted Sept. 26, 2023); 2479-EX-ST-2023 (granted Dec. 20, 2023); 0519-EX-ST-2024 (granted Mar. 29, 2024); 0934-EX-ST-2024 (granted June 21, 2024; re-issued Oct. 2, 2024); 1210-EX-ST-2024 (granted Jul. 9, 2024; re-issued Sept. 20, 2024); 1287-EX-ST-2024 (granted Sept. 26, 2024); 1209-EX-ST-2024 (granted Oct. 7, 2024); 1798-EX-ST-2024 (granted Nov. 8, 2024; re-issued Nov. 18, 2024).

⁴⁸ See ICFS File Nos. SAT-STA-20241007-00215 (granted Oct. 4, 2024 and renewed Oct. 23, 2024); SAT-STA-20241007-00216 (granted Oct. 7, 2024 and renewed Oct. 23, 2024).

⁴⁹ See SpaceX February 20, 2024 Letter. Two parties, Kuiper Systems LLC (Kuiper) and O3b Limited (O3b) responded to SpaceX's letter, raising interference concerns and requesting the Commission place the SpaceX Gen2 Application, as amended, on public notice again to give interested parties an opportunity to raise any additional concerns with respect to SpaceX's request to operate at lower altitudes. See Letter from Suzanne Malloy, Vice President Legal and Regulatory Affairs, O3b Limited, to Marlene H. Dortch, Secretary, FCC, ICFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105 (dated Feb. 28, 2024) (O3b February 28, 2024 Letter); Letter from Michael J. Carlson, Senior Corporate Counsel, Kuiper Systems LLC, to Marlene H. Dortch, Secretary, FCC, ICFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105 (dated March 8, 2024) (Kuiper March 8, 2024 Letter). SpaceX replied to these letters, objecting to the possibility of the Commission placing its Gen2 application, as amended, on public notice for a second time, noting that the application had already been placed on public notice on December 23, 2021. See *Satellite Policy Branch Information, Space Station Applications Accepted for Filing*, Report No. SAT-01598 (Dec. 23, 2021); Letter from Jameson Dempsey, Satellite Policy Director, Space Exploration Holdings, LLC, to Marlene H. Dortch, Secretary, FCC ICFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105 (dated Mar. 11, 2024) (SpaceX March 11, 2024 Letter). In response, the Satellite Programs and Policy Division on July 12, 2024 placed the application, as amended, on public notice again, but only with respect to the additional information provided in the SpaceX June 20, 2024 Response. See Letter from David Goldman, Vice President of Satellite Policy, Space Exploration Technologies Corp., to Merissa L. Velez, Chief, Satellite Programs and Policy Division, FCC, ICFS File Nos. SAT-LOA-20200526-00055, SAT-AMD-20210818-00105, SAT-AMD-20221216-00175, SAT-MOD-20240423-00089, SAT-MOD-20230207-00021, SAT-AMD-20240322-00061, and GN Docket No. 23-135 (dated June 20, 2024) (SpaceX June 20, 2024 Response); see also *Satellite Licensing Division and Satellite Programs and Policy Division Information, Space Station Applications Accepted for Filing*, Report No. SAT-01836 (Jul. 12, 2024) (SPPD July 12, 2024 Public

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request to operate in the 340 km, 345 km, 350 km, and 360 km range.⁵⁰ In this amendment, SpaceX requests authority to operate its Gen2 Starlink satellites in the mobile-satellite service (MSS) using frequencies in the 1429-2690 MHz (space-to-Earth and Earth-to-space) range for links to end-user devices outside the United States.⁵¹ On April 23, 2024, SpaceX filed a modification⁵² seeking to operate using authorized V-band frequencies in the 340 km to 360 km altitude shells.⁵³ On June 6, 2024, SpaceX supplemented its amendment with a request for a waiver, *inter alia*, of section 25.202(k)(1) of the Commission's rules regarding out of band emission (OOBE) limits.⁵⁴

13. On June 7, 2024, the Satellite Programs and Policy Division requested SpaceX provide additional information to assist in the review of SpaceX's 300 km altitude request and SCS application, as amended.⁵⁵ SpaceX responded on June 20, 2024.⁵⁶ Because part of SpaceX's response, specifically SpaceX's average direct-to-cell transmit antenna pattern, was filed confidentially, EchoStar filed a request for a protective order to allow outside counsel and experts for interested parties to review the information SpaceX designated as confidential, which Omnispace supported and SpaceX objected to.⁵⁷ On July 12, 2024, the Satellite Programs and Policy Division accepted SpaceX's requests for filing and placed the

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Notice). The Public Notice also clarified that it did not initiate a second petition-to-deny period. *See id.* *See also* GN Docket No. 23-135.

⁵⁰ *See* SpaceX SCS Modification Amendment.

⁵¹ *See id.*, Narrative at 6; Schedule S at 3. We note that SpaceX has recently submitted two filings seeking to modify the orbital parameters, operational characteristics, and frequency use of the previously authorized 7,500 Gen2 satellites, as well as amend the deferred portion of its Gen2 application, as amended, including a request to use the 1429-2690 MHz band for MSS across all of its proposed 29,988 Gen2 Starlink satellites. *See* ICFS File Nos. SAT-MOD-20241011-00224 and SAT-AMD-20241017-00228. These requests remain pending, and this authorization is without prejudice to any potential future action in connection with these filings.

⁵² *See* SpaceX Second V-band Modification Application.

⁵³ SpaceX filed a request for STA on May 22, 2024, seeking to operate satellites at lower altitudes while its underlying request, amendment, and modification applications were reviewed. *See* Space Exploration Holdings, LLC, Request for Special Temporary Authority, ICFS File No. SAT-STA-20240522-00108 (filed May 22, 2024). *See also* Letter from Jameson Dempsey, Director of Satellite Policy, Space Exploration Holdings LLC, to Marlene H. Dortch, Secretary, FCC, ICFS File No. SAT-STA-20240522-00108 (dated Aug. 31, 2024). To date, no action has been taken on this STA request.

⁵⁴ 47 CFR § 25.202(k)(1); *see* SpaceX June 6, 2024 Letter at 1-2.

⁵⁵ *See* Letter from Merissa L. Velez, Chief, Satellite Programs and Policy Division, Space Bureau, Federal Communications Commission, to William M. Wiltshire, Counsel, Space Exploration Holdings, LLC, ICFS File Nos. SAT-LOA-20200526-00055, SAT-AMD-20210818-00105, SAT-AMD-20221216-00175, SAT-MOD-20240423-00089, SAT-MOD-20230207-00021, SAT-AMD-20240322-00061, GN Docket No. 23-135 (dated Jun. 7, 2024) (Commission June 7, 2024 Information Request).

⁵⁶ *See* SpaceX June 20, 2024 Response.

⁵⁷ EchoStar June 28, 2024 Request for Protective Order; Letter from Mindel De La Torre, Chief Regulatory and International Strategy Officer, Omnispace LLC, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-135 (dated Jul. 5, 2024) (Omnispace July 5, 2024 Letter); Letter from Jameson Dempsey, Director of Satellite Policy, Space Exploration Technologies Corp., to Marlene H. Dortch, Secretary, FCC, ICFS File Nos. SAT-LOA-20200526-00055, SAT-AMD-20210818-00105, SAT-AMD-20221216-00175, SAT-MOD-20240423-00089, SAT-MOD-20230207-00021, and SAT-AMD-20240322-00061, GN Docket No. 23-135 (dated Jul. 9, 2024) (SpaceX July 9, 2024 Letter); Letter from Pantelis Michalopoulos, Counsel, EchoStar Corporation, to Marlene H. Dortch, Secretary, FCC, ICFS File Nos. SAT-LOA-20200526-00055, SAT-AMD-20210818-00105, SAT-AMD-20221216-00175, SAT-MOD-20240423-00089, SAT-MOD-20230207-00021, SAT-AMD-20240322-00061, GN Docket No. 23-135 (dated Jul. 12, 2024) (EchoStar July 12, 2024 Letter).

applications on public notice.⁵⁸ EchoStar and AT&T filed Petitions to Deny,⁵⁹ Omnispace filed an informal objection,⁶⁰ and Verizon filed an opposition.⁶¹ SpaceX and T-Mobile filed consolidated oppositions,⁶² and EchoStar, AT&T, and the Rural Wireless Association (RWA) filed replies.⁶³ SpaceX has also submitted multiple *ex parte* filings.⁶⁴ We note that with the exception of Omnispace's informal objection, no commenters raised concerns regarding SpaceX's proposed operations at lower altitudes, while all other commenters, with T-Mobile excepted, raise concerns regarding SpaceX's request for waiver of the Commission's OOB limit for SCS operations.⁶⁵ The Space Bureau and WTB requested SpaceX provide additional information on September 6, 2024, and SpaceX responded on September 13, 2024.⁶⁶ Also, on September 18, 2024, SpaceX filed reference patterns and a comma-separated values (CSV)⁶⁷ file with the specific data points in the pattern, and SpaceX withdrew its average direct-to-cell

⁵⁸ See SPPD July 12, 2024 Public Notice. In this public notice, the Division also placed the original Gen2 application, as amended, on public notice for a second time, but only with respect to the additional information provided in the SpaceX June 20, 2024 Response. *Id.* See *supra* n.49. See also GN Docket No. 23-135.

⁵⁹ See EchoStar Petition; AT&T Petition.

⁶⁰ See Omnispace Informal Objection; see also *supra* n.14.

⁶¹ See Verizon August 12, 2024 Opposition.

⁶² Opposition of Space Exploration Holdings LLC, ICFS File Nos. SAT-MOD-20230207-00021 and SAT-AMD-20240322-00061, GN Docket No. 23-135 (filed Aug. 22, 2024) (SpaceX August 22, 2024 Opposition); Response of T-Mobile USA, ICFS File Nos. SAT-MOD-20230207-00021 and SAT-AMD-20240322-00061, GN Docket No. 23-135 (filed Aug. 22, 2024) (T-Mobile August 22, 2024 Response).

⁶³ Reply of EchoStar Corporation, ICFS File Nos. SAT-MOD-20230207-00021 and SAT-AMD-20240322-00061, GN Docket No. 23-135 (filed Aug. 27, 2024) (EchoStar Reply); Reply of AT&T Inc., ICFS File Nos. SAT-MOD-20230207-00021 and SAT-AMD-20240322-00061, GN Docket No. 23-135 (filed Aug. 29, 2024) (AT&T August 29, 2024 Reply); Reply of The Rural Wireless Association Inc., ICFS File Nos. SAT-MOD-20230207-00021 and SAT-AMD-20240322-00061, GN Docket No. 23-135 (filed Aug. 30, 2024) (RWA August 30, 2024 Reply).

⁶⁴ See *e.g.*, Ex Parte Presentation of Space Exploration Holdings LLC, ICFS File Nos. SAT-MOD-20230207-00021 and SAT-AMD-20240322-00061, GN Docket No. 23-135 (dated Aug. 12, 2024) (SpaceX August 12, 2024 Ex Parte); Ex Parte Presentation of Space Exploration Holdings LLC, ICFS File Nos. SAT-MOD-20230207-00021 and SAT-AMD-20240322-00061, GN Docket No. 23-135 (dated Aug. 23, 2024) (SpaceX August 23, 2024 Letter).

⁶⁵ See *e.g.*, EchoStar Petition at 2-4 (arguing that the Commission has already responded to, and rejected, SpaceX's call for a weaker aggregate out-of-band emissions limit and that there is still no evidence that SpaceX's proposed operations can provide any protection from harmful interference for services operating in adjacent bands); AT&T Petition at 3, 6 (arguing that granting the waiver request will cause harmful interference to incumbent terrestrial mobile networks and that SpaceX has yet to demonstrate why it cannot meet the Commission's aggregate PFD limit); Verizon Opposition at 3 (arguing that SpaceX's proposal would undermine the Commission's core goal of protecting incumbent terrestrial licensee operations from SCS satellite operations in adjacent bands by subjecting them to harmful interference).

⁶⁶ See Letter from Merissa L. Velez, Chief, Satellite Programs and Policy Division, Space Bureau, Federal Communications Commission, to William M. Wiltshire, Counsel, Space Exploration Holdings, LLC, ICFS File Nos. SAT-LOA-20200526-00055, SAT-AMD-20210818-00105, SAT-AMD-20221216-00175, SAT-MOD-20240423-00089, SAT-MOD-20230207-00021, SAT-AMD-20240322-00061, SAT-STA-20240522-00108, GN Docket No. 23-135, ULS File Nos. 0010303032, 0010303084, 0010303124, and 0010303146 (dated Sept. 6, 2024) (Commission September 6, 2024 Information Request); see also Letter from David Goldman, Vice President Satellite Policy, Space Explorations Technologies Corp., to Merissa Velez, Chief, Satellite Programs and Policy Division, Space Bureau, Federal Communications Commission, File Nos. SAT-LOA-20200526-00055, SAT-AMD-20210818-00105, SAT-AMD-20221216-00175, SAT-MOD-20240423-00089, SAT-MOD-20230207-00021, SAT-AMD-20240322-00061, SAT-STA-20240522-00108, GN Docket No. 23-135, ULS File Nos. 0010303032, 0010303084, 0010303124, and 0010303146 (dated Sept. 13, 2024) (SpaceX September 13, 2024 Letter).

⁶⁷ A CSV file "is a text file in which information is separated by commas." See Dave Johnson, *What is a CSV file? How to Open and Use the Popular Spreadsheet File* (Apr. 8, 2022),

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transmit antenna pattern for which SpaceX had sought confidential treatment.⁶⁸

14. *The Commission's SCS Framework.* On March 14, 2024, in the *SCS R&O*, the Commission adopted an SCS licensing framework.⁶⁹ The Commission modified the United States Table of Frequency Allocations to authorize bi-directional, secondary MSS operations in certain spectrum bands that have no primary, non-flexible-use legacy incumbents, federal or non-federal.⁷⁰ The Commission further adopted rules that would authorize SCS only where one or more terrestrial licensees—together holding all licenses on the relevant channel throughout a defined geographically independent area (GIA)—lease access to their spectrum rights to a participating satellite operator, whose part 25 license reflects these frequencies and the GIA in which they will offer SCS.⁷¹ Similarly, the Commission adopted entry criteria that satellite operators must meet to apply for or modify an existing part 25 space station license to operate satellites in certain bands that will be available for the provision of SCS (SCS Bands) while imposing technical rules and other recommendations to mitigate potential harmful interference to existing services.⁷² The Commission also clarified applicable international coordination obligations and outlined steps to ensure that SCS operations will be consistent with relevant ITU Radio Regulations.⁷³ In a Further Notice of Proposed Rulemaking accompanying the *SCS R&O (SCS FNPRM)*,⁷⁴ the Commission seeks comment on improving 911 service for SCS and on procedures related to the protection of radio astronomy.

III. DISCUSSION

15. Below, we address the various outstanding issues raised by SpaceX's applications and comments raised on the record. Where appropriate we defer matters of general applicability to ongoing or potential future rulemakings.

A. Public Interest Considerations

16. We find that it is in the public interest to authorize SpaceX to provide SCS in the United States and to operate with the purpose of performing direct-to-cell operations outside the United States with all of its 7,500 previously authorized Gen2 Starlink satellites and to authorize SpaceX to operate its previously authorized 7,500 Gen2 Starlink satellites at altitudes of 340 km, 345 km, 350 km, and 360 km.

17. In the *SCS R&O*, the Commission recognized that satellite-to-device connectivity can support critical public interest benefits, including ubiquitous connectivity, access to 911 service from remote areas, technological advancement, and innovative spectrum use.⁷⁵ The Commission also found that the SCS framework will expand the reach of communications services, particularly emergency services, spur advancements in cutting-edge, space-based technologies, and continue the Commission's

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<https://www.businessinsider.com/guides/tech/what-is-csv-file>. It can be “open[ed] in a wide variety of programs, including any program that works with plain text.” *See id.*

⁶⁸ *See* Letter from David Goldman, Vice President of Satellite Policy, SpaceX, to Marlene H. Dortch, Secretary, FCC, ICFS File Nos. SAT-LOA-20200526-00055, SAT-AMD-20210818-00105, and SAT-MOD-20230207-00021; GN Docket No. 23-135; ULS File Nos. 0010303032, 0010303084, 0010303124, 0010303146 at 1 (dated Sept. 18, 2024) (SpaceX September 18, 2024 Letter).

⁶⁹ *See generally SCS R&O.*

⁷⁰ *See id.* at para. 47.

⁷¹ *See id.* at para. 63.

⁷² *See id.* at paras. 62-77, 140-152, 193-222.

⁷³ *See id.* at paras. 223-235.

⁷⁴ *See id.* at paras. 239-256.

⁷⁵ *See SCS R&O*, para. 18.

efforts to promote the innovative and efficient use of our nation's spectrum resources.⁷⁶ We find that, in utilizing the SCS framework that the Commission established, SpaceX is directly furthering those goals that the Commission envisioned. Through its lease arrangement with T-Mobile, SpaceX's Gen2 Starlink satellites can enable consumers outside the range of T-Mobile's network to be connected while using their existing devices.⁷⁷ We find that SpaceX and T-Mobile's SCS operations will yield many benefits, including an increase in access to emergency services in areas where consumers would otherwise not have the capability to access a terrestrial network to call or text 911, as evidenced, for example, through SpaceX's provision of emergency SCS in areas affected by Hurricanes Helene and Milton.⁷⁸ Also, SpaceX and T-Mobile's SCS service is reflective of an increase in innovation, investment, and competition in the marketplace that the Commission sought to encourage in the *SCS R&O*.⁷⁹ Similarly, by utilizing this SCS framework, SpaceX is able to provide a service that will benefit consumers while minimizing any risk of harmful interference to terrestrial providers and other satellite operators.⁸⁰

18. Moreover, we conclude that authorization to operate at lower altitudes will improve service to SpaceX's customers, as well as reduce risk of long-term debris at these altitudes by reducing collision risk and satellite demise times in the event of an anomaly on orbit. Granting SpaceX's request to include the lower altitudes of 340 km, 345 km, 350 km, and 360 km as an option for deployment for its previously-authorized 7,500 satellites, conditioned on limited deployment to these lower altitudes consistent with SpaceX's coordination with NASA pursuant to their Space Act Agreement, will allow the Commission to continue to monitor operations, noting additional issues raised in the Gen2 application record regarding interference, orbital debris mitigation, and impacts on optical astronomy with respect to SpaceX's entire proposed constellation of nearly 30,000 satellites.⁸¹

19. In an *ex parte* letter, Kuiper raises questions about the extent to which the Space Bureau can "modify the altitudes" adopted in the *SpaceX Gen2 First Partial Grant*, which was adopted by the Commission, or whether this amounts to an untimely Petition for Reconsideration.⁸² The Space Bureau has delegated authority under the Commission's rules to "act upon applications for satellite systems and earth stations pursuant to part 25."⁸³ Our action today is consistent with prior actions, including prior

⁷⁶ See *id.* at para. 2.

⁷⁷ See *id.* at para. 1; SpaceX SCS Modification, Narrative at 13; ULS File Nos. 0010303032, 0010303084, 0010303124, and 0010303146 (filed Dec. 6, 2022, and amended on Feb. 7, 2023 and Sept. 23, 2024; granted on Nov. 26, 2024). *But see* AT&T June 5, 2023 Reply at 5 (arguing that replacing fifth-generation terrestrial mobile broadband services with the basic texting capability SCS currently offers contravenes the public interest). AT&T's argument is incorrect since SCS will only be enabled where there has not been fifth-generation buildout by the mobile broadband provider.

⁷⁸ See ICFS File Nos. SAT-STA-20241007-00215 (granted Oct. 4, 2024 and renewed Oct. 23, 2024); SAT-STA-20241007-00216 (granted Oct. 7, 2024 and renewed Oct. 23, 2024); *see e.g.*, Chris Velazco, *When Storms Knock Out Cell Service, Satellites Can Help Keep You Connected* (Oct. 10, 2024), <https://www.washingtonpost.com/technology/2024/10/10/how-text-message-satellite-without-cell-service/>.

⁷⁹ See *SCS R&O*, paras. 2, 44, 238; SpaceX SCS Modification, Narrative at 5, 10; *see also* Letter from Kara Azocar, Vice President, Regulatory, Iridium Communications Inc., and L. Barbee Ponder IV, General Counsel and Vice President, Regulatory Affairs, Globalstar, Inc., to Marlene H. Dortch, Secretary, FCC at 3 (dated June 28, 2023).

⁸⁰ See *SCS R&O*, para. 3; SpaceX SCS Modification, Narrative at 12. *But see* Reply of DISH Network Corporation, GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 at 2 (filed June 5, 2023) (DISH SCS Reply); Reply of AT&T Services, Inc., GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 at 5-6 (filed June 5, 2023) (AT&T June 5, 2023 Reply).

⁸¹ As noted, SpaceX's request that its license cover deployment and operations of satellites in its proposed Gen2 system beyond the 7,500 satellites previously authorized remains pending.

⁸² See Kuiper March 8, 2024 Letter at 2, fn. 8.

⁸³ 47 CFR § 0.261(a)(2).

modifications or further grants in part of SpaceX's licenses made at the Bureau level after an initial authorization at the Commission level.⁸⁴ We make our findings in these application proceedings taking into account prior Commission determinations and guidance, including the Commission's SCS rulemaking proceeding and the Commission's initial license grant for SpaceX's Gen2 system. Consistent with our delegated authority, we address any concerns raised in the record and process the modification requests consistent with the Commission's rules and the established SCS framework. In addition, we are not "modifying the altitudes" adopted in the *SpaceX Gen2 First Partial Grant*, as Kuiper claims.⁸⁵ Instead, we are further granting in part SpaceX's application, as amended, for its Gen2 system, which originally included a request to operate at the 340 km, 345 km, 350 km, and 360 km shells that we authorize today.⁸⁶ Finally, we are not authorizing any additional satellites beyond the 7,500 already authorized in the *SpaceX Gen2 First Partial Grant*.

20. Additionally, we disagree with Kuiper's characterization that SpaceX's February 20, 2024 request to add the 340 km, 345 km, 350 km, and 360 km orbital shells as options for deployment for its Gen2 satellites is an untimely Petition for Reconsideration.⁸⁷ When the Commission adopted the *SpaceX Gen2 First Partial Grant*, it deferred consideration of SpaceX's proposed operations at lower altitudes and higher altitudes, as well as the additional 22,488 satellites SpaceX proposed to operate as part of its Gen2 Starlink constellation, but the Commission did not deny SpaceX's application for these operations.⁸⁸ Petitions for Reconsideration may only be filed on final Bureau or Commission actions.⁸⁹ Therefore, SpaceX is not requesting the Commission reconsider the *SpaceX First Partial Grant*, but rather requesting further action on the pending portion of its Gen2 application, as amended, to expand operational flexibility based on new information on the performance of its Gen2 satellites at lower altitudes that SpaceX did not have at the time the Commission adopted the *SpaceX Gen2 First Partial Grant*.⁹⁰ Our action today is therefore a further partial grant of SpaceX's Gen2 Application, as amended, and not an action taken on an untimely Petition for Reconsideration.

21. Kuiper also requests that the Commission "establish a clear process for future expansions of SpaceX's Gen2 system."⁹¹ We decline to adopt a bespoke process for consideration of future expansions of SpaceX's Gen2 system, as requested by Kuiper.⁹² Kuiper states that such a process need not be overly lengthy or formalistic but should ensure that interested parties have a reasonable opportunity to comment on any changes proposed by SpaceX.⁹³ Interested parties, however, had appropriate notice and time to comment on SpaceX's request to operate in the 300 km shells during the

⁸⁴ See e.g., *Space Exploration Holdings, LLC*, Grant Stamp, ICFS File No. SAT-MOD-20230215-00036 (granted Aug. 16, 2024) (*SpaceX Gen1 Fourth Modification Grant Stamp*) (Bureau-level grant stamp modifying initial Commission-level Order authorizing SpaceX's Gen1 system, see *Space Exploration Holdings, LLC, Application for Approval for Orbital Deployment and Operating Authority for the SpaceX NGSO Satellite System*, Memorandum Opinion, Order and Authorization, 33 FCC Rcd 3391 (2018)); *SpaceX E-band Partial Grant* (Bureau-level Order modifying initial Commission-level Order authorizing SpaceX's Gen2 system).

⁸⁵ Kuiper March 8, 2024 Letter at 2, fn. 8.

⁸⁶ See SpaceX Gen2 Application, as amended. We also note that Kuiper's arguments were concerned only with SpaceX's Gen2 Application, as amended, and were not filed on SpaceX's V-band or SCS Modifications.

⁸⁷ See Kuiper March 8, 2024 Letter at 2, fn. 8.

⁸⁸ See generally *SpaceX Gen2 First Partial Grant*.

⁸⁹ 47 CFR § 1.106(a).

⁹⁰ See generally SpaceX February 20, 2024 Request.

⁹¹ See Kuiper March 8, 2024 Letter at 2.

⁹² See *id.*

⁹³ See *id.*

public notice period for SpaceX's original Gen2 application, as amended.⁹⁴ Additionally, interested parties had appropriate notice and time to comment on SpaceX's request to modify its V-band authorization⁹⁵ and SpaceX's amended request to modify its SCS authorization.⁹⁶ Finally, interested parties were also able to comment on any new information related to SpaceX's operations at 340-360 km that was provided in SpaceX's June 20, 2024 letter responding to the Space Bureau's information request.⁹⁷ With respect to the issues raised during the initial comment period for SpaceX's Gen2 system that were deferred in the *SpaceX Gen2 First Partial Grant*, we address those concerns in this Order as they pertain to the 7,500 satellites authorized today. We will continue to consider these issues concerning SpaceX's proposed operations at lower shells and address them in any future grants of authority for operations at lower shells or for deployment of additional satellites. We also note that this authorization is without prejudice to any further action regarding aspects of SpaceX's various applications deferred today or any other application SpaceX has filed with the Commission or may file in the future.⁹⁸

B. Supplemental Coverage from Space

22. After review of the record, we grant in part SpaceX's application, as amended, authorizing SpaceX to provide SCS in the 1910-1915 MHz (Earth-to-space) and 1990-1995 MHz (space-to-Earth) bands in the United States pursuant to a lease arrangement with T-Mobile and to operate its satellites in the MSS in certain sub-bands within the 1429 MHz to 2690 MHz (space-to-Earth and Earth-to-space) bands for the purpose of direct-to-cell operations outside the United States, as conditioned.⁹⁹ We defer consideration of SpaceX's request for waiver of the OOB limit required for SCS operations in section 25.202(k)(1) of the Commission's rules.

1. Grant of Application to Provide SCS

23. In the *SCS R&O*, the Commission adopted entry criteria for NGSO and geostationary satellite orbit (GSO) operators that seek to apply for or modify an existing part 25 license to operate satellites in the SCS Bands in the United States and its territories.¹⁰⁰ Specifically, the Commission established an SCS framework allowing satellite operators to apply to modify a current part 25 license to

⁹⁴ See *Satellite Policy Branch Information, Space Station Applications Accepted for Filing*, Report No. SAT-01598 (Dec. 23, 2021). Commenters filed numerous letters, *ex parte* presentations, and comments on the record for SpaceX's Gen2 Application, as amended, prior to the application being placed on public notice and well after the deadline for filing comments. See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14887-88, para. 6. Additionally, pursuant to a request from Kuiper supported by Viasat, the Satellite Division extended the original deadline for filing petitions to deny on SpaceX's Gen2 Application, as amended, from January 24, 2022, to February 8, 2022. See *Satellite Policy Branch Information, Actions Taken*, Report No. SAT-01601 (Jan. 13, 2021). Interested parties have had adequate notice and time to comment on SpaceX's request to operate in the 300 km shells, and parties have continued to file comments on the record in the two years since the *SpaceX Gen2 First Partial Grant*.

⁹⁵ See SpaceX Second V-band Modification Application. This application was placed on public notice on July 12, 2024. See SPPD July 12, 2024 Public Notice.

⁹⁶ See SpaceX SCS Modification Amendment. This application was placed on public notice on July 12, 2024. See SPPD July 12, 2024 Public Notice.

⁹⁷ See SPPD July 12, 2024 Public Notice. In this public notice, the Division also placed the original Gen2 application, as amended, on public notice for a second time, but only with respect to the additional information provided in the SpaceX June 20, 2024 Response. *Id.* See *supra* n.49. See also GN Docket No. 23-135.

⁹⁸ See *e.g.* ICFS File Nos. SAT-LOA-20200526-00055, SAT-AMD-20210818-00105, SAT-AMD-20221216-00175, SAT-MOD-20230207-00021, SAT-AMD-20240322-00061, SAT-MOD-20240423-00089, SAT-MOD-20240813-00138, SAT-MOD-20241011-00224, and SAT-AMD-20241017-00228.

⁹⁹ In this document, the term "United States" refers to the contiguous United States (CONUS), as well as Alaska, Hawaii, Puerto Rico, the U.S. Virgin Islands and all U.S. territories.

¹⁰⁰ See *SCS R&O*, at paras. 62-77.

include SCS where: (1) the satellite operator has one or more leasing notification(s) or application(s), or in the case of FirstNet, a Form 601, on file with the Commission to access the spectrum allocated for MSS provision of SCS from a single terrestrial licensee or multiple licensees that hold, collectively or individually, all co-channel licenses throughout a GIA; (2) the current part 25 space station licensee or part 25 grantee of market access for NGSO or GSO satellite operation seeks modification of authority to provide SCS in the same geographic areas covered in the relevant GIA; and (3) the terrestrial devices involved in SCS qualify as “licensed by rule” earth stations under the new provisions of part 25.¹⁰¹

24. As informed by these entry criteria, we find that SpaceX’s application supports the grant of a license for the provision of SCS in the United States.¹⁰² SpaceX holds an existing part 25 license for its Gen2 Starlink satellites and has a lease arrangement with T-Mobile who holds all co-channel licenses throughout all relevant GIAs, namely CONUS, Alaska, Hawaii, and Puerto Rico.¹⁰³ In addition, SpaceX has certified that the lease notification covering the arrangement between SpaceX and T-Mobile is on file with the Commission.¹⁰⁴ SpaceX further states that this lease arrangement covers CONUS, Alaska, Hawaii, and Puerto Rico—across which SpaceX will provide SCS.¹⁰⁵ Earlier today, the Commission granted SpaceX and T-Mobile’s applications for SpaceX’s SCS leases of T-Mobile’s PCS-G spectrum.¹⁰⁶ SpaceX likewise certifies that the terrestrial devices used for SCS will qualify as “licensed by rule” earth stations.¹⁰⁷ We also find, as a whole, SpaceX has provided a comprehensive and consistent proposal for the prospective SCS system on FCC Form 312, Main Form and Schedule S in accordance with the Commission’s rules.¹⁰⁸ DISH argues that SpaceX has not provided clarity about the number of satellites it seeks to deploy and the timeline for launch of those satellites and that such information is critical to evaluating the instant application.¹⁰⁹ However, we find that the information SpaceX has provided is sufficient for this grant, as conditioned. SpaceX’s application solely seeks to add a new antenna to 7,500 currently authorized Gen2 Starlink satellites, and SpaceX has provided the necessary information about those 7,500 satellites, including analysis relating to issues including the potential for harmful interference,

¹⁰¹ See 47 CFR § 25.125; *SCS R&O*, at para. 63.

¹⁰² We note that some of the rules encompassing our entry criteria are not yet effective, pending completion of Paperwork Reduction Act review. See *SCS R&O*, Appx. B, paras. 2, 16; see also OMB Control Numbers 3060-1058, 3060-0678. Here, we take into account information that SpaceX provided in its application of its own volition, and we consider that information in light of the Commission’s policy determinations in the *SCS R&O*.

¹⁰³ See 47 CFR § 25.125(a); SpaceX SCS Modification Amendment, Narrative, Exh. B at B-2; ULS File Nos. 0010303032, 0010303084, 0010303124, and 0010303146 Second Amended Description of Transaction, at 2 (filed Dec. 6, 2022 and amended on Feb. 7, 2023 and Sept. 23, 2024; granted on Nov. 26, 2024); see also 47 CFR §§ 1.9047, 25.103.

¹⁰⁴ See SpaceX SCS Modification, Narrative at 7; see also File Nos. 0010303032, 0010303084, 0010303124, and 0010303146.

¹⁰⁵ See SpaceX SCS Modification, Technical Annex at 8; SpaceX September 18, 2024 Letter at 1; ULS File Nos. 0010303032, 0010303084, 0010303124, and 0010303146 (filed Dec. 6, 2022 and amended on Feb. 7, 2023 and Sept. 23, 2024; granted on Nov. 26, 2024).

¹⁰⁶ ULS File Nos. 0010303032, 0010303084, 0010303124, and 0010303146 (filed Dec. 6, 2022 and amended on Feb. 7, 2023 and Sept. 23, 2024; granted on Nov. 26, 2024).

¹⁰⁷ See SpaceX September 18, 2024 Letter at 1.

¹⁰⁸ See 47 CFR § 25.114. DISH argued that SpaceX’s application should be rejected pursuant to the unbuilt system rule under section 25.159(b) of the Commission’s rules. See DISH SCS Petition at 3-5. However, section 25.159(b) has since been revised and the unbuilt system restriction removed from the Commission’s rules, and this argument is thus dismissed as moot. See *Expediting Initial Processing of Satellite and Earth Station Applications; Space Innovation*, Report and Order and Further Notice of Proposed Rulemaking, 38 FCC Rcd 8838, 8853, para. 31 (2023) (*Streamlining Satellite Application Processing Order*).

¹⁰⁹ See DISH SCS Petition at 8; DISH SCS Reply at 3-4.

coordination with other operators, orbital debris mitigation, and collision mitigation.¹¹⁰ In addition, EchoStar argues that SpaceX has submitted multiple ITU filings, FCC applications, and FCC modifications, and such volume prevents regulators and other satellite operators and members of the public from understanding SpaceX's exact request and its implications.¹¹¹ Despite the number of SpaceX filings and applications associated with the Gen2 Starlink satellites, SpaceX's comprehensive proposals, coupled with our public notices seeking comment as well as our requests for additional information from SpaceX when needed, have provided us and interested parties with sufficient information to understand SpaceX's requests and the implications of those requests.¹¹²

25. Given that SpaceX filed its application before adoption and release of the *SCS R&O*, some commenters raised concerns about SCS generally.¹¹³ However, we will not revisit general issues

¹¹⁰ See Consolidated Opposition to Petitions and Response to Comments of Space Exploration Holdings, LLC, GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 at 8, 23 (filed May 30, 2023) (SpaceX Consolidated Opposition) (clarifying that, with the addition of the new antenna, satellite operations will fall within the area-to-mass ratio of the largest form factor that the Commission approved for the Gen2 Starlink system in the SpaceX Gen2 Partial Grant). In addition, SpaceX provided information about two of its new antenna form factors and sample DAS logs that demonstrate that this new antenna fits within the parameters SpaceX already provided. See *id.* at 24, Attachment A; see also SpaceX Gen2 Application, Technical Attachment at 35-49; SpaceX Gen2 Amendment, Technical Attachment at 15-18; SpaceX October 4, 2022 Letter at Exhibit B.

¹¹¹ See Letter from Pantelis Michalopoulos and Christopher Bjornson, Counsel, DISH Network Corporation, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 at 6 (dated Jan. 2, 2024) (DISH January 2, 2024 Letter).

¹¹² When we have had additional questions for SpaceX or otherwise found a need for SpaceX to clarify its requests, we have asked SpaceX for additional information or clarification. See, e.g., Letter from Kathryn J. Medley, Acting Chief, Satellite Licensing Division, Space Bureau, FCC, to Mr. William M. Wiltshire, Counsel, Space Exploration Holdings, LLC, ICFS File No. SAT-MOD-20230207-00021; GN Docket No. 23-135; Call Sign: S3069 (dated Nov. 7, 2023); Letter from Merissa L. Velez, Chief, Satellite Programs and Policy Division, Space Bureau, FCC to Mr. William M. Wiltshire, Counsel, Space Exploration Holdings, LLC, ICFS File Nos. SAT-LOA-20200526-00055, SAT-AMD-20210818-00105, SAT-AMD-20221216-00175, SAT-MOD-20240423-00089, SAT-MOD-20230207-00021, and SAT-AMD-20240322-00061; GN Docket No. 23-135; Call Sign: S3069 (dated June 7, 2024); Letter from Merissa Velez, Chief, Satellite Programs and Policy Division, Space Bureau, FCC et al., to Mr. William M. Wiltshire, Counsel, Space Exploration Holdings, LLC, ICFS File Nos. SAT-LOA-20200526-00055, SAT-AMD20210818-00105, SAT-AMD-20221216-00175, SAT-MOD-20240423-00089, SAT-MOD-20230207-00021, SAT-STA-20240522-00108 and SAT-AMD-20240322-00061; Call Sign: S3069; GN Docket No. 23-135; ULS File Nos. 0010303032, 0010303084, 0010303124, and 0010303146 (dated Sept. 6, 2024).

¹¹³ See NRAO May 4, 2023 Opposition at 2-3 (arguing about the classification of SpaceX's operations as MSS, potential derogation of ITU Radio Regulations, and the status of mobile handsets as earth stations); Comments of AT&T Services, Inc., GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 at 2-3, 11 (filed May 18, 2023) (AT&T Comments) (arguing that WTB should be gatekeeper for operations in terrestrial frequencies and about a sufficient OOB limit); DISH SCS Reply at 4 (arguing about applicable OOB limits); Reply Comments of TerreStar Solutions Inc., GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 at 3 (filed May 30, 2023) (TerreStar Reply) (arguing about possible reduced terrestrial spectrum and advocating for use of existing MSS allocations); Letter from Jennifer A. Manner, Senior Vice President, Regulatory Affairs, EchoStar Corporation, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-65, IB Docket No. 22-271, GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021, Attach. at 1 (dated Jan. 26, 2024) (EchoStar January 26, 2024 Letter) (arguing that there must be studies before the Commission can finalize technical rules or, an alternative, that applicants submit showings that they will not cause harmful interference that are subject to public comment); Letter from Mindel De La Torre, Chief Regulatory and International Strategy Officer, Omnispace, LLC, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-135; ICFS File No. SAT-MOD20230207-00021 at 2 (dated Dec. 13, 2023) (Omnispace December 13, 2023 Letter) (arguing that the 3GPP standards associated with that service should be the basis for the MSS service offered); Letter from Steve B. Sharkey Vice President, Government Affairs Technology and Engineering Policy, T-Mobile, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-65, IB Docket No. 22-271, ICFS File No. SAT-MOD-20230207-00021, ULS File No. 0010303032, et al. at 2 (dated Mar. 5, 2024) (T-Mobile March 5, 2024 Letter) (suggesting various refinements to the Commission's draft *SCS R&O*);

(continued....)

about SCS raised in the record that were already addressed in the *SCS R&O*.¹¹⁴ Relatedly, since we grant SpaceX's application for SCS following the release of the *SCS R&O*, we see no reason to address arguments about whether we can grant such operations before the rulemaking concludes.¹¹⁵ Although the *SCS FNPRM* is still pending,¹¹⁶ we find that we are able to proceed with the grant without final resolution of the issues on which we sought comment in the *SCS FNPRM*. We note that, in the *SCS R&O*, the Commission established interim 911 requirements that apply to SpaceX and T-Mobile's SCS network while it continues to consider final 911 rules for SCS.¹¹⁷ Similarly, we address herein radio astronomy issues specific to SpaceX's planned operations—consistent with the *SCS R&O*—and therefore need not wait for final resolution of the questions related to radio astronomy covered in the *SCS FNPRM*.¹¹⁸ Should the Commission adopt additional or more stringent requirements for satellite operators in the SCS rulemaking proceeding, the grant here is conditioned on SpaceX's compliance with those future rules.

2. Operations in the 1910-1915 MHz and 1990-1995 MHz Bands

26. We grant SpaceX authority to provide SCS within the United States using the 1910-1915 MHz (Earth-to-space) and 1990-1995 MHz (space-to-Earth) bands on a secondary basis.¹¹⁹ The *SCS R&O* identified a list of SCS Bands, which includes Broadband PCS, *i.e.* the greater 1850-1915 MHz and 1930-1995 MHz bands.¹²⁰ Moreover, the *SCS R&O* modified the United States Table of Frequency Allocations by adding a secondary and bidirectional MSS allocation in certain bands, including Broadband PCS, through non-federal footnote NG33A.¹²¹ In accordance with footnote NG33A of the United States Table of Frequency Allocations, SpaceX may provide SCS on a secondary basis using the 1910-1915 MHz (Earth-to-space) and 1990-1995 MHz (space-to-Earth) bands, but SpaceX's SCS operations may not cause harmful interference to—and are not entitled to interference protection from—any primary service operating in those bands.¹²²

27. *Terrestrial Co-Channel Interference.* In the *SCS R&O*, the Commission adopted rules to limit SCS authorizations to GIAs where the terrestrial wireless licensee partner(s) hold all co-channel licenses because it would minimize the risk of potential interference between geographically adjacent

(Continued from previous page) _____

see also Letter from Michael P. Goggin, AT&T Services, Inc., to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-135, ICFS File No. SAT-STA20231002-00240 at 1-2 (dated Oct. 10, 2023) (AT&T October 10, 2023 Letter).

¹¹⁴ *See SCS R&O*, paras. 28-31, 65, 78-87, 202-207, 224-236.

¹¹⁵ *See* SpaceX Consolidated Opposition at 6; Response to Comments and Petitions of T-Mobile USA, Inc., GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 at 3 (filed May 30, 2023) (T-Mobile May 30, 2023 Response); AT&T June 5, 2023 Reply at 3; DISH SCS Reply at 2.

¹¹⁶ *See SCS R&O*, paras. 239-256.

¹¹⁷ *See id.* at paras. 173-192 (noting the interim 911 requirements).

¹¹⁸ *See id.* at paras. 252-256.

¹¹⁹ Under the Commission's rules, 47 CFR § 2.105(c)(2), stations of a secondary service: (i) Shall not cause harmful interference to stations of primary services to which frequencies are already assigned or to which frequencies may be assigned at a later date; (ii) Cannot claim protection from harmful interference from stations of a primary service to which frequencies are already assigned or may be assigned at a later date; and (iii) Can claim protection, however, from harmful interference from stations of the same or other secondary service(s) to which frequencies may be assigned at a later date.

¹²⁰ *See SCS R&O*, para. 28.

¹²¹ *See* 47 CFR § 2.106(a)(d)(33)(i); *SCS R&O*, para. 47.

¹²² *See* 47 CFR § 2.106(d)(33)(i).

markets.¹²³ AT&T argues that SpaceX must show how its service will not cause interference to T-Mobile's own operations in the PCS G Block.¹²⁴ However, because SpaceX will be complying with the framework adopted in the *SCS R&O*, we find that SpaceX can avoid harmful interference with in-band terrestrial operations and that it is in T-Mobile's best interest to ensure that SpaceX will not cause harmful interference. Consistent with the Commission's obligations for spectrum manager leases, SpaceX and T-Mobile have agreed to technical limits for satellite operations in T-Mobile's PCS G Block spectrum such that they will be indistinguishable from terrestrial PCS G Block operations from an interference perspective and will not cause harmful interference to existing in-band terrestrial operations.¹²⁵ SpaceX and T-Mobile also commit to continued coordination to enable efficient use of PCS G Block spectrum in the public interest.¹²⁶ We accordingly find that our existing secondary market rules will adequately ensure that the risk of harmful interference to T-Mobile's terrestrial operations is mitigated.¹²⁷

28. *Satellite-to-Satellite Co-Channel Interference.* While the United States has assigned the 1990-1995 MHz band for downlink terrestrial operations, a global allocation remains in the 1990-1995 MHz band for MSS uplinks.¹²⁸ Some commenters raise concerns about the potential for satellite-to-satellite interference from SpaceX's downlink operations in the 1990-1995 MHz band to existing MSS operations performing uplink operations in that same band.¹²⁹ Omnispace purports that SpaceX's downlink transmissions will increase the noise floor of Omnispace's receivers, which conform to the directionality imposed by the global MSS allocation for the S-band in the International Table of Frequency Allocations, and SpaceX's downlink transmissions will therefore disrupt Omnispace's ability to provide MSS outside the United States.¹³⁰ Omnispace also argues that, although T-Mobile suggests that tens of millions of handsets are already in operation that use the 1990-1995 MHz band for downlink, the degree of interference caused by T-Mobile's terrestrial base stations is of reduced power and over a

¹²³ See *SCS R&O*, paras. 54-55, 60.

¹²⁴ See AT&T Comments at 8 (we also note that AT&T discusses concerns about the potential for interference to services in adjacent bands in this part of its comments); AT&T June 5, 2023 Reply at 5; see also AT&T Comments at 10 (arguing that Space X should provide predictive modeling demonstrating that its deployments will comply with the technical rules and not cause any harm to T-Mobile's network and should show that it will comply with PCS frequency stability requirements with respect to Doppler shifts).

¹²⁵ See SpaceX Consolidated Opposition at 14; Letter from David Goldman, Vice President, Satellite Policy, SpaceX, to Marlene H. Dortch, Secretary, FCC, Attach. B at 3, GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 (dated Aug. 1, 2024) (SpaceX August 1, 2024 Letter).

¹²⁶ See *id.*, Attach. B at 3.

¹²⁷ See *SCS R&O*, para. 195; Letter from David Goldman, Vice President, Satellite Policy, Space Exploration Technologies Corp., to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-135; ICFS File No. SAT-MOD-20230207-00021, Attach. B at 3 (dated Jul. 26, 2023) (SpaceX July 26, 2023 Letter).

¹²⁸ See ITU Radio Regulations, Art. 5; see also Omnispace May 18, 2024 Opposition at 1.

¹²⁹ See Omnispace May 18, 2024 Opposition at 5; DISH SCS Petition at 4-5; DISH January 2, 2024 Letter at 1-2; see also TerreStar Reply at 2-3.

¹³⁰ See Omnispace May 18, 2024 Opposition at 6; Omnispace, LLC Reply Comments to Responses, GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 at 2 (filed June 5, 2023) (Omnispace June 5, 2023 Reply); Letter from Mindel De La Torre, Chief Regulatory and International Strategy Officer, Omnispace, LLC, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-135; ICFS File No. SAT-MOD20230207-00021 at 1-2 (dated Oct. 20, 2023) (Omnispace October 20, 2023 Letter); Letter from Mindel De La Torre, Chief Regulatory and International Strategy Officer, Omnispace, LLC, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-135; ICFS File No. SAT-MOD-20230207-00021 at 1 (dated Nov. 17, 2023) (Omnispace November 17, 2023 Letter); Omnispace December 13, 2023 Letter at 1; Letter from Mindel De La Torre, Chief Regulatory and International Strategy Officer, Omnispace, LLC, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-135; ICFS File No. SAT-MOD-20230207-00021 at 2-3 (dated Feb. 9, 2024) (Omnispace February 9, 2024 Letter).

more limited area than the satellite-to-satellite interference that is their concern.¹³¹ Omnispace further contends that satellite-to-satellite interference will occur even if large distances separate the two satellite systems.¹³² Omnispace has submitted technical analyses in support of its interference concerns with SpaceX's proposal for SCS in this band.¹³³ Relatedly, Omnispace claims that SpaceX does not adequately model the complete dynamics of its constellation.¹³⁴

29. SpaceX, on the other hand, contends that it has sufficiently demonstrated that proposed downlink operations do not pose a risk of harmful interference to other satellite operators, including Omnispace.¹³⁵ T-Mobile additionally argues that SpaceX's satellites will operate within the same directionality scheme in the band that the already-existing system uses and will cause no greater harm than exists today.¹³⁶ SpaceX submitted a Monte Carlo analysis¹³⁷ that simulates its 7,500-satellite constellation, split into multiple operational planes with transmit power, antenna gains values from their link path profile, as well as PFD levels as measured on the ground.¹³⁸ SpaceX also submitted maps showing its coverage across all of T-Mobile's nationwide PCS G Block service territories along with an

¹³¹ See Omnispace June 5, 2023 Reply at 17-18; Omnispace October 20, 2023 Letter at 1-2.

¹³² See Omnispace June 5, 2023 Reply at 2.

¹³³ *Id.* at 12-16; Omnispace October 20, 2023 Letter, Attach. at 3-16; Letter from Mindel De La Torre, Chief Regulatory and International Strategy Officer, Omnispace, LLC, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-135; ICFS File No. SAT-MOD-20230207-00021, Attach. at 3-11 (dated Aug. 18, 2023) (Omnispace August 18, 2023 Letter).

¹³⁴ See Omnispace August 18, 2023 Letter, Attach at 6-11; Omnispace October 20, 2023 Letter at 2; Omnispace November 17, 2023 Letter at 2-3; Omnispace December 13, 2023 Letter, Attach. at 2-8; *see also* DISH January 2, 2024 Letter at 2, 4-5 (arguing that SpaceX has not provided sufficient information to refute Omnispace's technical analysis, including minimum elevation angles in this band and the power levels at which its satellites would transmit at various angles below 34.3 degrees.).

¹³⁵ See SpaceX Consolidated Opposition at 16-17; *see also* Letter from David Goldman, Vice President, Satellite Policy, Space Exploration Technologies Corp., to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 at 1-3 (dated Sept. 29, 2023) (SpaceX September 29, 2023 Letter); Letter from David Goldman, Vice President, Satellite Policy, Space Exploration Technologies Corp., to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 at 1-2 (dated Nov. 24, 2023) (SpaceX November 24, 2023 Letter); Letter from David Goldman, Vice President, Satellite Policy, Space Exploration Technologies Corp., to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 at 2 (dated Jan. 29, 2024) (SpaceX January 29, 2024 Letter); Letter from David Goldman, Vice President, Satellite Policy, Space Exploration Technologies Corp., to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 at 1 (dated Feb. 14, 2024) (SpaceX February 14, 2024 Letter).

¹³⁶ See T-Mobile May 30, 2023 Response at 9; *see also* Reply to Response of T-Mobile USA, Inc., GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 at 3-4 (filed June 2, 2023) (T-Mobile June 2, 2023 Reply).

¹³⁷ A Monte Carlo simulation is a "computer-based numerical method[] for carrying out precise, quantitative risk analyses of complex projects." Michael Asbury, *JSTAR Monte Carlo Simulation* (Jul. 29, 2024), <https://www.nasa.gov/monte-carlo-simulation/#:~:text=This%20unique%20analytical%20advantage%20over,associated%20with%20such%20an%20occurrence>.

¹³⁸ See Letter from Jameson Dempsey, Principal, Satellite Policy, Space Exploration Technologies Corp., to Marlene H. Dortch, Secretary, GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021, Exh. A at A-1-A-8 (dated Nov. 14, 2023) (SpaceX November 14, 2023 Letter); Letter from Jameson Dempsey, Principal, Satellite Policy, Space Exploration Technologies Corp., to Marlene H. Dortch, Secretary, GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021, Exh. A at A-1-A-7 (dated Nov. 30, 2023) (SpaceX November 30, 2023 Letter); SpaceX SCS Modification Amendment, Narrative, Attach. A at A-1-A-7; SpaceX June 20, 2024 Response at 9.

explanation of how SpaceX will dynamically meet applicable limits.¹³⁹

30. As the Commission acknowledged in the *SCS R&O*, the 1910-1915 MHz/1990-1995 MHz band presents a level of technical complexity for SCS.¹⁴⁰ We have conducted a rigorous analysis of SpaceX's application, as amended, and in particular the technical materials submitted, to ensure compliance with our entry criteria and any applicable rules and requirements.¹⁴¹ We have also reviewed the technical analyses and the results of measurements Omnispace submitted.¹⁴² Ultimately, we find that SpaceX has demonstrated that it can adjust its equivalent isotropically radiated power (EIRP) to conduct downlink SCS in the 1990-1995 MHz band and maintain the level of sidelobe power towards Omnispace satellites to effectively reduce PFD as measured on the ground, and therefore will maintain 100% of the time an interference level below the harmful interference threshold for Omnispace satellites and other satellites performing uplink operations in the 1990-1995 MHz band.¹⁴³ In analyzing potential interference, we evaluate the likelihood of harmful interference to incumbent services. Based on its analysis, Omnispace anticipates an increase in the noise floor from SpaceX's SCS downlink where the Omnispace satellites are authorized to operate;¹⁴⁴ however, this increase does not appear to rise to a level of harmful interference. Our close review of Omnispace's analysis finds that it initially relied on ITU-R S.1528 recommendations and later changed to ITU-R M.1184 recommendations, which do not accurately reflect the actual modeled/measured sidelobe off-axis gain of SpaceX's system. These latter assumptions consequently grossly overestimated the anticipated levels of interference. Moreover, in its link budget analysis, SpaceX shows that it will maintain a maximum PFD level that ensures that it will not cause harmful interference to other satellite operators, including Omnispace.¹⁴⁵ In addition, as SpaceX deploys its constellation, it is able to dynamically adjust its PFD level to avoid causing harmful interference to any other system.¹⁴⁶ Finally, SpaceX's satellites will operate within the technical parameters identified for SCS operations in the *SCS R&O*, which will mitigate concerns of harmful interference given that T-Mobile's base stations currently operate with the same directionality in the 1990-1995 MHz band in the United States.¹⁴⁷ Should harmful interference ever occur, under the SCS rules, SpaceX must cease such

¹³⁹ See SpaceX November 14, 2023 Letter, Exh. B at B-1-B-3; SpaceX November 30, 2023 Letter, Exh. B at B-1; SpaceX SCS Modification Amendment, Narrative, Attach. A at B-1; SpaceX January 29, 2024 Letter at 1-2. *But see* DISH January 2, 2024 Letter at 2.

¹⁴⁰ See *SCS R&O*, para. 194.

¹⁴¹ See *id.*

¹⁴² See *supra* para. 28.

¹⁴³ See, e.g., SpaceX November 14, 2023 Letter, Exh. A at A-4; SpaceX November 30, 2023 Letter, Exh. A at A-5; SpaceX SCS Modification Amendment, Narrative, Attach. A at A-5; SpaceX June 20, 2024 Response at 8-10 (showing how SpaceX can adjust PFD while remaining below the applicable interference threshold even in the worst-case scenario at the lower altitude shells granted herein).

¹⁴⁴ See, e.g., Omnispace May 18, 2024 Opposition at 6-8; *id.* at Annex 1 at 19-22; Omnispace June 5, 2023 Reply at 11, 13-16; Omnispace August 18, 2023 Letter, Attach. at 9-10; Omnispace October 20, 2023 Letter, Attach. at 16.

¹⁴⁵ See SpaceX November 14, 2023 Letter, Exh. A at A-4; SpaceX November 30, 2023 Letter, Exh. A at A-1-A-5; SpaceX SCS Modification Amendment, Narrative, Attach. A at A-1-A-5; SpaceX June 20, 2024 Response at 9; *see also* SpaceX February 13, 2024 Letter at 1 ("Omnispace is wrong that SpaceX's direct-to-cellular antennas will have grating lobes in the PCS G Block. They will not.").

¹⁴⁶ See SpaceX November 14, 2023 Letter, Exh. A at A-4; SpaceX November 30, 2023 Letter, Exh. A at A-4; SpaceX SCS Modification Amendment, Narrative, Attach. A at A-4; SpaceX June 20, 2024 Response at 8-10; *see also* SpaceX November 24 Letter at 2; SpaceX September 18, 2024 Letter.

¹⁴⁷ See *SCS R&O*, paras. 193-223; T-Mobile May 30, 2023 Response at 4-5. *But see* Omnispace June 5, 2023 Reply at 18.

operations.¹⁴⁸

31. We also find that SpaceX's calculations relied upon reasonable data points to demonstrate that its operations will not cause in-band harmful interference to other satellite operators.¹⁴⁹ SpaceX performed its calculations using EIRP values as measured in its lab and values provided by Omnispace for the Omnispace constellation.¹⁵⁰ SpaceX also utilized different PFD levels at different satellite counts, given that SpaceX can dynamically adjust its PFD levels.¹⁵¹ Also, although Omnispace and SpaceX disagree over the appropriate thermal noise floor to use in showing non-harmful interference, we believe SpaceX has successfully shown that its operations will not cause harmful interference to the operations of Omnispace using both the thermal noise floor values assumed by Omnispace and the thermal noise floor value assumed by SpaceX.¹⁵² In addition, we find SpaceX properly and reasonably relied on the ITU-R Rec. S.1528 antenna patterns, which more closely represents a real world antenna pattern, since the patterns provided in Rec. M.1184 would produce flat sidelobes at 10 dBi in all directions outside the main beam when using a 30 dBi reference antenna and therefore would not reflect the actual parameters of Omnispace's satellite operations.¹⁵³

32. In the alternative, Omnispace argues that, if the Commission decides to proceed with authorizing SpaceX to use the 1990-1995 MHz band as a nonconforming MSS use, SpaceX should be required to operate on an unprotected, non-interference basis for NGSO systems properly notified at the ITU.¹⁵⁴ We adopt a similar requirement here: that, for operations in the 1990-1995 MHz band insofar as SpaceX's SCS downlink operations conflict with the ITU Radio Regulations and the International Table, such operations are authorized on an unprotected, non-harmful interference basis with respect to the services in other countries that are operating in accordance with ITU Radio Regulations, and any harmful interference must be immediately eliminated pursuant to No. 4.4 of the ITU Radio Regulations.¹⁵⁵ In addition, we require SpaceX as an SCS provider to mitigate harmful interference with operations outside the United States, as discussed below.¹⁵⁶ Similarly, Omnispace argues that we should condition any grant for the 1990-1995 MHz band with "(1) appropriate non-interference conditions amenable to Omnispace that SpaceX would have to satisfy prior to commencing operations; and (2) a binding requirement to immediately cease operations once any harmful interference to these operators or systems is identified or

¹⁴⁸ ITU Radio Regulation No. 4.4; *see also SCS R&O*, para. 227.

¹⁴⁹ The Commission did not adopt 3GPP standards in the SCS framework as Omnispace suggested, and we accordingly not apply 3GPP standards here. *See SCS R&O*, at para. 11; Omnispace November 17, 2023 Letter at 2.

¹⁵⁰ *See* SpaceX November 30, 2023 Letter, Exh. A at A-4; *see also* SpaceX August 1, 2024 Letter, Attach. B at 4 (explaining that, after correcting the assumption Omnispace made regarding SpaceX's average EIRP toward Omnispace's satellites, Omnispace's assumption regarding the number of satellites SpaceX's analysis assumed in view, and use of a worst-case example that is representative of how the satellites operate, the aggregate interference of SpaceX SCS downlink into Omnispace satellite uplink will fall significantly below internal noise power).

¹⁵¹ *See* SpaceX November 30, 2023 Letter Exh. A at A-4-A-5; SpaceX November 14 Letter, Exh. A at A-4; SpaceX June 20, 2024 Response at 9.

¹⁵² *See* SpaceX November 24, 2023 Letter at 2; *see also* Letter from David Goldman, Vice President of Satellite Policy, SpaceX Technologies, Corp., to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-135; ICFS File No. SAT-MOD-20230207-00021; ULS File Nos. 0010303032, 0010303084, 0010303124, and 0010303146 at 1 (dated Feb. 13, 2024). *But see* Omnispace November 17, 2023 Letter at 3; Omnispace February 9, 2024 Letter at 3.

¹⁵³ *See* SpaceX November 24, 2023 Letter at 2-3.

¹⁵⁴ *See* Omnispace June 5, 2023 Reply at 18.

¹⁵⁵ *See* ITU Radio Regulation No. 4.4; *SCS R&O*, para. 194; Letter from Amit Saluja, General Counsel, Omnispace, LLC, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-135; ICFS File Nos. SAT-MOD-20230207-00021; SAT-AMD20240322-00061 at 2 (dated Nov. 22, 2024) (Omnispace November 22, 2024 Letter).

¹⁵⁶ *See infra* paras. 41-42.

deemed to have occurred.”¹⁵⁷ Because SpaceX’s operations shall be in accordance with No. 4.4 of the ITU Radio Regulations requiring it to avoid causing harmful interference to stations operating in accordance with the ITU Radio Regulations and will be operating in accordance with the conditions adopted herein, we do not require SpaceX to reach a binding agreement with other satellite operators. SpaceX has also agreed to engage in coordination with other spectrum users and must do so accordingly.¹⁵⁸

33. In addition to the competing studies submitted in the record, in response to SpaceX’s part 5 STA applications, Omnispace raised concerns as to the real-world impact of SpaceX’s part 5 testing on Omnispace’s operations in the 1990-1995 MHz band, as measured by Omnispace’s satellite currently in orbit.¹⁵⁹ In the interest of addressing all relevant technical issues, we conclude here that we do not find that Omnispace’s studies and related arguments regarding SpaceX’s part 5 testing weigh against grant of SpaceX’s part 25 modification. As noted above, our international commitments focus on eliminating harmful interference; simply noting an increase in the noise floor over an area in which no actual operations are occurring—as Omnispace has done here¹⁶⁰—does not constitute harmful interference. Accordingly, we find that granting SpaceX’s modification request with the conditions adopted herein and consistent with the *SCS R&O* will serve the public interest.

34. *Adjacent Band Interference.* In the *SCS R&O*, the Commission adopted an aggregate OOB limit of -120 dBW/m²/MHz for the SCS bands.¹⁶¹ SpaceX petitioned the Commission to reconsider the aggregate OOB limit adopted in the *SCS R&O* and also requested a waiver of the SCS OOB limit.¹⁶² In comments to the instant application filed by SpaceX and in response to SpaceX’s

¹⁵⁷ See Omnispace Informal Objection at 5-6; see also Omnispace November 22, 2024 Letter at 2.

¹⁵⁸ See SpaceX July 26, 2023 Letter at 1. *But see* Omnispace February 9, 2024 Letter at 4 (arguing that 2 GHz MSS operators will have no equivalent impact on SpaceX for its uplink operations in the 1905-1910 MHz band as SpaceX’s downlink operations have on 2 GHz MSS uplink operations, and SpaceX therefore does not have incentive to work with affected operators to cooperatively manage interference between systems).

¹⁵⁹ See Letter from Mindel De La Torre Chief Regulatory and International Strategy Officer Omnispace, LLC, GN Docket No. 23-65 and IB Docket No. 22-271; Call Sign WW9XPI, File Nos. 2479-EX-ST-2023, 0519-EX-ST-2024, 0661-EX-ST-2024 (dated May 17, 2024) (Omnispace May 17, 2024 Letter); see also Letter from Amit Saluja, General Counsel, Omnispace, LLC, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-135; ICFS File Nos. SAT-MOD-20230207-00021; SAT-AMD-20240322-00061 at 2 (dated Oct. 7, 2024) (summarizing Omnispace studies regarding SpaceX part 5 testing in the record for the part 25 application); Omnispace November 1, 2024 Letter at 1-3, 9, 14.

¹⁶⁰ Omnispace May 17, 2024 Letter at 5 (arguing that the increase in noise floor caused by SpaceX transmissions detected by Omnispace’s Omni-F2 satellite operating over Asia was sufficient to demonstrate harmful interference to Omnispace’s proposed operations over South America).

¹⁶¹ See 47 CFR § 25.202(k)(1); *SCS R&O*, paras. 202, 205.

¹⁶² Petition for Reconsideration of SpaceX, GN Docket No. 23-65, SB Docket No. 22- 271 (filed May 30, 2024); Federal Communications Commission, Petition for Reconsideration of Action in Rulemaking Proceeding, 89 FR 51864 (June 20, 2024) (*SCS PFR*); SpaceX June 6, 2024 Letter at 2. By rule, with certain exceptions, only the full Commission can act upon a Petition for Reconsideration and as such, we cannot and do not opine upon the reconsideration request, which remains pending. 47 CFR § 1.429(a), 1.429(1). The public comment periods for both SpaceX’s petition for reconsideration and waiver request have closed. See *SCS PFR* (noting deadlines of July 5, 2024, and July 15, 2024); Satellite Licensing Division and Satellite Programs and Policy Division Information, Space Station Applications Accepted for Filing, Public Notice, Report No. SAT-01836 (Jul. 12, 2024) (referring to 47 CFR § 25.154); Space Bureau and Wireless Telecommunications Bureau Clarify Filing Procedures for Recent PN, GN 23-135, ICFS File Nos. SAT-MOD-20230207-00021 and SAT-AMD-20240322-00061, Public Notice, DA 24-726 (Jul. 26, 2024) (listing deadlines of August 12, 2024, August 22, 2024, and August 27, 2024); Space Bureau and Wireless Telecommunications Bureau Correct Reply Comment Deadline on Recent Public Notice, GN Docket

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request for a waiver of the OOB limit, parties have expressed concern that SpaceX's operations, either as described in SpaceX's application, or upon receipt of SpaceX's requested OOB waiver, would not adequately protect adjacent services.¹⁶³ With this Order, we require SpaceX to comply with the OOB limit in section 25.202(k)(1) of the Commission's rules. As such, we find that SpaceX is able to adequately protect adjacent band users during downlink SCS in the 1990-1995 MHz band.¹⁶⁴ Many commenters' concerns regarding adjacent band interference were raised before the Commission adopted the OOB limit in section 25.202(k)(1), and we therefore find those concerns about the appropriate OOB limit for SCS to be resolved, and we find concerns about SpaceX's compliance with different OOB limits to be not applicable here.¹⁶⁵ At this time, we defer consideration of SpaceX's request for a waiver of the aggregate OOB PFD limit of -120 dBW/m²/MHz on SCS operations, and we will not address the merits of either SpaceX's waiver request or filings from other parties on the matter. SpaceX supports prompt grant of the authority to provide SCS even if that means deferring consideration of SpaceX's Petition for Reconsideration regarding the OOB limit for SCS in the United States.¹⁶⁶ AT&T

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No. 23-135; ICFS File Nos. SAT-MOD-20230207-00021 and SAT-AMD-20240322-00061, Public Notice, DA 24-819 (Aug. 14, 2024) (correcting the third deadline to August 29, 2024).

¹⁶³ Comments filed in response to SpaceX's waiver request can be found in GN Docket No. 23-135. Other comments were filed in response to SpaceX's application, most of which were filed prior to the *SCS R&O*, the *SCS PFR*, and SpaceX's waiver request. See DISH SCS Petition at 6; Comments of Rural Wireless Association, GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 at 2-3 (filed May 18, 2023) (RWA May 18, 2023 Comments); AT&T Comments at 8; AT&T June 5, 2023 Reply at 5; TerreStar Reply at 3; Letter from Mindel De La Torre, Chief Regulatory and International Strategy Officer, Omnispace, LLC, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-135, ICFS File Nos. SAT-MOD-20230207-00021, SAT-STA-20231002-00240 at 3 (dated Nov. 2, 2023) (Omnispace November 2, 2023 Letter); DISH January 2, 2024 Letter at 6; Letter from Michael P. Goggin, AT&T Services, Inc., to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-65, IB Docket No. 22-271, GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 at 2-4 (dated Feb. 7, 2024) (AT&T February 7, 2024 Letter); RWA May 18, 2023 Comments at 2; Letter from Amit Saluja, General Counsel, Omnispace, LLC, to Marlene H. Dortch, Secretary, FCC GN Docket No. 23-135; ICFS File Nos. SAT-MOD-20230207-00021; SATAMD-20240322-00061 at 7-9 (dated Nov. 1, 2024) (Omnispace November 1, 2024 Letter); see also Omnispace November 2, 2023 Letter at 3. We grant RWA a waiver of section 25.154(a)(5) of the Commission's rules which requires that comments must contain a certificate of service showing that it has been mailed to the applicant no later than the date the pleading is filed with the Commission. See 47 CFR § 25.154(a)(5). RWA served its comments on SpaceX two days after filing in the publicly available ICFS docket. See Waiver Request of Rural Wireless Association, Inc., GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 at 2 (filed May 22, 2023). We therefore find that the purpose of this rule was not frustrated, and SpaceX was made aware of RWA's comments in a timely fashion and had an opportunity to respond in the response and reply to response periods. TerreStar Reply at 2-3. SpaceX argues that TerreStar's reply comments were filed two weeks late. See Reply of Space Exploration Holdings, LLC, GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 at 1 (filed June 2, 2023) (SpaceX June 2, 2023 Reply). However, TerreStar filed its reply comments on May 30, 2023, which was within the reply comment period specified in the public notice. *Space Bureau and Wireless Telecommunications Bureau Seek Comment on Filings of SpaceX and T-Mobile Requesting to Establish Supplemental Coverage from Space; Space Exploration Holdings, LLC Application Accepted for Filing*, Public Notice, DA 23-338 (Apr. 18, 2023). Nothing in our rules prohibits a commenter from filing during the reply comment period when that commenter did not file during the initial comment or response period. DISH SCS Petition at 6-8.

¹⁶⁴ See *SCS R&O*, paras. 202-207.

¹⁶⁵ See DISH SCS Petition at 4; DISH SCS Reply at 4; DISH January 2, 2024 Letter at 6; AT&T February 7, 2024 Letter at 2-4. Some commenters address compliance with the limits in section 24.238 of the Commission's rules, 47 CFR § 24.238. See DISH SCS Petition at 7; AT&T Comments at 11. Others address compliance with the limits in section 25.202 of the Commission's rules, 47 CFR § 25.202. See DISH January 2, 2024 Letter at 6.

¹⁶⁶ See Letter from David Goldman, Vice President of Satellite Policy, Space Exploration Technologies Corp., to Marlene H. Dortch, Secretary, FCC, ICFS File Nos. SAT-LOA-20200526-00055, SAT-AMD-20210818-00105, SAT-AMD-20221216-00175, SAT-MOD20240423-00089, SAT-MOD-20230207-00021, SAT-STA-20240522-00108 and SAT-AMD-20240322-00061; Call Sign: S3069; GN Docket No. 23-135; ULS File Nos. 0010303032,

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also supports prompt grant for SpaceX's SCS system provided it meets the OOBE limit established in the *SCS R&O*.¹⁶⁷

35. *Protection of Radio Astronomy.* Under the SCS licensing framework, satellite operators and terrestrial licensees providing SCS are required to comply with existing satellite and terrestrial rules to avoid harmful interference into radio astronomy and related services.¹⁶⁸ In the *SCS R&O*, the Commission likewise found that that addressing federal and other stakeholders' concerns with respect to radio astronomy in the licensing context would serve the public interest by allowing us to strike a reasonable balance among competing public interest benefits and narrowly tailor any remedies that may be appropriate on a case-by-case basis.¹⁶⁹

36. NRAO raises concerns about the effect of SpaceX's SCS on radio astronomy operations and the effect of SCS on radio astronomy operations more generally. NRAO contends that the Gen2 Starlink satellites' peak surface level PFD from a satellite overhead will bathe the National Radio Quiet Zone (NRQZ) at harmfully-interfering levels and will moot the protections afforded to the NRQZ.¹⁷⁰ SpaceX offers that it has coordinated in good faith with the National Science Foundation (NSF), the NRAO, and the wider radio astronomy community.¹⁷¹ In addition, SpaceX states that SpaceX and NSF recently reached a coordination agreement addressing SpaceX's first- and second-generation satellite systems, and the parties continue to collaborate in good faith to extend that agreement to cover SpaceX's application to enable T-Mobile to provide SCS to its subscribers.¹⁷² SpaceX also states that it remains committed to continuing to work with NRAO on this and the other issues through its direct coordination efforts.¹⁷³ This authorization has been coordinated with federal spectrum users through the National Telecommunications Information Administration (NTIA) and we condition this grant on SpaceX's continued coordination with both the NSF and NRAO, and compliance with any resulting coordination agreements. We further require that SpaceX complete coordination with NSF for SCS operations prior to commencing SCS operations pursuant to this Order. If SpaceX completes coordination with NSF for a specific geographic area, once SpaceX notifies the Commission of the completion of this coordination, SpaceX may commence SCS operations in that specific geographic area. T-Mobile adds that its own operations currently respect the NRQZ, as required by the Commission's rules,¹⁷⁴ and we require that SpaceX also respects the NRQZ while providing SCS.

37. More generally, NRAO submits that a very high degree of isolation from SCS operations

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0010303084, 0010303124, and 0010303146; ICFS File Nos. SAT-AMD-20240311-00053, SAT-AMD-20230717-00172, SAT-AMD20201028-00126, SAT-AMD-20200727-00088, and SAT-LOA-20200413-00034 at 1 (dated Oct. 18, 2024).

¹⁶⁷ See Letter from Raquel Noriega, AT&T Services, Inc., to Marlene H. Dortch, Secretary, FCC, ICFS File Nos. SAT-MOD-20230207-00021, SAT-AMD-20240322-00061; GN Docket No. 23-135 at 1 (dated Oct. 7, 2024).

¹⁶⁸ See *SCS R&O*, para. 211.

¹⁶⁹ See *id.*

¹⁷⁰ See NRAO May 4, 2023 Opposition at 4-5; see also Letter from Harvey Steven Liszt, Astronomer and Spectrum Manager, NRAO, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-65, IB Docket No. 22-271, GN Docket No. 23- 135 at 1 (dated Feb. 24, 2024) (NRAO February 24, 2024 Letter).

¹⁷¹ See Letter from David Goldman, Senior Director Satellite Policy, Space Exploration Technologies Corp., to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-135, ICFS File No. SAT-MOD-20230207-00021 at 1 (dated May 18, 2023) (SpaceX May 18, 2023 Letter); SpaceX July 26, 2023 Letter at 8.

¹⁷² See SpaceX May 18 Response at 1; SpaceX Consolidated Opposition at 21-22; see also SpaceX November 14, 2023 Letter at 2; SpaceX SCS Modification Amendment, Narrative, Attach. C at 2.

¹⁷³ See SpaceX May 18, 2023 Letter at 1; SpaceX July 26, 2023 Letter at 8.

¹⁷⁴ See T-Mobile May 30, 2023 Response at 8.

will be needed to reproduce NRQZ levels.¹⁷⁵ NRAO also purports that, while coordination may be possible, study is needed to determine for example how large a coordination zone would maintain protection of the passive receivers in the NRQZ at the same level at which they are currently protected from fixed transmitters, such as cellular towers.¹⁷⁶ Moreover, NRAO argues that prospective satellite operators providing SCS should provide technical analyses demonstrating how their system will achieve the isolation needed to protect radio astronomy operations in the NRQZ, while also assessing the impact of SCS operation on instruments like the Very Large Array (VLA) that do not enjoy the formal protections of the NRQZ.¹⁷⁷ While we recognize NRAO's more general concerns regarding protections of radio astronomy and SCS, we have addressed, and continue to address such issues in the SCS proceeding, which is the appropriate forum for such issues of general applicability.¹⁷⁸ Should we adopt additional protections for radio astronomy services in connection with the *SCS FNPRM*, SpaceX shall be required to comply with those protections as well.

3. Operations in the 1429-2690 MHz Band

38. SpaceX seeks authority to operate its satellites to conduct MSS operations outside the United States on frequencies within the broader 1429-2690 MHz (space-to-Earth and Earth-to-space) band for the purpose of performing direct-to-cell operations.¹⁷⁹ The International Table of Frequency Allocations contains an MSS allocation for some, but not all, of those requested bands. In the *SCS R&O*, the Commission established a regulatory framework to consider satellite applications for SCS on an unprotected, non-harmful interference basis with respect to the services in other countries that are operating in accordance with ITU Radio Regulations.¹⁸⁰ Pursuant to the *SCS R&O* framework, SpaceX provided detailed interference analyses and associated link budgets showing that its requested operations will not cause harmful interference to stations operating in accordance with the ITU Radio Regulations.¹⁸¹ Specifically, SpaceX has provided link budgets at a variety of PFD levels, accounting for different elevation angles and constellation deployment.¹⁸² Further, for this analysis, SpaceX provided a dynamic Monte Carlo analysis and time-based statistics.¹⁸³ SpaceX has also described the measures that it will take to immediately eliminate any harmful interference issues for operations outside the United States.¹⁸⁴ SpaceX further specifies that its direct-to-cell network and topology software can re-plan the network in near real-time, allowing it to quickly cease operations by all satellites and over any number of geographic areas.¹⁸⁵ SpaceX expects to refine its keep-out distances to further eliminate coverage gaps near international borders while complying with applicable cross-border limits while using a dynamic, software-based approach and existing field strength limits to protect any other geographic areas where it is required to reduce power. In addition, SpaceX has agreed to enter into cooperative arrangements with local terrestrial providers to protect services allocated under Safety-of-Life, Radio Astronomy, Space

¹⁷⁵ See NRAO February 24, 2024 Letter at 1-2.

¹⁷⁶ See NRAO May 4, 2023 Opposition at 5.

¹⁷⁷ See NRAO February 24, 2024 Letter at 2.

¹⁷⁸ See *SCS R&O*, paras. 210-212, 252-256; SpaceX Consolidated Opposition at 22.

¹⁷⁹ See SpaceX SCS Modification Amendment, Schedule S at 3; SpaceX June 20, 2024 Response at 8.

¹⁸⁰ See *SCS R&O*, para. 225.

¹⁸¹ See ITU Radio Regulation 4.4; *SCS R&O*, para. 226; TerreStar Reply at 3-4; T-Mobile June 2, 2023 Reply at 3-4.

¹⁸² See SpaceX Nov. 14 Letter, Exh. A at A-1-A-3; SpaceX SCS Modification Amendment, Narrative, Attach. A at A-1-A-3.

¹⁸³ See SpaceX Nov. 14 Letter, Exh. A at A-3-A-7; SpaceX SCS Modification Amendment, Narrative, Attach. A at A-3-A-7.

¹⁸⁴ See *SCS R&O*, para. 226; TerreStar Reply at 3-4.

¹⁸⁵ SpaceX November 14, 2023 Letter at 3; SpaceX SCS Modification Amendment, Narrative, Attach. C at 3.

Research, Radionavigation Satellite, Aeronautical Radionavigation, Earth-Exploration Satellite, and Space Operations.¹⁸⁶

39. We conclude that SpaceX's initial demonstrations are sufficient to grant SpaceX authority in part, with conditions, to operate satellites in bands within the 1429-2690 MHz band for operations outside the United States. In particular, outside the United States, SpaceX is authorized to transmit in the 1475-1518 MHz, 1805-1880 MHz, 1930-2000 MHz, 2110-2180 MHz, 2180-2200 MHz, 2345-2360 MHz, and 2620-2690 MHz (space-to-Earth) bands and to receive in the 1429-1470 MHz, 1710-1785 MHz, 1850-1920 MHz, 1920-1980 MHz, 2000-2020 MHz, 2305-2320 MHz, and 2500-2570 MHz (Earth-to-space) bands.¹⁸⁷ Each of these authorized sub-bands is recognized internationally for International Mobile Telecommunications (IMT).¹⁸⁸ When operating in part of the 1429-2690 MHz band in a manner that is not in conformity with the International Table of Frequency Allocations or the provisions of the ITU Radio Regulations, SpaceX shall not cause harmful interference to, and shall not claim protection from harmful interference caused to it by, a station operating in accordance with the ITU Radio Regulations. Furthermore, in the unforeseen and unlikely case that harmful interference occurs, SpaceX must cease transmissions from its satellites and immediately eliminate any harmful interference pursuant to No. 4.4 of the ITU Radio Regulations.¹⁸⁹ We also require that any direct-to-cell operations outside the United States be duly authorized by the relevant administrations and will be subject to the laws, regulations, and requirements applicable to such operations in the territories of the authorizing administrations.¹⁹⁰ Likewise, SpaceX's operations must be consistent with the parameters specified in its ITU filings.¹⁹¹ We also remind SpaceX that it shall protect any radio astronomy operations from harmful interference in any adjacent bands allocated to Radio Astronomy on a primary or secondary basis in the ITU Radio Regulations while conducting direct-to-cell operations outside the United States. SpaceX is limited to operations in the sub-bands outside the United States specified herein, and any further addition of other services or modifications within internationally harmonized Global Positioning System (GPS) bands, safety bands, or in the adjacent bands will be considered with great scrutiny to ensure the principal purpose to protect the safety of life, health or property of Americans is maintained and is in support of the public interest.

40. Furthermore, we emphasize that SpaceX, prior to initiation of communications with earth stations in a particular country, must inform the Commission that it has obtained all necessary authorizations from the relevant country and demonstrate that such operations will not cause harmful interference to operations in conformity with the ITU Radio Regulations before the initiation of service in that country.¹⁹² This includes certifying to the Space Bureau and the Office of International Affairs (OIA) that SpaceX has obtained all necessary authorizations from the relevant country and includes steps that were taken to address harmful interference concerns and that provision of SCS will not result in harmful interference to operations that are in conformity with the ITU Radio Regulations in neighboring or nearby

¹⁸⁶ See SpaceX SCS Modification, Technical Annex at 13.

¹⁸⁷ We remind SpaceX that that to provide service outside the United States in any of these bands, SpaceX must receive authorization from other countries and must demonstrate that such a service will not cause harmful interference. See *infra* conditions 89yy, fff, jjj.

¹⁸⁸ Should SpaceX seek authority to perform direct-to-cell operations in additional sub-bands within the 1429-2690 MHz band, SpaceX must make a request for a further grant in part for specific sub-bands via a letter to be filed with the Commission.

¹⁸⁹ ITU Radio Regulation No. 4.4; see also 47 CFR § 25.207; Omnispace May 18, 2024 Opposition at 2.

¹⁹⁰ See SCS R&O, para. 228;

¹⁹¹ See *infra* condition 89jjj.

¹⁹² See SCS R&O, para. 236.

countries.¹⁹³ In addition to this certification, SpaceX shall also provide a demonstration specifying the measures that SpaceX will take to eliminate any harmful interference immediately, in the event that it is notified of harmful interference resulting from such SCS operations.¹⁹⁴ SpaceX shall only commence operations in another country after the Space Bureau and OIA have reviewed such certification and demonstration and have notified SpaceX that such documentation is acceptable or if additional documentation is required.¹⁹⁵ In addition, prior to conducting space-to-Earth direct-to-cell operations in 2300-2395 MHz within radio line-of-sight of any NASA Deep Space Network facility outside the United States, SpaceX must certify to the Space Bureau that it has completed successful coordination with NASA.¹⁹⁶

4. Cross-Border Interference

41. We find that SpaceX has also addressed mitigation of cross-border interference for SCS in the United States and direct-to-cell operations outside the United States. SpaceX has designed its SCS system to dynamically avoid international borders and will implement software controls at service territory edges.¹⁹⁷ Furthermore, SpaceX has agreed to engage in coordination with cross-border users.¹⁹⁸ And specifically for SCS within the United States, SpaceX has committed to space downlink beams away from borders to protect primary terrestrial mobile operations in Canada and Mexico from interference.¹⁹⁹

42. We also adopt conditions to further ensure mitigation of cross-border interference in accordance with the framework adopted in the *SCS R&O*. First and foremost, when providing SCS in the United States or direct-to-cell operations outside the United States, in accordance with the ITU Radio Regulations and the *SCS R&O*, SpaceX shall operate on a non-harmful interference basis to other countries' operations and must address and eliminate any harmful interference cases immediately.²⁰⁰ For operations in the United States, SpaceX shall respect all existing rules and limits in the 1910-1915 MHz and 1990-1995 MHz bands to protect incumbent users.²⁰¹ This includes observing a maximum PFD based on the section 25.208(w) field strength limits.²⁰² Finally, for operations both inside and outside the

¹⁹³ See *id.* at para. 235.

¹⁹⁴ See *id.*

¹⁹⁵ See *id.*

¹⁹⁶ Letter from Jennifer A. Manner, Senior Advisor, Space and Satellite Policy, Office of Spectrum Management, NTIA, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 23-135, ICFS File Nos. SAT-LOA-20200526-00055, SAT-AMD-20210818-00105, SAT-AMD-20221216-00175, SAT-MOD-20230207-00021, SAT-AMD-20240322-00061, SAT-MOD-20240423-00089, SAT-STA-20240522-00108 (dated Nov. 22, 2024) (NTIA November 22, 2024 Letter). As with any coordination, we would expect that both parties would coordinate in good faith towards a timely and mutually acceptable coordination agreement.

¹⁹⁷ SpaceX July 26, 2023 Letter, Attach. B at 5; SpaceX July 26, 2023 Letter at 1.

¹⁹⁸ SpaceX July 26, 2023 Letter at 1.

¹⁹⁹ 47 CFR § 24.236; see SpaceX Consolidated Opposition at 18; SpaceX August 1, 2024 Letter, Attach. B at 5; SpaceX July 26, 2023 Letter at 1; TerreStar Reply at 3-4. *But see* AT&T Comments at 11-12 (arguing that SpaceX should demonstrate how it will comply with field strength limits at edge-of-service area at the border with Canada and Mexico).

²⁰⁰ See ITU Radio Regulation No. 4.4; *SCS R&O*, para. 231; see also Omnispace August 18, 2023 Letter at 2; Omnispace November 17, 2023 Letter at 3.

²⁰¹ See *SCS R&O*, para. 231.

²⁰² 47 CFR § 25.208(w); see also SpaceX Consolidated Opposition at 18. However, we note that SpaceX is required to meet, at a minimum, the Commission's OOB limit for operations inside the United States and at U.S. borders. See Letter from Pantelis Michalopoulos et al., Counsel to EchoStar Corporation, to Marlene H. Dortch, Secretary,

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United States, we condition this authorization such that, in accordance with the framework adopted in the *SCS R&O*, SpaceX's operations remain subject to bilateral agreements that ensure terrestrial licensees meet a particular signal level limit at the relevant international border, including field strength and PFD limits. SpaceX may only exceed PFD limits where it has been authorized pursuant to an approval from the regulatory authority of the appropriate border country and after providing documentation of such approval to the Commission.²⁰³ Cross-border coordination and any negotiated technical parameters must be mutually acceptable to all involved, including U.S. counterpart agencies who oversee or regulate spectrum use in other countries.²⁰⁴

5. SCS in Lower Altitude Shells

43. In addition to its initial request to operate the direct-to-cell antennas on up to 7,500 satellites within the orbital shells at altitudes of 525 km, 530 km, and 535 km, SpaceX requests the option to operate its direct-to-cell antennas in lower orbital shells at altitudes of 340 km, 345 km, 350 km, and 360 km.²⁰⁵ As such, we address herein SpaceX's proposed operations in both the 500 km and 300 km shells.²⁰⁶

44. As part of our interference analyses at the lower altitude shells granted herein, we reviewed reference antenna patterns provided by SpaceX and a CSV file with the specific data points in the pattern that address possible satellite-to-satellite interference given the sidelobe angles.²⁰⁷ Initially, SpaceX submitted and requested confidential treatment for SpaceX's average direct-to-cell transmit antenna pattern to address mitigation of possible satellite-to-satellite interference.²⁰⁸ EchoStar filed a petition seeking the Commission issue a protective order regarding these patterns to allow outside counsel and experts for interested parties to review the information SpaceX designated as confidential.²⁰⁹ However, SpaceX has since withdrawn these initial antenna patterns and filed reference antenna patterns and an accompanying CSV file in the publicly available record.²¹⁰ In our analyses, we relied solely on

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FCC, GN Docket No. 23-135, ELS File Nos. 0661-EX-ST2024, 0934-EX-ST-2024, 1209-EX-ST-2024, and 1210-EX-ST-2024 at 1-4 (dated Jul. 10, 2024).

²⁰³ See *SCS R&O*, para. 229.

²⁰⁴ See *id.* at paras. 229, 231. SpaceX argued that the Commission should alter the precedent set in the *Lynk Order* regarding field strength limits and the requirement to obtain separate coordination agreements with each border country. See Letter from Jameson Dempsey, Principal, Satellite Policy, Space Exploration Technologies Corp., to Marlene H. Dortch, Secretary, FCC, GN Docket Nos. 23-65, 23-135; ICFS File No. SAT-MOD-20230207-00021 at 1-2 (dated Feb. 21, 2024); *Lynk Global, Inc. Application to deploy and operate space stations filed under the FCC streamlined small space station authorization process*, 47 CFR § 25.122, Order and Authorization, 37 FCC Rcd 10681 (2022) (*Lynk Order*). DISH objects to SpaceX's requests and argues over the validity of the *Lynk Order*. See Letter from Jennifer A. Manner, Senior Vice President, Regulatory Affairs, EchoStar Corporation, to Marlene H. Dortch, Secretary, FCC, GN Docket Nos. 23-65, 23-135; IB Docket No. 22-271 at 1-3 (dated Apr. 3, 2024). Since the Commission has established the SCS framework in the *SCS R&O*, and we have addressed the issues of field strength limits and procedures for direct-to-cell operations outside the United States, we will consider SpaceX's arguments moot. See also Letter from Jameson Dempsey, Director, Satellite Policy, Space Exploration Technologies Corp., to Marlene H. Dortch, Secretary, FCC, GN Docket Nos. 23-65, 23-135; ICFS File No. SAT-MOD-20230207-00021 at 1-2 (dated Apr. 8, 2024).

²⁰⁵ See SpaceX SCS Modification Amendment.

²⁰⁶ See *supra* paras. 27-34.

²⁰⁷ See SpaceX September 18, 2024 Letter.

²⁰⁸ See SpaceX June 21, 2024 Letter.

²⁰⁹ See EchoStar June 28, 2024 Request for Protective Order; EchoStar Petition at 4; see also Omnispace July 5, 2024 Letter at 1-2.

²¹⁰ See SpaceX September 18, 2024 Letter.

this updated publicly available information, and not on the initial filing SpaceX submitted containing proprietary information.²¹¹ As such, we find EchoStar's Petition for a Protective Order, as well as SpaceX's request for confidential treatment, moot.

45. Only Omnispace objects to SpaceX's SCS operations at these lower orbital shells and filed an informal objection to SpaceX's amended application requesting such authority.²¹² Omnispace argues that SpaceX's requested use of the 1990-1995 MHz band, including at the 340 km, 345 km, 350 km, and 360 km altitudes, is incompatible with primary MSS systems licensed by other administrations and properly notified at the ITU, including those of Omnispace.²¹³ However, Omnispace does not raise any additional concerns that differ from those we address above regarding possible harmful interference from SpaceX's SCS downlink.²¹⁴ In fact, Omnispace purports that the interference risk is even lower at lower altitudes.²¹⁵ Because we have considered Omnispace's concerns regarding harmful interference as applied to both the requested 500 km and 300 km altitude shells in this authorization, we deny Omnispace's informal objection.²¹⁶ We note that the Commission previously deferred consideration of SpaceX's proposal to operate satellites at altitudes of 340-360 km, based on concerns raised on the record regarding interference, orbital debris mitigation, and satellite reflectivity; we address these concerns below with respect to the up to 7,500 satellites we authorize SpaceX to potentially deploy and operate at 340 km, 345 km, 350 km, and 360 km in this Order.

6. ITU Filings

46. We find that SpaceX has properly submitted materials to support an ITU filing for its proposed operations. Omnispace and TerreStar argue that SpaceX's proposed use of the 1990-1995 MHz band for MSS downlink is inconsistent with its ITU filings.²¹⁷ Omnispace also purports that grant of SpaceX's application must be on a secondary basis with regard to already existing MSS systems that have been properly notified at the ITU and planned systems that will be coordinated in the future.²¹⁸ Omnispace further contends that one of SpaceX's associated ITU filings, USASAT-NGSO-ULS, is only an Advance Publication Information (API) filing, which has no coordination status except to start the seven-year time clock for satellite coordination, notification and bringing into use (BIU) of the satellite filing.²¹⁹ Moreover, Omnispace contends that because the 1990-1995 MHz band has no ITU allocation for operating MSS as a downlink, there is no duty to coordinate under Article 9, and SpaceX must operate on a non-interference basis under No. 4.4 of the ITU Radio Regulations and initiate coordination for operations that rely on the USASAT-NGSO-ULS filing.²²⁰

47. Along with this modification application, SpaceX has submitted ITU filing materials to

²¹¹ *See id.*

²¹² *See generally* Omnispace Informal Objection.

²¹³ *See id.* at 2.

²¹⁴ *See supra* paras. 27-33.

²¹⁵ *See* Omnispace Informal Objection at 4; Consolidated Opposition to Petitions and Response to Comments of Space Exploration Holdings, LLC at 14 (filed Aug. 22, 2024).

²¹⁶ *See supra* paras. 27-33.

²¹⁷ *See* Omnispace May 18, 2024 Opposition at 8; TerreStar Reply at 4.

²¹⁸ *See* Omnispace May 18, 2024 Opposition at 9.

²¹⁹ *See* Omnispace June 5, 2023 Reply at 3.

²²⁰ *See* Omnispace June 5, 2023 Reply at 4. Omnispace relatedly argues that SpaceX does not meet the standards to gain U.S. market access. *See id.* at 5. However, given that SpaceX is requesting a modification of its U.S. license and submitted the necessary ITU materials to the Commission, and is no longer seeking a grant of market access, we consider this argument moot.

the Commission.²²¹ In turn, on behalf of the United States, we found those materials satisfactory to submit to the ITU. The USASAT-NGSO-MVLS (CR) filing includes all frequencies in which SpaceX's operations align with the service allocations and directionality of the International Table of Frequency Allocations, and the USASAT-NGSO-MULS (API) filing include all frequencies that either do not require coordination or fall outside of the allocations or directionality of the International Table of Frequency Allocations, but do align with the directionality that the Commission established for PCS G Block mobile services.²²² We thus find that SpaceX's ITU filings cover all necessary frequencies.²²³ We do note, as discussed above, that operations that do not conform with the International Table of Frequency Allocations must be conducted pursuant to No. 4.4 of the ITU Radio Regulations, and SCS within the United States must be conducted on a secondary basis.

7. DISH Petition for Reconsideration of SCS Deployment Partial Grant

48. On January 2, 2024, DISH filed a Petition for Reconsideration of the partial, limited grant, issued by the Satellite Programs and Policy Division, permitting SpaceX to deploy a modified version of the previously authorized Gen2 Starlink satellites with the capability to operate in certain frequencies in the 1429 MHz to 2690 MHz range and to operate these satellites on frequencies within the 1910-1915 MHz and 1990-1995 MHz bands for limited on-orbit check out of the antennas.²²⁴ DISH argues that the grant was not sufficiently limited,²²⁵ and expresses concerns regarding out-of-band interference to adjacent and near-adjacent band spectrum users.²²⁶ DISH requests reconsideration of the grant until SpaceX can answer and resolve questions of harmful interference and further requests that the grant be limited to fewer satellites.²²⁷ We disagree that the partial grant for SpaceX was overly broad. The grant was designed to address deployment-only authority, with a limited on-orbit checkout typically lasting as little as a few minutes per day, which has occurred.²²⁸ Additional operations have been authorized under experimental STA. This authorization grants SpaceX's broader request for SCS operations, effectively superseding the operations authorized in the earlier grant, and addresses potential interference concerns in detail. Therefore, we dismiss DISH's Petition for Reconsideration of the prior limited grant as moot.

8. Additional SCS-Related Waiver Requests

49. SpaceX requests waivers of the Commission's rules related specifically to its SCS operations, and we address those requests here.²²⁹ We first note that, since the adoption of the *SCS R&O*

²²¹ See USASAT-NGSO-MVLS and USASAT-NGSO-MULS. SpaceX initially filed a request for U.S. market access to provide SCS, identifying a German ITU filing. The U.S. market access application was subsequently withdrawn and replaced with a request for modification of its U.S. Gen2 license to provide SCS and direct-to-cell operations. U.S. ITU filings have also now been submitted for these operations. Therefore, to the extent that DISH and Omnispace argued that SpaceX improperly sought to provide SCS pursuant to a German ITU filing, see DISH SCS Petition at 4; Omnispace June 5, 2023 Reply at 6; DISH SCS Reply at 7, we dismiss the arguments as moot. We also note that SpaceX has coordinated its U.S. filing with the previous German filings so that its U.S. filings have maintained the same priority status as prior German filings.

²²² See SpaceX November 14, 2023 Letter at 4; SpaceX SCS Modification Amendment, Narrative, Attach. C at 4.

²²³ See SpaceX Consolidated Opposition at 11.

²²⁴ See generally DISH SCS Petition for Reconsideration; *SpaceX SCS Modification Partial Grant*.

²²⁵ DISH SCS Petition for Reconsideration at 1, 3.

²²⁶ See *id.* at 4.

²²⁷ See *id.* at 5.

²²⁸ See Opposition of Space Exploration Holdings, LLC to Petition for Reconsideration at 2 (filed Jan. 17, 2024).

²²⁹ SpaceX requested waivers of section 25.112(a)(3) of the Commission's rules, which provided that the Commission will dismiss applications that request authority to operate space stations in bands not allocated

and the SCS framework, fewer of SpaceX's initial requests remain relevant.²³⁰ Of those relevant waiver requests, we have addressed our deferral of SpaceX's OOB limit waiver request above. SpaceX also requests waiver of the United States Table of Frequency Allocations, section 2.106 of the Commission's rules, and the Ka-band Plan to allow designation of gateway links in the Ka-band and E-band spectrum for use as MSS feeder links.²³¹ However, we find that SpaceX's feeder link operations in the Ka-band and E-band can be classified as fixed-satellite service (FSS) operations, since SpaceX's satellites will be communicating directly with fixed earth stations when performing feeder link operations.²³² Therefore, SpaceX's proposed gateway operations conform with the United States Table of Frequency Allocations, and SpaceX's request for this waiver is unnecessary and therefore dismissed as moot.

C. Operations in Previously Authorized Frequency Bands at 340 km, 345 km, 350 km, and 360 km Altitudes

50. We authorize SpaceX to conduct operations in the Ku-, Ka-, V-, and E-bands with all of its previously authorized 7,500 satellites at operational altitudes of 340 km, 345 km, 350 km, and 360 km. As discussed in more detail below, SpaceX's operations below the ISS are limited to the number of satellites for which SpaceX has completed physical coordination with NASA.²³³

51. As discussed in prior authorizations for the Gen2 Starlink constellation, SpaceX has previously provided the Commission with the relevant technical specifications for its operations in the

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internationally for the requested operations under the ITU Radio Regulations, and relatedly of section 25.112(b) of the Commission's rules, which formerly cited to section 25.112(a)(3). *See* SpaceX SCS Modification, Waiver Requests at 3-5, 7-9. NRAO similarly argued that we should not accept SpaceX's application for filing under section 25.112(a)(3) of the Commission's rules. *See* NRAO May 4, 2023 Opposition at 3. However, section 25.112(a)(3) has since been removed from the Commission's rules, and SpaceX's request is thus dismissed as moot. *See Streamlining Satellite Application Processing Order*, 38 FCC Rcd at 8850, para. 27. We similarly find NRAO's related arguments moot.

²³⁰ SpaceX sought waiver sections 2.106 and 25.202(a)(1) of the Commission's rules, 47 CFR §§ 2.106(a) and 25.202(a)(1), to operate in the 1910-1915 MHz and 1990-1995 MHz bands, which were not allocated for satellite use. *See* SpaceX SCS Modification, Waiver Requests at 4-5. However, the Commission has since updated the U.S. Table to add a secondary MSS allocation for these requested bands with corresponding footnote NG33A, which permits SCS in these bands. 47 CFR § 2.106(a)&(d)(33)(i). Thus, SpaceX's waiver request is unnecessary and dismissed as moot. SpaceX further requested waiver of the Commission's processing round rules, 47 CFR §§ 25.156(d)(1) and 25.157. *See* SpaceX SCS Modification, Waiver Requests at 5-7. However, the Commission has established that applications to modify an authorization to provide SCS in the bands identified in § 2.106(d)(33)(i) of the Commission's rules, which include the 1910-1915 MHz and 1990-1995 MHz bands, will not be subject to the processing round procedures. *See* 47 CFR § 25.125(b)(3). Thus, SpaceX's waiver request is unnecessary and dismissed as moot. Furthermore, SpaceX sought a waiver of the requirement to license earth stations communicating with the direct-to-cellular system, *id.* §§ 25.102(a) and 25.115(a)(1)(i). *See* SpaceX SCS Modification, Waiver Requests at 9-10. However, in the United States, SpaceX's user terminals will be unmodified, commercial off-the-shelf cellular phones that will already be certified to operate under Part 24 rules within the United States. *See* SpaceX SCS Modification, Technical Annex at 4. In addition, SpaceX certifies that all terrestrial devices involved in provision of SCS will qualify as "licensed-by-rule" pursuant to 47 CFR § 25.125. *See* SpaceX September 18, 2024 Letter at 1. Thus, SpaceX's user terminals will qualify as SCS earth stations under the Commission's rules, *see* 47 CFR §§ 25.115(q) and 25.103, and SpaceX's waiver request is unnecessary and dismissed as moot.

²³¹ *See* SpaceX SCS Modification, Waiver Requests at 1-3.

²³² FSS is a radiocommunication service between earth stations at given positions, when one or more satellites are used; the given position may be a specified fixed point or any fixed point within specified areas. *See* 47 CFR § 2.1.

²³³ *See* NASA November 19, 2024 Letter ("NASA writes to clarify that it requests that the Commission condition SpaceX authorization to operate satellites below the International Space Station ("ISS") on continuously operating up to the number of satellites the parties have coordinated").

Ku-, Ka-, V-, and E-bands, as well as for its operations with VHF beacons.²³⁴ We reiterate that SpaceX is required to operate consistent with these technical specifications provided to the Commission as part of its application, including any supplemental specifications.²³⁵ The relevant technical information includes antenna beam patterns; GSO avoidance angle; physical characteristics; frequencies used for satellite communications, including outside the United States; and other technical information.²³⁶ Should SpaceX wish to alter these technical specifications, it must apply for a license modification from the Commission. We also note that SpaceX is not authorized to conduct operations at orbital altitudes and inclinations that differ from this authorization, which is based on the information provided in the Schedule S forms in the SpaceX Gen2 application, as amended; the V-band modification application, and the SCS modification application, as amended.²³⁷

52. *Ku-band.* We grant SpaceX's request to operate in the 10.7-12.7 GHz (space-to-Earth), 12.75-13.25 GHz (Earth-to-space), and 14.0-14.5 GHz (Earth-to-space) bands operating at 340 km, 345 km, 350 km, and 360 km altitudes. For these satellites operating at lower altitudes, we adopt the same conditions as those applicable to SpaceX's operations at the previously authorized higher altitudes.²³⁸ We also grant SpaceX's request to communicate in the 12.7-12.75 GHz (space-to-Earth) frequency band with these satellites at these lower altitudes, limited to operations outside the United States consistent with the Commission's prior grant. All conditions previously adopted that required coordination before commencement of operations will continue to apply, and SpaceX must ensure that coordination has been completed with respect to its operations in the authorized orbital shells of 340 km, 345 km, 350 km, and 360 km.

53. In its original Petition to Deny the SpaceX Gen2 application, as amended, DISH argues that the satellites operating below 400 km will result in more frequent, though briefer, instances of potential interference for direct broadcast service (DBS) customers.²³⁹ DISH characterizes SpaceX plans to reduce the EIRP of these satellites and only communicate with these satellites with minimum earth station elevation angles of 25 degrees as a "positive development from an interference perspective," but DISH argues the "exponential" increase in the number of satellites (i.e., the nearly 20,000 satellites SpaceX has proposed for operations below 400 km) negates these mitigation efforts.²⁴⁰ We note that our authorization today is for only 7,500 satellites operating at altitudes of 340 km, 345 km, 350 km, and 360

²³⁴ See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14910-14920, paras. 42-69; *SpaceX First V-band Modification Grant*; *SpaceX E-band Partial Grant*, at paras. 6-7; *SpaceX Gen2 Beacon Order* at paras. 5-6; see also generally *SpaceX Gen2 Application*, Narrative and Technical Attachment; *SpaceX Second V-band Modification Application*, Narrative and Technical Attachment.

²³⁵ See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14910-14920, paras. 42-69; *SpaceX First V-band Modification Grant*; *SpaceX E-band Partial Grant* at paras. 6-7; *SpaceX Beacon Order* at para. 6; see generally, *SpaceX Gen2 Application*, Narrative and Technical Attachment; *SpaceX Gen2 Amendment*, Narrative and Technical Attachment; *SpaceX Second V-band Modification Application*, Narrative and Technical Attachment.

²³⁶ See *SpaceX Gen2 Application*, Narrative and Technical Attachment; *SpaceX Gen2 Amendment*, Narrative and Technical Attachment; *SpaceX Beacon Amendment*, Narrative and Technical Attachment; *SpaceX Second V-band Modification Application*, Narrative and Technical Attachment.

²³⁷ See *SpaceX Gen2 Application*, Schedule S; *SpaceX Gen2 Amendment*, Schedule S; *SpaceX Beacon Amendment*, Schedule S; *SpaceX Second V-band Modification Application*, Schedule S; *SpaceX SCS Modification Application*, Schedule S; *SpaceX SCS Amendment*, Schedule S.

²³⁸ See *SpaceX E-band Partial Grant*, at para. 22.

²³⁹ See *DISH Gen2 Petition* at 6-7, 21-22. We note that the D.C. Circuit rejected arguments made in DISH's original petition to deny and found that DISH did not present sufficient evidence that SpaceX would cause unacceptable interference to DISH's system. See *International Dark-Sky Association, Inc., v. FCC*, 106 F.4th at 1212-13. The Court concluded that the initial partial grant of SpaceX's Gen2 system was reasonable. See *id.* at 1217.

²⁴⁰ *DISH Gen2 Petition* at 6-7, 21-22 (citing *SpaceX Gen2 Application*, Technical Attachment at 17, 20).

km, which is slightly more than one third of the total number of satellites SpaceX proposes at these altitudes in its Gen2 constellation, as amended. We also note that while we authorize SpaceX to conduct operations with up to 7,500 satellites at these lower altitudes, at this time SpaceX is limited to deploying only the number of satellites for which it has completed physical coordination with NASA.²⁴¹ We find that the smaller number of satellites coupled with SpaceX's 25 degree minimum elevation angle, which will reduce the potential for in-line interference events, and the lower EIRP for the satellites operating at these altitudes, which will reduce the received power level at the victim receivers (all of which DISH found to be a "positive development from an interference perspective"),²⁴² will result in no additional interference into GSO systems. We reiterate that SpaceX's authorization is conditioned on SpaceX operating consistent with all technical specifications provided to the Commission, including the reduced power levels.²⁴³ We do, however, commit to continuing to review this issue in any potential future authorizations for SpaceX's Gen2 Starlink satellites at altitudes below 400 km.²⁴⁴

54. *Ka-band.* We grant SpaceX's request for communications in the Ka-band with up to a total of 7,500 satellites operating in the authorized orbital shells of 340 km, 345 km, 350 km, and 360 km, limited to the total number of satellites SpaceX has coordinated with NASA under their Space Act Agreement. No comments were filed specifically regarding SpaceX's proposed operations in the Ka-band at lower altitudes. For these satellites operating at lower altitudes, we adopt the same conditions as those applicable to SpaceX's operations at the higher altitudes.²⁴⁵ All conditions previously adopted that required coordination before commencement of operations will continue to apply, and SpaceX must ensure that coordination has been completed with respect to its operations in the authorized orbital shells of 340 km, 345 km, 350 km, and 360 km.

55. *Processing Round Considerations for Ku- and Ka-band.* SpaceX originally applied for authorization as part of the 2020 Ku/Ka-band processing round.²⁴⁶ SpaceX is required to continue to comply with all obligations regarding its participation in the 2020 Ku- and Ka-band processing round.²⁴⁷ SpaceX must coordinate its Gen2 Starlink system operations with other operational systems that were licensed or granted U.S. market in certain prior NGSO FSS processing rounds—specifically those referred to in Public Notices DA 16-804, 31 FCC Rcd 7666 (IB 2016) and DA 17-524, 32 FCC Rcd 4180 (IB 2017). If such coordination cannot be successfully completed, SpaceX must make a showing to the Commission demonstrating and certifying that its operations will not cause harmful interference to those

²⁴¹ See NASA November 19, 2024 Letter.

²⁴² See DISH Gen2 Petition at 22.

²⁴³ See SpaceX Gen2 Application, Narrative and Technical Attachment; SpaceX Gen2 Amendment, Narrative and Technical Attachment

²⁴⁴ SpaceX has recently filed a modification and amendment application, seeking to change the orbital configuration, operational characteristics, and frequency use of the previously authorized Gen2 satellites as well as the pending portions of its Gen2 application, as amended, including changes to its minimum elevation angle. See ICFS File Nos. SAT-MOD-20241011-00224 and SAT-AMD-20241017-00228. We reiterate that partial grant of this authorization is without prejudice to any potential future action in connection with these applications or any other pending applications for the Gen2 Starlink constellation, call signs S2992 and S3069, and SpaceX is not authorized to conduct operations outside the scope of this Order.

²⁴⁵ See *SpaceX E-band Partial Grant*, at para. 22.

²⁴⁶ See 2020 Ku/Ka-band Processing Round Public Notice; SpaceX has made no changes to its proposed operations at lower altitudes in the Ku- and Ka-bands, and so we need not analyze whether further partial grant of SpaceX's Gen2 application, as amended, requires placement in a later processing round. 47 CFR § 25.117(d)(2)(ii); see also *Space Exploration Holdings, LLC, Request for Modification of the Authorization for the SpaceX NGSO Satellite System*, Order and Authorization and Order on Reconsideration, 36 FCC Rcd 7995, 8006-07, para. 16 (2021) (*SpaceX Third Modification Order*).

²⁴⁷ See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14951-52, paras. 135u and v.

operational systems, which will be subject to Commission approval.²⁴⁸ O3b posits that SpaceX's demonstration and certification of no harmful interference to operational systems authorized in the earlier processing rounds must take into account all operational altitudes, including operations in the lower altitude orbital shells authorized in this grant.²⁴⁹ We agree, and condition this authorization accordingly.²⁵⁰ We also note that the Commission recently adopted rules governing methodologies to be used for demonstrations of protection of earlier-round systems.²⁵¹ SpaceX must comply with these rules when they come into effect.

56. *E-band.* We authorize SpaceX to conduct communications in the E-band with up to 7,500 satellites operating at 340 km, 345 km, 350 km, and 360 km, limited to the total number of satellites SpaceX has coordinated with NASA under their Space Act agreement. We note that no comments were filed on the record specifically with respect to SpaceX's proposed operations in the E-band at these lower altitudes. SpaceX's operations in the E-band at these lower altitudes must be conducted in accordance with the technical parameters SpaceX has provided in its Gen2 application, as amended, and subject to the same conditions we adopted in prior orders for operations in the E-band at higher altitudes.²⁵² All conditions previously adopted that required coordination before commencement of operations will continue to apply, and SpaceX must ensure that coordination has been completed with respect to its operations in the authorized orbital shells of 340 km, 345 km, 350 km, and 360 km.²⁵³ We reiterate in particular that SpaceX must comply with any sharing requirements adopted as part of a future E-band processing round. And SpaceX is also required to complete coordination with federal operators utilizing the 86-92 GHz band for passive services prior to SpaceX commencing operations, including operations at 340 km, 345 km, 350 km, and 360 km. We also adopt an additional condition, similar to the conditions on SpaceX's Ku- and V-band operations, requiring SpaceX to operate its gateway earth stations in the E-band with minimum elevation angles of 25 degrees, except in regions above 62 degrees latitude, where it may operate with a minimum elevation angle of 5 degrees.²⁵⁴

57. *V-band.* SpaceX filed its original V-band application in response to an International Bureau public notice that initiated a processing round for additional NGSO applications in the 37.5-40.0 GHz, 40.0-42.0 GHz, 47.2-50.2 GHz, and 50.4-51.4 GHz bands (First V-band Processing Round).²⁵⁵ On April 23, 2024, SpaceX filed its Second V-Band Modification Application, proposing to communicate between its Gen2 Starlink satellites at altitudes of 340 km, 345 km, 350 km, and 360 km and gateway and user terminals in the 37.5-40.0 GHz (space-to-Earth), 40.0-42.0 GHz (space-to-Earth), 47.2-50.2 GHz

²⁴⁸ In the event that it becomes necessary for SpaceX to make such a demonstration to the Commission, SpaceX may commence operations at its own risk, on a non-harmful interference, unprotected basis with respect to any operations authorized in earlier processing rounds for which coordination has not been completed, prior to the approval of its showing by the Commission. See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14952-53, para. 135v.

²⁴⁹ See O3b February 28, 2024 Letter at 1-2.

²⁵⁰ See *infra*, para. 89x.

²⁵¹ See generally *Revising Spectrum Sharing Rules for Non-Geostationary Orbit, Fixed-Satellite Service Systems, Second Report and Order and Order on Reconsideration*, FCC-24-117 (2024).

²⁵² See *SpaceX E-band Partial Grant*, at para. 22.

²⁵³ See *infra*, para. 89.

²⁵⁴ SpaceX has committed to operating in this manner in its Gen2 application, as amended, and addition of this condition is consistent with similar conditions on SpaceX's operations in the Ku- and V-bands. See *SpaceX E-band Partial Grant* at paras. 7, 22; SpaceX Gen2 Application, Technical Attachment at 13.

²⁵⁵ *Boeing Application Accepted for Filing in Part*, ICFS File No. SAT-LOA-20160622-00058; *Cut-off Established for Additional NGSO-Like Satellite Applications or Petitions for Operations in the 37.5-40.0 GHz, 40.0-42.0 GHz, 47.2-50.2 GHz, and 50.4-51.4 GHz Bands*, Public Notice, 31 FCC Rcd 11957 (IB 2016).

(Earth-to-space), and 50.4-51.4 GHz (Earth-to-space) bands.²⁵⁶ SpaceX is authorized to operate with a minimum elevation angle of 35 degrees in the 37.5-40.0 GHz band and with a minimum elevation angle of 25 degrees in the 40.0-42.0 GHz, 47.2-50.2 GHz, and 50.4-51.4 GHz bands²⁵⁷ and SpaceX does not propose to modify these minimum elevation angles.²⁵⁸ Specifically, SpaceX proposes a maximum EIRP density between 14.2 dBW/MHz and 14.7 dBW/MHz, depending on the operational altitude of the satellites.²⁵⁹ SpaceX states that with respect to operations at the 350 km altitude in the 40.0-42.0 GHz and 37.5-40.0 GHz bands, as a satellite steers its beam, it adjusts power to maintain a constant PFD on the surface of the Earth.²⁶⁰ Additionally, SpaceX states that all of its V-band operations will comply with the PFD limits on the surface of the Earth.²⁶¹

58. The Commission has addressed the impact of modifications on processing round status.²⁶² Specifically, under our rules governing modifications, “applications for modifications of space station authorizations will be granted,” unless one of several enumerated exceptions applies, including the provision stating that the modification will not be granted if it “would not serve the public interest, convenience, and necessity.”²⁶³ The Commission has applied the Bureau’s interpretation of that provision and found that in the context of applications to modify authorized NGSO systems that were originally subject to modified processing round procedures, a proposed modification will be granted generally if such modification “does not present any significant interference problems and is otherwise consistent with Commission policies.”²⁶⁴ But if the modification “presents significant interference problems,” that modification would be treated as a newly filed application and considered in a subsequent satellite processing round.²⁶⁵

59. As SpaceX is a participant in the First V-band Processing Round, we therefore must consider whether its request to further modify its V-band authorization would present significant interference concerns,²⁶⁶ necessitating consideration of this modification application as a newly filed application to be placed in a subsequent processing round.²⁶⁷ SpaceX states that this modification request

²⁵⁶ SpaceX Second V-Band Modification Application, Technical Attachment at 5.

²⁵⁷ See *SpaceX First V-band Modification Grant*.

²⁵⁸ See SpaceX Second V-Band Modification Application, Technical Attachment at 5-6.

²⁵⁹ See *id.* at 7.

²⁶⁰ See *id.* at 6.

²⁶¹ See *id.* at 8.

²⁶² See *SpaceX Third Modification Order*, 36 FCC Rcd at 8006-07, para. 16.

²⁶³ 47 CFR § 25.117(d)(2)(ii); see also *SpaceX Third Modification Order*, 36 FCC Rcd at 8006-07, para. 16. None of the other exceptions in Section 25.117(d)(2) appear to be relevant, and none have been raised in connection with SpaceX’s modification request.

²⁶⁴ *SpaceX Third Modification Order*, 36 FCC Rcd at 8006-07, para. 16 (quoting *Teledesic LLC*, Order and Authorization, 14 FCC Rcd 2261, 2264, para. 5 (IB 1999)).

²⁶⁵ See *id.* (concluding that the SpaceX Third Modification Application would not present significant interference problems and granting the modification without treating it as a newly filed application).

²⁶⁶ As discussed above, we need not conduct this analysis for SpaceX’s operations in the Ku-, Ka-, and E-bands at lower altitudes, as these operations were part of SpaceX’s original proposal in its Gen2 Application, as amended, and are therefore contemplated as part of the 2020 Ku/Ka-Band Processing Round in the case of the Ku- and Ka-bands or part of a potential future processing round, in the case of the E-band.

²⁶⁷ We note that SpaceX has filed an additional application, seeking to modify its V-band authorization to extend its milestone deadline by placing the remaining V-band satellites, which SpaceX has not yet launched, into a subsequent processing round, arguing that under the Commission’s standard, extending a milestone will present significant interference problems to the environment of the current processing round. See generally *Space*

will not have any significant interference impact on other users of the V-band.²⁶⁸ On the contrary, SpaceX asserts that operating V-band payloads at orbital altitudes of 340 km, 345 km, 350 km, and 360 km will improve the spectrum sharing environment among authorized V-band systems rather than increase interference.²⁶⁹ This is because there will be no increase in the number of satellites and SpaceX will be able to operate its V-band payloads at these lower altitudes at a lower EIRP to maintain the same PFD at the surface of the Earth that SpaceX is currently authorized for operations at higher altitudes.²⁷⁰ In addition, because the satellite downlink transmit power is adjustable on orbit, SpaceX has the ability to manage each satellite's PFD levels during all phases of the mission, as needed. All downlink spot beams on each SpaceX satellite are independently steerable over the full field of view of the Earth. Earth stations communicate only with satellites above a minimum elevation angle. SpaceX has provided a technical analysis that confirms and quantifies this commitment that V-band operations at 340 km, 345 km, 350 km, and 360 km will not present significant interference concerns.²⁷¹ No parties filed comments on SpaceX's operations in the V-band at lower altitudes. Space Bureau staff have reviewed SpaceX's technical demonstration and determined that SpaceX has provided sufficient information to demonstrate that its V-band operations at lower altitudes will not present interference concerns. We therefore find that SpaceX's V-band Modification Application will not increase interference into the environment of the First V-band Processing Round.

60. We therefore grant SpaceX authority to operate its previously authorized 7,500 satellites in the 37.5-40.0 GHz and 40.0-42.0 GHz (space-to-Earth) and 47.2-50.2 GHz and 50.4-51.4 GHz (Earth-to-space) bands at altitudes of 340 km, 345 km, 350 km, and 360 km. This authorization is also subject to the same conditions we have placed upon these operations at higher altitudes in prior authorizations. Again, we note that for conditions previously adopted for higher-altitude satellites that required coordination before commencement of operations, SpaceX must likewise complete the same coordination for the satellites we authorize to operate at altitudes of 340 km, 345 km, 350 km, and 360 km.

61. *VHF Beacons.* SpaceX is authorized to operate VHF beacons on up to 450 Gen2 Starlink satellites for backup telemetry, tracking, and command (TT&C) during orbit raising and emergency situations while at operational altitudes.²⁷² The *SpaceX Gen2 Beacon Order* did not include authorization for communications using the VHF beacons at operational altitudes of 340 km, 345 km, 350 km, and 360 km, and instead stated that operations at these altitudes would be considered as part of SpaceX's general request to include these lower altitudes in its authorization.²⁷³ We now authorize SpaceX to communicate using its VHF beacons on up to 450 Gen2 Starlink satellites during emergency situations for backup TT&C at operational altitudes of 340 km, 345 km, 350 km, and 360 km, in addition to the previously-authorized communications during orbit raising and while at operational altitudes of 525 km, 530 km, and 535 km. The *SpaceX Gen2 Beacon Order* authorized SpaceX to conduct communications with the VHF beacons during orbit raising from insertion orbit—which is lower than the operational altitudes of 340-

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Exploration Holdings, LLC, Application for Modification of Authorization of the SpaceX V-band NGSO Satellite System, ICFS File No. SAT-MOD-20240813-00183 (filed Aug. 13, 2024). We do not address these issues here and instead focus on any potential interference concerns raised in the instant application to include V-band antennas on Gen2 Starlink satellites operating at 340 km, 345 km, 350 km, and 360 km.

²⁶⁸ See SpaceX Second V-Band Modification Application, Technical Attachment at 11.

²⁶⁹ See *id.*, Narrative at 5.

²⁷⁰ See *id.*; see also, *SpaceX First V-Band Modification Grant*.

²⁷¹ See SpaceX Second V-Band Modification Application, Technical Attachment at Annex 1.

²⁷² See generally *SpaceX Gen2 Beacon Order*.

²⁷³ See *id.* at para. 7.

360 km—as well as for backup TT&C at operational altitudes of 525-535 km,²⁷⁴ and the technical parameters for SpaceX’s operations with the VHF beacons are consistent regardless of operational altitude,²⁷⁵ so we find that SpaceX’s proposed operations with the VHF beacons for emergency TT&C at altitudes of 340 km, 345 km, 350 km, and 360 km do not raise any additional interference concerns that were not already fully considered in the *SpaceX Gen2 Beacon Order*. SpaceX’s operations with these beacons remain subject to all conditions adopted in the *SpaceX Gen2 Beacon Order*.²⁷⁶ Finally, we reiterate that for conditions previously adopted for operations of the beacons on higher-altitude satellites that required coordination before commencement of operations, SpaceX must likewise complete the same coordination for the communications we authorize at altitudes of 340 km, 345 km, 350 km, and 360 km.

D. Orbital Debris Mitigation

62. In the *SpaceX Gen2 First Partial Grant*, the Commission approved SpaceX’s orbital debris mitigation plans for up to 7,500 Gen2 Starlink satellites operating at 525 km, 530 km, and 535 km, but deferred consideration of several issues specifically related to SpaceX’s proposed orbital shells below 400 km.²⁷⁷ Specifically, the Commission deferred authorization for any satellites operating below 400 km, citing concerns raised by NASA and others related to protection of inhabitable space stations, protection of launch windows for ISS resupply and NASA’s science missions, the functioning of SpaceX’s autonomous collision avoidance system at low altitudes, and general concerns related to congestion and collision risk in LEO.²⁷⁸

63. We approve SpaceX’s orbital debris mitigation plan, as modified to account for operations of up to 7,500 satellites at altitudes of 340 km, 345 km, 350 km, and 360 km. The operations of satellites in these lower orbits will result in a lower collision risk in the event of an anomaly during normal operations and will shorten the time required for post-mission disposal maneuvers.²⁷⁹ SpaceX has certified that its orbital debris mitigation plans and supplemental information previously submitted to the Commission, including plans to reserve sufficient propellant for collision avoidance maneuvers and information on risk of collision with small debris and meteoroids, remain unchanged.²⁸⁰ These plans comply with our rules and were approved by the Commission for satellite operations at higher altitudes.²⁸¹ Finally, SpaceX has completed coordination with NASA for physical operations for up to 400 satellites to operate below the ISS,²⁸² and coordination remains ongoing for additional satellites.²⁸³ NASA has

²⁷⁴ See *id.* at para. 15III; see also *SpaceX Gen2 First Partial Grant* 37 FCC Rcd at 14953, para. 135cc.

²⁷⁵ See *SpaceX Gen2 Beacon Order* at para. 5-6.

²⁷⁶ See *id.* at para. 13-21.

²⁷⁷ See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14920-27, para. 70-86.

²⁷⁸ See *id.* at 14922-23, 14926, paras. 76-77, 79, 88.

²⁷⁹ The Commission has previously stated that operations at lower altitudes pose less risk to the orbital environment. See e.g. *SpaceX Third Modification Order*, 36 FCC Rcd at 8027, para. 54 (“we agree with SpaceX that specification of a lower altitude provides for operations that present considerably lower risk than at the higher altitude”).

²⁸⁰ See SpaceX Second V-band Modification Application, Technical Attachment at 12-13; SpaceX SCS Modification Application, Technical Attachment at 14; SpaceX September 13, 2024 Letter at 2; see also *SpaceX SCS Modification Partial Grant* at N.16 (addressing comments on the record and affirming that the addition of SCS antennas to the SpaceX Gen2 Starlink satellites will not change the previously submitted orbital debris mitigation plans).

²⁸¹ See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14920, para. 71.

²⁸² See Letter from Lauren E. Morgan, NASA Representative to the Commercial Transportation Interagency Group Space Operation Mission Directorate, Launch Services Office, to Marlene H. Dortch, Secretary, FCC, ICFS File Nos. SAT-LOA-20200526-00055, SAT-AMD-20210818-00105, SAT-AMD-20221216-00175, SAT-MOD-

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indicated this completed and ongoing coordination has resolved its prior concerns, and likewise we are satisfied that this coordination resolves the concerns previously raised. Below, we address specific issues deferred in prior orders as they relate to the orbital debris mitigation plans for the Gen2 satellites we authorize to operate at 340 km, 345 km, 350 km, and 360 km in this Order.²⁸⁴

64. *Protection of Inhabitable Space Stations.* The ISS operates in an orbit of roughly 400 km altitude. In connection with SpaceX's Gen2 application as initially filed, NASA and LeoLabs both expressed concerns that satellites SpaceX proposes to operate in its lower altitude shells would pose safety risks to inhabitable space stations, including the ISS.²⁸⁵ NASA has subsequently indicated that it has completed coordination with SpaceX for up to 400 satellites operating below the ISS, and that such coordination allays its concerns regarding risks to the ISS posed by these particular Gen2 Starlink satellites.²⁸⁶ NASA has also indicated that its physical coordination with SpaceX is ongoing, that it is conducting a study of impacts on ISS visiting vehicles, and that once that study is complete it expects to be able to complete physical coordination with SpaceX for an increased number of Gen2 Starlink satellites operating below the ISS.²⁸⁷ We agree this coordination is sufficient to address these concerns.

65. NASA recommends we condition this authorization on SpaceX only deploying the number of satellites for which it has completed physical coordination with NASA under SpaceX and NASA's Space Act agreement.²⁸⁸ Such an approach would therefore limit SpaceX's deployment to 400 satellites initially, which is the number of satellites NASA and SpaceX have completed physical coordination for,²⁸⁹ but would allow SpaceX to operate additional satellites below the ISS as the parties complete further coordination.²⁹⁰ We agree that such an approach will serve the public interest by lessening the burden on Commission staff to repeatedly authorize an increasing number of Gen2 Starlink satellites at these altitudes at a rapid clip. We note that concerns raised on the original record of the SpaceX Gen2 application, as amended, went beyond physical coordination with NASA and also included concerns regarding interference into other systems, SpaceX's impacts on orbital congestion and therefore access to space for other commercial operators, and increased satellite reflectivity, but we have addressed these concerns and applied conditions where appropriate throughout this order for all 7,500 Gen2 Starlink satellites. NASA recommends the Commission require SpaceX to provide an update on physical

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20230207-00021, SAT-AMD-20240322-00061, SAT-MOD-20240423-00089, SAT-STA-20240522-00108, and GN Docket No. 23-135 (dated Oct. 29, 2024) (NASA October 29, 2024 Letter).

²⁸³ See NASA November 19, 2024 Letter.

²⁸⁴ We address only comments specific to operations at 340 km, 345 km, 350 km, and 360 km. We do not address comments previously filed on the record that relate solely to the scale of SpaceX's proposed Gen2 Starlink constellation, as we do not increase the number of authorized satellites in this authorization beyond the 7,500 satellites authorized in the *SpaceX Gen2 First Partial Grant* and subsequent orders. We also do not revisit comments on the record that we have addressed in prior orders. See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14920-27, para. 70-86; *SpaceX SCS Modification Partial Grant* at N.16 (addressing comments filed by DISH on the record and affirming that the addition of SCS antennas to the SpaceX Gen2 Starlink satellites will not change the previously submitted orbital debris mitigation plans).

²⁸⁵ See NTIA Letter, NASA Letter at 4; LeoLabs March 29, 2022 Letter at 4.

²⁸⁶ See NASA October 29, 2024 Letter.

²⁸⁷ See *id.*; NASA November 19, 2024 Letter.

²⁸⁸ See NASA November 19, 2024 Letter.

²⁸⁹ See NASA October 29, 2024 Letter.

²⁹⁰ See NASA November 19, 2024 Letter.

coordination with NASA in its semiannual report for the Gen2 constellation,²⁹¹ but as the Commission has committed to continued monitoring of a number of aspects of SpaceX's deployment, including deployment at altitudes below the ISS, we require SpaceX to notify the Commission of any increase in the number of satellites coordinated with NASA prior to launch of those satellites. We also note that regardless of additional coordination with NASA, SpaceX's operations are limited to the operations described in its Gen2 application, as amended, as well as SpaceX's second V-band modification application and SpaceX's SCS Modification Application, as amended, including the Schedule S and other supplemental technical information provided,²⁹² and SpaceX may not operate satellites in orbital shells it has requested in additional amendments or modifications that the Commission has not acted upon.²⁹³ We therefore condition this authorization such that SpaceX may only continually operate the total number of satellites at altitudes of 340 km, 345 km, 350 km, and 360 km that SpaceX and NASA have coordinated in their Space Act Agreement. SpaceX must provide a certification of the completion of coordination of additional satellites with NASA to the Commission at least 30 days prior to the launch of the additional satellites.

66. *Coordination of Launch Windows for NASA Missions.* NASA also originally expressed concerns that SpaceX's proposed 19,440 Gen2 Starlink satellites at altitudes below the ISS might impact launch windows for NASA missions, including ISS resupply missions and science missions with narrow launch windows such as NASA's Europa Clipper.²⁹⁴ In the *SpaceX Gen2 First Partial Grant*, we required SpaceX to coordinate with NASA to resolve these concerns, and SpaceX has completed physical coordination with NASA.²⁹⁵ We find that, based on the coordination between SpaceX and NASA, the coordinated operations will not endanger launch windows for NASA missions. SpaceX must continue to communicate and collaborate with NASA to ensure that deployment and operation of its satellites does not unduly constrain deployment and operation of NASA assets and missions, supports safety of both SpaceX and NASA assets and missions, and preserves long-term sustainable space-based communications services.

67. *Autonomous Collision Avoidance.* NASA also raised concerns on the record of the Gen2 application, as amended, about the functioning of SpaceX's autonomous collision avoidance system, particularly at lower altitudes where atmospheric drag is higher.²⁹⁶ SpaceX has previously confirmed to the Commission that it is continuing to coordinate with NASA regarding the use of its autonomous collision avoidance system, including frequent and regular meetings regarding these matters.²⁹⁷ As we acknowledged in the *SpaceX Gen2 First Partial Grant*, "through its partnership with NASA, both NASA and SpaceX are confident NASA's assets can remain safe while sharing space with Gen2 Starlink, and neither NASA nor SpaceX have identified issues that cannot be resolved by continued coordination."²⁹⁸

²⁹¹ See *id.*

²⁹² See generally SpaceX Gen2 Application; SpaceX Gen2 Amendment; SpaceX Gen2 Beacon Amendment; SpaceX Second V-band Modification Application; SpaceX SCS Modification Application; SpaceX SCS Amendment.

²⁹³ See e.g. ICFS file nos. SAT-MOD-20241011-00224 and SAT-AMD-20241017-00228.

²⁹⁴ See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14926, para. 88.

²⁹⁵ See NASA October 29, 2024 Letter.

²⁹⁶ See Letter from Kathy Smith, Chief Counsel, National Telecommunications and Information Administration, to Marlene H. Dortch, Secretary, FCC, ICFS File No. SAT-AMD-20210818-00105 (dated Feb. 8, 2022); *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14922, paras. 75-76.

²⁹⁷ See SpaceX August 19, 2022 Letter at 5; see also *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14922-23, para. 77.

²⁹⁸ *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14922-23, para. 77 (citing SpaceX August 19, 2022 Letter at 5).

In its June 20, 2024 letter, SpaceX indicated that discussions remain ongoing with NASA regarding its autonomous collision avoidance system, but to date these discussions have not required SpaceX to make any changes to its use of its automated collision avoidance system “beyond those that SpaceX has proactively made based on its on-orbit experience.”²⁹⁹ SpaceX has indicated that its autonomous collision avoidance system has functioned as planned, even on recently launched satellites at lower altitudes, including during the geomagnetic storm in May 2024 and while avoiding debris from the Russian antisatellite test in 2021.³⁰⁰

68. We find requiring SpaceX to coordinate with NASA to ensure safety of NASA missions is sufficient to resolve these concerns regarding potential operations of currently authorized satellites at altitudes of 340 km, 345 km, 350 km, and 360 km, especially as deployment to these altitudes of more than the 400 satellites SpaceX has already coordinated with NASA is contingent on further coordination with NASA.³⁰¹ We also continue to condition SpaceX’s authorization to require reporting with respect to any collision avoidance system outages or unavailability, either on a system wide basis or for individual satellites, due to any cause other than disabling of the system for a single satellite in order to facilitate operator-to-operator coordination. An “outage” would include any individual satellite anomaly that results in a satellite not achieving targeted risk mitigation via maneuver. We also commit to continuing to monitor and evaluate this issue, particularly once SpaceX begins operating satellites at the altitudes authorized today. While we are confident in the performance of SpaceX’s autonomous collision avoidance system to date, we note that the limitation on the number of satellites SpaceX may deploy and operate below 400 km should allow any unanticipated malfunctions to be identified and remedied before a larger deployment. To that end, the functioning of SpaceX’s autonomous collision avoidance system at low altitudes will impact any future authorization for additional satellites at altitudes below 400 km.

69. *Congestion and Collision Risk at Lower Altitudes.* In the *SpaceX Gen2 First Partial Grant*, we deferred consideration of issues raised on the record by NASA and commercial operators regarding increased congestion in low-Earth orbit that would be caused by SpaceX’s proposed 19,440 satellites operating between 340 km and 360 km, as well as specific issues regarding collision risk at these altitudes.³⁰² We reiterate that this authorization permits SpaceX to operate up to a total of 7,500 satellites at altitudes of 340 km, 345 km, 350 km, and 360 km, diminishing the risks these commenters raise regarding a full deployment of 19,440 satellites. We also reiterate that SpaceX has successfully coordinated physical operations for up to 400 satellites with NASA at this time, and deployment of satellites at these lower altitudes beyond that 400 satellites is conditioned on further coordination with NASA and certification to the Commission of that coordination at least 30 days prior to launch of additional satellites destined for operations below the ISS.³⁰³

70. Viasat previously argued that SpaceX satellites planned for operations at 360 km did not comply with the Commission’s collision risk limits should a satellite’s propulsion fail.³⁰⁴ We did not reach this issue in the *SpaceX Gen2 First Partial Grant*, but we note today that SpaceX has provided

²⁹⁹ See SpaceX June 20, 2024 Response at 4.

³⁰⁰ See *id.*

³⁰¹ See *infra*, conditions 89yyy, zzz, ffff.

³⁰² See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14923, para. 79; Viasat Petition at I-II, 10-12; Viasat Reply at 3, 6-7; Kepler Comments at 2; Viasat October 4, 2022 Letter at 4-5.

³⁰³ See NASA October 29, 2024 Letter; NASA November 19, 2024 Letter.

³⁰⁴ See Viasat October 4, 2022 Letter at 4-5. *But see SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14923, para. 79, N.306 (“SpaceX later stated there had been an administrative error in its DAS calculations and provided the correct large object collision risk value for the satellites at 360 km, demonstrating that they do comply with the Commission’s collision risk limit”) (citations omitted).

updated collision risk information for its satellites operating at 340 km, 345 km, 350 km, and 360 km.³⁰⁵ Under our rules, SpaceX's satellites are assumed to have a collision risk of zero because they are equipped with propulsion, and the collision risk information SpaceX has provided complies with our rules in the event a Gen2 Starlink satellite becomes non-maneuverable.³⁰⁶ We also note that SpaceX has recently informed the Commission that it now conducts maneuvers for conjunction events with a 1 in 1 million chance of collision, two orders of magnitude more sensitive than industry standards,³⁰⁷ which we find will further work to reduce collision risk on orbit. Therefore, we find that SpaceX's updated collision risk information for these lower altitudes in conjunction with its low threshold for maneuvering to avoid collisions with other space objects, resolve Viasat's concerns on this matter.

71. In addition to the conditions discussed above, we continue to require SpaceX to submit semiannual reports to the Commission, detailing the number of conjunction events for its Gen2 Starlink constellation; the satellites SpaceX has screened from future deployment; the satellites that have reentered the atmosphere; and any satellites that have experienced disposal failures, *i.e.* satellites that have lost maneuverability above injection orbit and therefore will not complete post-mission disposal as planned.³⁰⁸

72. In conclusion, we approve SpaceX's orbital debris mitigation plan with regard to up to 7,500 satellites for potential operations at altitudes of 340 km, 345 km, 350 km, and 360 km. SpaceX must comply with all conditions previously adopted for satellite operations at higher altitudes, and SpaceX's deployment at altitudes below the ISS is conditioned on SpaceX completing coordination with NASA. We continue to defer consideration of issues raised on the record of the Gen2 application, as amended, for any larger deployment of satellites at altitudes below the ISS.

E. Orbital Tolerances

73. SpaceX requests to operate its satellites at lower altitudes with orbital tolerances of +70/-50 km (*i.e.* satellites could operate from 290 km to 430 km).³⁰⁹ SpaceX has explained that larger orbital tolerances are necessary, particularly at lower altitudes, due to the effects of solar radiation on its spacecraft: this orbital tolerance will allow the satellites in Gen2 Starlink not only to raise to a higher altitude to retain their operational life in periods of high drag but also to lower the altitude if it appears a satellite may become non-maneuverable to maintain low passive decay times.³¹⁰ We also understand that the requested orbital tolerances may give SpaceX additional flexibility with respect to locating its satellites to reduce collision risks, if needed.³¹¹ SpaceX further states that it "will ensure that its operations in its lower-altitude shells do not affect any operations of crewed space stations within its orbital tolerance, including the ISS and the Chinese space station, by avoiding ongoing, nominal operations between altitudes of 385 km and 430 km, except as necessary to ensure space sustainability and subject to crewed

³⁰⁵ See SpaceX June 20, 2024 Response at 6, Attachment A. SpaceX states that the large object collision risk for these satellites has remained relatively stable and even decreased slightly. *Id.* at 6.

³⁰⁶ 47 CFR § 25.114(d)(14)(iv)(A); *see also* *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14921, paras. 72-73.

³⁰⁷ See Report of Space Exploration Holdings LLC, ICFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105 at 2 (filed Jul. 1, 2024).

³⁰⁸ See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14924-25, 14952-53, paras. 84-85, 135y, z; *SpaceX Gen2 E-band Partial Grant*, at paras. 22bbb, ccc.

³⁰⁹ We note that this Order does not impact the decision made in the *SpaceX Gen2 First Partial Grant* rejecting SpaceX's request pertaining to orbital tolerances at higher altitudes. See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14924, para. 82.

³¹⁰ See *id.* at 14923-24, paras. 80-82 (citing SpaceX August 19, 2022 Letter at 4).

³¹¹ SpaceX September 13, 2024 Letter at 2-3; *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14923-24, paras. 80-82 (citing SpaceX August 19, 2022 Letter at 4).

station movement.”³¹²

74. Based on SpaceX’s coordination with NASA and statement that it will generally operate below 385 km, we authorize SpaceX’s requested orbital tolerances at these lower altitudes. However, we will continue to monitor SpaceX’s operations and may reevaluate SpaceX’s orbital tolerances at lower altitudes in the future, particularly taking into account any potential increase in the number of satellites operating below the ISS and Chinese space stations. We therefore require SpaceX to operate in such a way as to minimize risk of collision with, and avoid operational constraints to, any inhabitable space stations, including the ISS. We also require SpaceX to file a report with the Commission within ten days of operating with any satellite that is part of its lower-altitude shells above 385 km, other than for purpose of transiting to a higher altitude. These reports must include the satellite or satellites operating above 385 km, the reasons for the higher-altitude operations within the orbital shells, and the amount of time the satellite or satellites is anticipated to spend at the above-385 km altitude. We will continue to address these considerations on a going forward basis if we proceed with any potential further grants authorizing additional SpaceX satellites to operate at altitudes below the ISS or at any altitudes near inhabitable space stations.

75. Finally, we also note that SpaceX must comply with Resolution 8 of WRC-23 for all satellites at all operational altitudes, and therefore SpaceX must provide the Commission, by March 15, 2025, the required information for each deployed Gen2 Starlink satellite, identified by NORAD tracking number, for submission to the ITU.³¹³ Additionally, for purposes of compliance with ITU milestone rules, we note that SpaceX must maintain orbital tolerances of +/-30 km altitude and of +/-2 degrees of inclination in order to count the satellites for the successive ITU milestones.³¹⁴

F. Authority for Orbit Raising, Testing, and Deorbit Operations

76. The Commission has previously authorized SpaceX to conduct TT&C operations on an ongoing basis with its Gen2 Starlink satellites during launch and early orbit phase (LEOP) operations, including testing of communications equipment at injection altitudes, as well as TT&C operations during post-mission disposal.³¹⁵ The Commission found that these operations serve the public interest by permitting SpaceX to test its satellites’ communications equipment before orbit raising the satellites, thereby identifying any satellites that do not function properly and allowing SpaceX to deorbit them in a matter of weeks, which minimizes the risk of satellites experiencing a disposal failure at their operational altitude and lessens the collision risk posed by the Gen2 Starlink constellation.³¹⁶ SpaceX’s authority to conduct these transition phase operations is subject to a number of conditions.³¹⁷ Specifically, during orbit-raising, including launch and early orbit phase operations, and deorbit of its satellites, SpaceX must operate on a non-harmful interference basis, *i.e.* SpaceX must not cause harmful interference and must

³¹² SpaceX September 13, 2024 Letter at 2-3.

³¹³ Int’l Telecomm. Union [ITU], Resolution 8 (WRC-23), Agenda for the 2027 world radiocommunication conference, at resolves 2 (2023); https://www.itu.int/dms_pub/itu-r/opb/act/R-ACT-WRC.16-2024-PDF-E.pdf.

³¹⁴ *Id.*

³¹⁵ See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14927-28, paras. 90-91; *SpaceX E-band Partial Grant* at para. 18.

³¹⁶ See *SpaceX Gen2 First Partial Grant* 37 FCC Rcd at 14927-28, paras. 90-91. Additionally, SpaceX’s rapid launch cadence and the sheer number of satellites it seeks to deploy, coupled with the satellites’ five-year operational life, means SpaceX is conducting LEOP and deorbit operations on a continuous basis, and ongoing authority to conduct these operations obviates the need for SpaceX to file, and Commission staff to process, a never-ending stream of requests for special temporary authority. *Id.*

³¹⁷ See *id.* at 14927-28, para. 91.

accept any interference received. In the event of any harmful interference under this grant, SpaceX must immediately cease operations upon notification of such interference and inform the Commission, in writing, of such an event. Additionally, SpaceX may not deploy any of its authorized 7,500 Gen2 Starlink satellites directly to their operational altitudes.

77. In authorizing SpaceX to deploy and operate satellites in the 340 km, 345 km, 350 km, and 360 km altitude shells proposed in its original Gen2 application, as amended, we continue to authorize SpaceX to conduct TT&C during LEOP and deorbit of its satellites and testing of communications equipment at injection altitude, including for satellites destined for lower altitudes, subject to all of these same conditions. We continue to find that SpaceX's testing of its satellites at injection altitude is in the public interest.³¹⁸ We limit the testing SpaceX may perform during LEOP to testing of the functionality of the Gen2 Starlink satellites. SpaceX has received experimental authority for additional testing of its SCS communications equipment. We note, however, that SpaceX's experimental authority does not contain any separate authority with respect to operations at specific orbital altitudes. SpaceX has indicated that it typically maintains satellites at their low insertion altitude for between 21 and 50 days to test the communications equipment before orbit raising the satellites to their operational altitudes.³¹⁹ Given this time range, and in light of the potentially large number of satellites that SpaceX may be operating at lower altitudes during LEOP because of SpaceX's launch cadence,³²⁰ we find it is in the public interest to require SpaceX to file a report with the Commission every thirty days containing the total number of Gen2 Starlink satellites currently conducting LEOP operations and the number of those satellites currently located below 400 km.

G. Consideration of Optical Astronomy

78. In response to the SpaceX Gen2 application, as amended, NASA, NSF, and several individual astronomers and amateur astronomy groups raised concerns regarding the protection of science missions involving astronomy and Earth observation that could be impacted by reflected sunlight from SpaceX's satellites.³²¹ In the *SpaceX Gen2 First Partial Grant*, the Commission found that SpaceX's efforts to mitigate the effects of reflected sunlight from its satellites, coupled with the limited number of satellites authorized in that grant and the Commission's commitment to continuing to monitor the situation, were sufficient to allay these concerns.³²² The Commission also conditioned SpaceX's authorization on continued coordination with NASA and NSF and reporting to the Commission on its ongoing efforts to mitigate satellite brightness.³²³ The Commission's findings were upheld by the D.C. Circuit on appeal, finding the Commission reasonably took into account SpaceX's mitigations.³²⁴

79. Some commenters expressed concerns specifically with operations at lower altitudes, in particular, that such operations would result in satellites appearing brighter.³²⁵ To date, SpaceX has taken a number of measures to mitigate reflected sunlight from its satellites. In particular, as we explained in the *SpaceX Gen2 First Partial Grant*, SpaceX has incorporated brightness mitigation into the design of its satellites and made changes to material specifications, satellite geometries, and maneuver operations to

³¹⁸ See *id.* at 14927-28, paras. 90-91.

³¹⁹ SpaceX June 20, 2024 Response at 3.

³²⁰ See NASA November 19, 2024 Letter.

³²¹ See *SpaceX Gen2 First Partial Grant*, 37 FCC Red at 14928-31, paras. 92-96.

³²² See *id.* at 14930-31, paras. 96-97.

³²³ See *id.* at 14931-32, para. 98-99.

³²⁴ See *International Dark Sky Association v. FCC*, 106 F.4th at 1212, 1219-20.

³²⁵ See Andy Lawrence September 18, 2022 Letter at 2.

reduce brightness.³²⁶ While SpaceX has explained that its satellites will be bright enough to be visible to the naked eye immediately after launch and during orbit-raising and deorbit phases, as well as during collision avoidance burns, as during these times SpaceX cannot maneuver to mitigate reflected sunlight while also meeting mission objectives, SpaceX is continuing to refine its mitigation practices to resolve this problem.³²⁷ And SpaceX has continued to coordinate with NSF, NASA, and the astronomy community to minimize the impact of its satellites on science missions,³²⁸ including to ensure any increased brightness of lower altitude satellites is offset by benefits such as transiting more quickly through the field of view, being visible to fewer observers, and passing into Earth's shadow more quickly after sunset.³²⁹

80. In considering concerns on the record regarding increased brightness of lower altitude operational satellites, we reiterate that at this time we are not authorizing SpaceX to deploy the nearly 20,000 satellites it proposes for the 340 km, 345 km, 350 km, and 360 km orbital shells in its Gen2 application, as amended, and contemplated in the letters from NASA, NSF, and astronomers in 2022. SpaceX's authorization remains limited to 7,500 satellites in total, and our authorization for operations below 400 km is conditioned on SpaceX completing physical coordination with NASA, which will limit SpaceX's deployment at lower altitudes initially to 400 satellites. NSF also approves of this approach and notes that satellites at lower altitudes have less impact on optical astronomy.³³⁰ We find that these limitations, along with SpaceX's continued mitigation of satellite reflectivity, indicate the impact of these satellites, if any, will be small. As we stated in the *SpaceX Gen2 First Partial Grant*, SpaceX continues to make highly accurate satellite tracking data available to astronomers so they can avoid the Gen2 Starlink satellites in their images, and the Gen2 Starlink satellites still do not reflect sunlight during the darkest parts of the night due to their low altitudes.³³¹ We also commit to continuing to monitor the impact of SpaceX's satellites on optical astronomy and other science missions using the electromagnetic spectrum. We maintain the conditions on SpaceX's authorization requiring SpaceX to continue to coordinate and collaborate with NASA to promote a mutually beneficial space environment that would minimize impacts to NASA's science missions involving astronomy and to require SpaceX to coordinate with NSF to achieve a mutually acceptable coordination agreement to mitigate the impact of its satellites on optical ground-based astronomy. We also continue to require SpaceX to submit an annual report to the Commission, by January 1st each year, covering the preceding year and containing the following information: (1) whether it has reached a coordination agreement with NSF addressing optical astronomy; and (2) any steps SpaceX has taken to reduce the impact of its satellites on optical astronomy, including but not limited to darkening, deflecting light away from the Earth, attitude maneuvering, and provision of orbital information to astronomers for scheduling observations around satellites' locations.³³² SpaceX shall also provide a copy of the annual report to NTIA, NASA, and NSF.

81. We note that the Commission previously considered potential impacts of the Gen2

³²⁶ See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14930-31, para. 96; Report of Space Exploration Holdings LLC, ICFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105, Attachment 2 at 1-2 (filed Dec. 29, 2023).

³²⁷ See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14930-31, para. 96.

³²⁸ See *id.* Report of Space Exploration Holdings LLC, ICFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105, Attachment 2 at 1-2 (filed Dec. 29, 2023); SpaceX June 20, 2024 Response at 7-8.

³²⁹ See SpaceX June 20, 2024 Response at 7-8.

³³⁰ See NASA November 19, 2024 Letter; NTIA November 19, 2024 Letter.

³³¹ See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14930-31, para. 96.

³³² See Report of Space Exploration Holdings LLC, ICFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105 (filed Dec. 30, 2022); Report of Space Exploration Holdings LLC, ICFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105 (filed Dec. 29, 2023).

Starlink satellites on diffuse sky glow and thus the human environment, along with other potential impacts on the human environment, and concluded that any potential impact on diffuse sky glow was mitigated by SpaceX's improvements to satellite reflectivity and conditions adopted to require coordination with NSF and the astronomy community regarding satellite reflectivity.³³³ Given NSF's statement that satellites operating at lower altitudes are less likely to impact optical astronomy than satellites operating at higher altitudes,³³⁴ along with the Commission's prior conclusion that the conditions we adopt to reduce effects on astronomy services will also address other satellite sunlight reflectivity concerns involving the general public,³³⁵ we continue to find that the conditions on SpaceX's authorization are sufficient to alleviate these concerns. We also note that we are not authorizing SpaceX to deploy any additional satellites as part of today's authorization, and with the exception of areas where we have addressed substantive issues regarding operations at lower altitudes and imposed additional conditions today, our previous analysis regarding these issues remains unchanged.

H. Waiver Requests

82. SpaceX requested waiver of several Commission rules in the various requests and applications we are acting on today. In addition to the requests for waiver related to specific frequency bands discussed above, we address SpaceX's requests that apply across all of its applications.

83. Generally, the Commission may waive any rule for good cause shown.³³⁶ Waiver is appropriate only if both (1) special circumstances warrant a deviation from the general rule, and (2) such deviation better serves the public interest.³³⁷ In making this determination, we may take into account considerations of hardship, equity, or more effective implementation of overall policy on an individual

³³³ See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14944-45, para. 122-123. The Commission also addressed concerns that increased rocket launches of Gen2 Starlink satellites, increased risk of collisions in space or human casualty from satellites surviving reentry, and atmospheric effects from the ablation of reentering satellites may have a significant impact on the human environment. The Commission found that the Federal Aviation Administration had addressed any impacts from rocket launches, that our existing orbital debris mitigation requirements substantively addressed the concerns regarding collision and casualty risk, and that at the time the existing research did not support a conclusion that reentering satellites would have a harmful impact on the upper atmosphere. *Id.* at 14937-46, paras. 113-125. This partial grant does not increase the total number of satellites SpaceX is authorized to deploy, and so we find our previous analysis, which was upheld by the D.C. Circuit Court of Appeals, remains valid. *Id.*; see also *International Dark-Sky Association, Inc., v. FCC*, 106 F.4th at 1219-1220. Additionally, we continue to address any differences in SpaceX's operations at lower altitudes which could increase collisions in space, human casualty risk, and satellite reflectivity from its operations at higher altitudes through our existing orbital debris mitigation requirements and authority under the Communications Act to ensure authorizations for communications by radio serve the public interest, convenience, and necessity. Regarding satellite reentry, we note that SpaceX has not specified any changes to the expected five-year operational lifetimes for individual satellites across all operational altitudes. We take this opportunity to reiterate that SpaceX's authorization is conditioned on SpaceX following its commitment to work with the scientific community to explore methods to collect observational data on the formation of alumina from satellite reentry, implement reasonable methods that are discovered to the extent practicable, and report findings from these measurements to the Commission. Additionally, as part of our orbital debris reporting requirements, we require SpaceX to report the satellites that have reentered the atmosphere and whether they reentered the atmosphere less than five years after deployment. See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14952-53, para. 135y; *SpaceX E-band Partial Grant* at para. 22bbb. Based on these reports, we may seek additional information or apply additional conditions regarding this matter in the future.

³³⁴ NTIA November 19, 2024 Letter.

³³⁵ See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14944-45, para. 122-123.

³³⁶ 47 CFR § 1.3.

³³⁷ *NetworkIP, LLC v. FCC*, 548 F.3d 116, 125-128 (D.C. Cir. 2008) (citing *Northeast Cellular Telephone Co. v. FCC*, 897 F.2d 1164, 1166 (D.C. Cir. 1990)).

basis.³³⁸

84. We grant SpaceX's requests for waiver of the Commission's rules governing information to be submitted on the Commission's Schedule S form.³³⁹ As required by the Commission's rules,³⁴⁰ SpaceX has submitted with both its V-band modification application and its SCS amendment completed Schedule S forms, which contains certain technical information in a prescribed form, including orbital characteristics and frequency bands requested. However, SpaceX has found that it cannot accurately describe its system in certain respects due to limitations in Schedule S itself and the size of the constellation SpaceX seeks to describe on the form.³⁴¹ In its V-band modification application and SCS amendment, SpaceX cites five aspects of its operations that fall into this category: (1) the impracticability of submitting complete orbital parameter data for the Gen2 System using the Schedule S web form; (2) the inability to enter "not applicable" under the section 25.114(c)(4)(v) request for maximum and minimum Saturation Flux Density values, as this question only applies to "bent pipe" systems; (3) the inability to enter more than two digits for the active service arc end angle; (4) the inability to enter any channel plan other than a single, static channel plan; and (5) the impracticability of entering all possible contours for a representative satellite at all altitudes as contemplated by section 25.114(c)(4)(vi)(B).³⁴² For both applications, SpaceX has provided information on how it completed the Schedule S and additional information to compensate for these difficulties, as appropriate, including complete frequency use and orbital information for its constellation in separate databases, and SpaceX requests that we waive these aspects of Schedule S, to the extent necessary. We agree that given the scale of SpaceX's constellation, as well as the characteristics of its satellites, orbital information, and frequency use, SpaceX is not able to complete certain aspects of the Commission's Schedule S form. Consistent with prior authorizations of SpaceX's system, including the *SpaceX Gen2 First Partial Grant*,³⁴³ and because SpaceX has again implemented workarounds to provide the relevant information on its application, we find that a waiver of the requirement to complete certain aspects or fields of Schedule S is warranted and will serve the public interest.

IV. ORDERING CLAUSES

85. Accordingly, IT IS ORDERED, that the Gen2 Starlink Application, as amended, filed by Space Exploration Holdings, LLC (SpaceX), IS GRANTED-IN-PART and DEFERRED-IN-PART to the extent set forth above, pursuant to sections 0.51 and 0.261 of the Commission's rules, 47 CFR §§ 0.51 and 0.261, and section 309(a) of the Communications Act of 1934, as amended, 47 USC § 309(a).

86. IT IS FURTHER ORDERED that the SCS modification application, as amended, filed by Space Exploration Holdings, LLC (SpaceX), IS GRANTED-IN-PART and DEFERRED-IN-PART to the

³³⁸ *Northeast Cellular*, 897 F.2d at 1166 ("[A] waiver is appropriate only if special circumstances warrant a deviation from the general rule and such deviation will serve the public interest. The agency must explain why deviation better serves the public interest and articulate the nature of the special circumstances to prevent discriminatory application and to put future parties on notice as to its operation"); *WAIT Radio v. FCC*, 418 F.2d 1153, 1159 (D.C. Cir. 1969) ("The agency's discretion to proceed in difficult areas through general rules is intimately linked to the existence of a safety valve procedure for consideration of an application for exemption based on special circumstances.").

³³⁹ See SpaceX Second V-band Modification Application, Waiver Requests at 1; SpaceX SCS Amendment, Waiver Requests at 1-2.

³⁴⁰ See 47 CFR § 25.114(a)(1).

³⁴¹ See SpaceX Second V-band Modification Application, Waiver Requests at 1; SpaceX SCS Amendment, Waiver Requests at 1-2.

³⁴² See SpaceX Second V-band Modification Application, Waiver Request at 1-4; SpaceX SCS Amendment, Waiver Requests at 2-3.

³⁴³ See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14900-01, para. 25.

extent set forth above, pursuant to sections 0.51 and 0.261 of the Commission's rules, 47 CFR §§ 0.51 and 0.261, and section 309(a) of the Communications Act of 1934, as amended, 47 USC § 309(a).

87. IT IS FURTHER ORDERED that the V-band modification application filed by Space Exploration Holdings, LLC (SpaceX), IS GRANTED, pursuant to sections 0.51 and 0.261 of the Commission's rules, 47 CFR §§ 0.51 and 0.261, and section 309(a) of the Communications Act of 1934, as amended, 47 USC § 309(a).

88. IT IS FURTHER ORDERED that this authorization of SpaceX's Gen2 Starlink application, as amended, is subject to all requirements and conditions specified in prior orders, included below,³⁴⁴ as well as the new conditions specified at paragraphs 89a, vv, ww, xx, yy, zz, aaa, bbb, ccc, ddd, eee, fff, ggg, hhh, iii, jjj, kkk, lll, mmm, zzz, aaaa, cccc, and dddd and the modified conditions specified at paragraphs 89o, sss, ttt, yyy, and gggg.

89. IT IS FURTHER ORDERED that this authorization is subject to the following requirements and conditions:

a. SpaceX is authorized to construct, deploy, and operate up to 7,500 Gen2 Starlink satellites operating at altitudes of 340 km, 345 km, 350 km, 360 km, 525 km, 530 km, and 535 km. SpaceX may only continually operate the total number of satellites at altitudes of 340 km, 345 km, 350 km, and 360 km that SpaceX and NASA have coordinated pursuant to their Space Act Agreement. SpaceX must provide a certification of the completion of coordination of additional satellites with NASA to the Commission at least 30 days prior to the launch of the additional satellites.

b. SpaceX must timely provide the Commission with the information required for Advance Publication, Coordination, and Notification of the frequency assignment(s) for this constellation, including due diligence information, pursuant to Articles 9 and 11 of the ITU Radio Regulations. This authorization may be modified, without prior notice, consistent with the coordination of the frequency assignment(s) with other Administrations. *See* 47 CFR § 25.111(b). SpaceX is responsible for all cost-recovery fees associated with the ITU filings. 47 CFR § 25.111(d).

c. In connection with the provision of service in any particular country, SpaceX is obliged to comply with the applicable laws, regulations, rules, and licensing procedures of that country.

d. Operations in the 10.7-11.7 GHz (space-to-Earth) frequency band are authorized up to the applicable power flux-density limits in 47 CFR § 25.208(b), and up to the equivalent power flux-density requirements of Article 22 of the ITU Radio Regulations, as well as Resolution 76 (Rev. WRC-15) of the ITU Radio Regulations.

e. In the 10.7-11.7 GHz band, operations must be coordinated with the radio astronomy observatories listed in 47 CFR § 2.106(c)(131), to achieve a mutually acceptable agreement regarding the protection of the radio telescope facilities operating in the 10.6-10.7 GHz band. For the purposes of coordination with these listed facilities or the National Radio Quiet Zone, correspondence should be directed to the National Science Foundation Spectrum Management Unit (Email: esm@nsf.gov).

f. Operations in the 11.7-12.2 GHz (space-to-Earth) frequency band are authorized up to the power flux-density limits in Article 21 of the ITU Radio Regulations, and up to the equivalent power flux-density requirements of Article 22 of the ITU Radio Regulations, as well as Resolution 76 (Rev. WRC-15) of the ITU Radio Regulations.

³⁴⁴ We note that SpaceX has previously satisfied some of these conditions. We also note that our decision to specify all of the conditions included in the *SpaceX Gen2 First Partial Grant* in this authorization is without prejudice to the pending petitions for reconsideration and clarification on that order. *See* Petition for Reconsideration of LeoLabs, Inc., ICFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105 (filed Dec. 30, 2023); Petition for Clarification of Viasat, Inc., ICFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105 (filed Jan. 3, 2023).

g. Operations in the 12.2-12.7 GHz (space-to-Earth) frequency band are authorized up to the power flux-density limits in 47 CFR § 25.208(o) and Article 21 of the ITU Radio Regulations, and up to the equivalent power flux-density requirements of Article 22 of the ITU Radio Regulations, as well as Resolution 76 (Rev. WRC-15) of the ITU Radio Regulations.

h. Operations in the 12.2-12.7 GHz (space-to-Earth) frequency band are subject to the condition that SpaceX may not use more than one satellite beam from any of its authorized Gen2 Starlink satellites in the same frequency in the same or overlapping areas at a time.

i. Operations in the 12.75-13.25 GHz (Earth-to-space) frequency band must be in accordance with footnote 5.441 to the U.S. Table of Frequency Allocations, 47 CFR § 2.106(b)(5.441), which states that operations in this band are subject to application of the provisions of No. 9.12 for coordination with other non-geostationary-satellite systems in the fixed-satellite service. Non-geostationary-satellite systems in the fixed-satellite service shall not claim protection from geostationary-satellite networks in the fixed-satellite service operating in accordance with the Radio Regulations. Non-geostationary-satellite systems in the fixed-satellite service in the 12.75-13.25 GHz (Earth-to-space) frequency band shall be operated in such a way that any unacceptable interference that may occur during their operation shall be rapidly eliminated.

j. Operations of non-geostationary-satellite systems in the 12.75-13.25 GHz (Earth-to-space) frequency band with earth stations in the United States are restricted to individually licensed earth stations in accordance with footnote NG57 to the U.S. Table of Frequency Allocations, 47 CFR § 2.106(d)(57). Licensing of earth stations (i.e. filed after Sept. 19, 2022) for operations in the 12.75-13.25 GHz band will be subject to the filing freeze on applications for new or modified authorizations for use of the 12.7-13.25 GHz band. *See* Public Notice, DA 22-974 (released Sept. 19, 2022); *Expanding Use of the 12.7-13.25 GHz Band for Mobile Broadband or Other Expanded Use*, Notice of Inquiry and Order, GN Docket No. 22-352, FCC 22-80 (rel. Oct. 28, 2022).

k. In the 13.85-14.5 GHz (Earth-to-space) frequency band, reception is permitted for levels up to the equivalent power flux-density requirements of Article 22 of the ITU Radio Regulations.

l. SpaceX's operations in the 13.85-14.0 GHz band must comply with footnotes 5.502 and US356 to the International and United States Table of Frequency Allocations, 47 CFR § 2.106(b)(5.502), (c)(356).

m. In the 14.47-14.5 GHz band, operations are subject to footnote US342 to the U.S. Table of Frequency Allocations, 47 CFR § 2.106(c)(342), and all practicable steps must be taken to protect the radio astronomy service from harmful interference. Prior to commencing operations in the 14.47-14.5 GHz band, SpaceX must certify that it has updated its coordination agreement with the National Science Foundation to protect the radio astronomy service from harmful interference.

n. SpaceX's operations in the Ku-band are limited to minimum elevation angles of 25 degrees for all user terminals located below 62 degrees north latitude and minimum elevation angles of 5 degrees for user terminals located at or above 62 degrees north latitude.

o. Space-to-Earth operations in the 17.8-18.6 GHz, 18.8-19.3 GHz, and 19.7-20.2 GHz frequency bands must complete coordination with U.S. Federal systems, in accordance with footnote US334 to the United States Table of Frequency Allocations, 47 CFR § 2.106(c)(334), prior to being used. The use of space-to-Earth operations in the 17.8-18.6 GHz, 18.8-19.3 GHz, and 19.7-20.2 GHz bands must be in accordance with any signed coordination agreement between SpaceX and U.S. Federal operators. Two weeks prior to the start of any operations in the 17.8-18.6 GHz, 18.8-19.3 GHz, and 19.7-20.2 GHz bands, SpaceX must provide contact information for a 24/7 point of contact for the resolution of any harmful interference to Jimmy Nguyen, Email: Jimmy.Nguyen@us.af.mil, or alternate contact provided by the U.S. Air Force.

p. Operations in the 18.8-19.3 GHz (space-to-Earth) frequency band are authorized up to the power flux-density limits in Article 21 of the ITU Radio Regulations.

q. Operations in the 19.7-20.2 GHz frequency band are subject to the condition that SpaceX may not use more than one satellite beam from any of its authorized Gen2 Starlink satellites in the same frequency in the same or overlapping areas at a time.

r. In the 27.5-28.6 GHz and 29.5-30 GHz (Earth-to-space) frequency bands reception is permitted at levels up to the applicable equivalent power flux-density requirements of Article 22 of the ITU Radio Regulations.

s. Operations in the 27.5-28.35 GHz (Earth-to-space) frequency band are secondary with respect to Upper Microwave Flexible Use Service (UMFUS) operations, except for FSS operations associated with earth stations authorized pursuant to 47 CFR § 25.136.

t. Operations in the 28.35-28.6 GHz and 29.5-30 GHz (Earth-to-space) frequency bands are on a secondary basis with respect to GSO FSS operations.

u. Under 47 CFR § 25.146(a), SpaceX must receive a favorable or “qualified favorable” finding in accordance with Resolution 85 (WRC-03) with respect to its compliance with applicable equivalent power flux-density limits in Article 22 of the ITU Radio Regulations. SpaceX must communicate the ITU finding to the Commission, and in case of an unfavorable finding, SpaceX must adjust its operation to satisfy the ITU requirements. SpaceX must cooperate with other NGSO FSS operators in order to ensure that all authorized operations jointly comport with the applicable limits for aggregate equivalent power flux-density in the space-to-Earth direction contained in Article 22 of the ITU Radio Regulations, as well as Resolution 76 (WRC-03) of the ITU Radio Regulations.

v. SpaceX must make available to any requesting party the data used as input to the ITU-approved validation software to demonstrate compliance with applicable Equivalent Power Flux Density (EPFD) limits, including the data that combine the Gen2 Starlink satellites into one consolidated file.

w. SpaceX operations in the Ku- and Ka-band frequencies must comply with spectrum sharing procedures among NGSO FSS space stations specified in 47 CFR § 25.261 with respect to any NGSO system licensed or granted U.S. market access pursuant to the 2020 Ku/Ka-band processing round initiated in Public Notice DA 20-325. Spectrum sharing between SpaceX’s operations and operations of NGSO systems granted U.S. market access, where such operations do not include communications to or from the U.S. territory, are governed only by the ITU Radio Regulations and are not subject to section 25.261.

x. Prior to commencing operations in the Ku- and Ka-band frequency bands, SpaceX must certify that it has made a coordination agreement with, or make a showing to the Commission demonstrating and certifying that its operations at all authorized altitudes and inclinations will not cause harmful interference to, any operational system licensed or granted U.S. market access in the NGSO FSS processing rounds referred to in Public Notices DA 16-804, 31 FCC Rcd 7666 (IB 2016) and DA 17-524, 32 FCC Rcd 4180 (IB 2017). SpaceX may commence operations at its own risk, on a non-interference, unprotected basis with respect to any operations authorized in earlier processing rounds for which coordination has not been completed, prior to the approval of its showing by the Commission.

y. Operations in the 37.5-40.0 GHz band are unprotected with respect to the non-federal fixed and mobile services, except as authorized pursuant to 47 CFR § 25.136.

z. Operations in the 37.5-40.0 GHz band are authorized up to the power flux-density limits in 47 CFR § 25.208(r)(1). Prior to starting operation in this band, SpaceX must present the showing described in Section 25.114(c)(8) to confirm compliance with these power flux-density limits.

aa. Operations in the 37.5-38.0 GHz and 40.0-40.5 GHz bands must be successfully coordinated with Federal Space Research Service (SRS) facilities, pursuant to Recommendation ITU-R SA.1396, “Protection Criteria for the Space Research Service in the 37-38 GHz and 40.0-40.5 GHz Bands.”

bb. Operations in the 40-42 GHz band are authorized up to the power-flux density limits in

47 CFR § 25.208(s) and (t). We note that as part of the first modification to its original V-band authorization, SpaceX reduced its power flux density by 8 dB in the 40.0-42.0 GHz (space-to-earth) frequency band.³⁴⁵ Therefore, SpaceX must operate its system consistent with this reduced PFD in the 40.0-42.0 GHz band.

cc. In accordance with 47 CFR § 2.106(c)(211), SpaceX is urged to take all practicable steps to protect radio astronomy observations in the adjacent bands from harmful interference from its operations in the 40.5-42 GHz band.

dd. Operations in the 47.2-48.2 GHz band must provide interference protection to the fixed and mobile services, except as authorized pursuant to 47 CFR § 25.136.

ee. Any future grant of earth station licenses for operations with the SpaceX system will be subject to the following condition, unless the condition is satisfied prior to such license grant: in the 48.94-49.04 GHz band, operations must be coordinated with radio astronomy stations operating on a co-primary basis in this band. Operations in the 47.2-50.2 GHz band are subject to rules adopted in the *Spectrum Frontiers Proceeding*, GN Docket 14-177.

ff. In accordance with 47 CFR § 2.106(c)(342), SpaceX is urged to take all practicable steps to protect radio astronomy observations from harmful interference from its operations in the 48.94-49.04 GHz band.

gg. Unwanted earth station emissions into the 50.2-50.4 GHz band, as measured at the antenna port, must comport with either of the applicable limits contained in ITU-R Resolution 750 (REV. WRC-19):

- i. -42 dBW into the 200 MHz of the EESS (passive) band for earth stations not employing uplink power control, or
- ii. -42 dBW into the 200 MHz of the EESS (passive) band at zenith increasing to a maximum level of -35 dBW into the 200 MHz of the EESS (passive) band at a minimum elevation angle of 15° for earth stations employing uplink power control.

hh. Operations in the 50.4-51.4 GHz band (Earth-to-space) must provide interference protection to the fixed and mobile services, except for earth stations authorized pursuant to 47 CFR § 25.136.

ii. Operations in the 50.4-51.4 GHz band (Earth-to-space) must not cause unacceptable interference to, or claim protection from, a geostationary satellite orbit (GSO) fixed satellite service or GSO broadcast satellite service network. These operations must comply with ITU Radio Regulations Nos. 22.5L and 22.5M.

jj. We note that as part of the modification to its original V-band authorization, SpaceX reduced its equivalent isotropic radiated power (EIRP) in the 47.2-50.2 GHz and 50.4-51.4 GHz (Earth-to-space) frequency bands.³⁴⁶ Therefore, SpaceX must operate its system in accordance with this reduced EIRP in the 47.2-50.2 and 50.4-51.4 GHz bands.

kk. SpaceX may conduct operations in the 40.0-42.0 GHz (space-to-Earth) and 47.2-50.2 GHz and 50.4-51.4 GHz (Earth-to-space) frequency bands down to a minimum elevation angle of 25 degrees. SpaceX may conduct operations in the 37.5-40.0 GHz band (space-to-Earth) frequency band down to a minimum elevation angle of 35 degrees.

³⁴⁵ See Space Exploration Holdings, LLC, Application for Modification of the Authorization for the SpaceX V-band NGSO Satellite System, ICFS File No. SAT-MOD-20230322-00062, Legal Narrative at 10 (filed Mar. 22, 2023) (SpaceX First V-band Modification Application).

³⁴⁶ *Id.*

ll. SpaceX operations in V-band frequencies must comply with the spectrum sharing procedures among NGSO FSS space stations specified in 47 CFR § 25.261 with respect to any NGSO system licensed or granted U.S. market access pursuant to the processing round initiated in Public Notice, DA 16-1244. Spectrum sharing between SpaceX's operations and operations of NGSO systems granted U.S. market access, where such operations do not include communications to or from U.S. territory, are governed only by the ITU Radio Regulations and are not subject to Section 25.261.

mm. SpaceX operations in V-band frequencies shall not cause interference to, and shall not claim protection from, GSO networks operating in the FSS and BSS in accordance with Section 25.289 of the Commission's rules, 47 CFR § 25.289. In the event that relevant EPFD limits or procedures related to sharing between GSO and NGSO networks are adopted by the Commission or the ITU, operations must be in conformance with such limits and procedures.

nn. SpaceX must coordinate its proposed frequency use for operations in the 71.0-76.0 GHz (space-to-Earth) and 81.0-86.0 GHz (Earth-to-space) frequency bands with any existing U.S. licensees or U.S. market access grantees in the Fixed-Satellite Service whose facilities could be affected by SpaceX's E-band operations, in terms of frequency interference or restricted capacity, and SpaceX must cooperate fully with other future co-frequency Fixed-Satellite Service satellites or satellite systems in coordinating operations in these bands.

oo. SpaceX must comply with any sharing requirements adopted as part of a future E-band processing round that includes the 71.0-76.0 GHz and 81.0-86.0 GHz bands.

pp. Operations in the 71.0-76.0 GHz (space-to-Earth) and 81.0-86.0 GHz (Earth-to-space) frequency bands must comply with the default service rules in section 25.217 of the Commission's rules, 47 CFR § 25.217. Should the Commission develop service rules specific to these frequency bands, SpaceX must come into compliance with those rules.

qq. Prior to filing an application for a gateway earth station for operations in the 71.0-76.0 GHz and 81.0-86.0 GHz bands, SpaceX must complete coordination with Federal users and non-federal terrestrial licensees (47 CFR § 101.1523) in accordance with the provisions in 47 CFR § 25.203(c) for links registered or pending in the third-party database.

rr. In the 81.0-86.0 GHz band, operations must be coordinated with the radio astronomy observatories listed in 47 CFR § 2.106(c)(161).

ss. In the 81.0-86.0 GHz band, operations are subject to footnote US342 to the U.S. Table of Frequency Allocations, 47 CFR § 2.106(c)(342), and all practicable steps must be taken to protect the radio astronomy service from harmful interference. Prior to commencing operations in the 81.0-86.0 GHz band, SpaceX must certify that it has updated its coordination agreement with the National Science Foundation to protect the radio astronomy service from harmful interference.

tt. Prior to commencing operations of downlink and uplink operations in the 71.0-76.0 GHz and 81.0-86.0 GHz frequency bands, respectively, SpaceX must demonstrate compliance with operational conditions as prescribed and coordinated with NTIA and the U.S. Federal Fixed Satellite Service (FSS) systems. Downlink and uplink operations in the 71.0-76.0 GHz and 81.0-86.0 GHz frequency bands, respectively, must be in accordance with any signed coordination agreement between SpaceX and U.S. Federal FSS operators. Two weeks prior to the start of any operations in the 71.0-76.0 GHz and 81.0-86.0 GHz bands, SpaceX must provide contact information for a 24/7 point of contact for the resolution of any harmful interference to Jimmy Nguyen, Email: Jimmy.Nguyen@us.af.mil, or alternate contact provided by the U.S. Air Force.

uu. In the 86.0-92.0 GHz band, operations are subject to footnote US246 to the U.S. Table of Frequency Allocations, 47 CFR § 2.106(c)(246). Prior to commencing operations in the 81.0-86.0 GHz band, SpaceX must certify that it has a signed coordination agreement or agreements with U.S. federal operators utilizing the 86-92 GHz band for passive services.

vv. SpaceX's operations in the E-band are limited to minimum elevation angles of 25 degrees

for all gateway earth stations located below 62 degrees north latitude and minimum elevation angles of 5 degrees for user terminals located at or above 62 degrees north latitude.

ww. SpaceX is authorized to operate SCS in the following bands: 1910-1915 MHz (Earth-to-space) (in the United States) and 1990-1995 MHz (space-to-Earth) (in the United States). SpaceX is authorized to operate in the MSS for the purpose of direct-to-cell operations within the 1429-2690 MHz band (space-to-Earth and Earth-to-space) in the following sub-bands bands: 1475-1518 MHz, 1805-1880 MHz, 1930-2000 MHz, 2110-2180 MHz, 2180-2200 MHz, 2345-2360 MHz, and 2620-2690 MHz (space-to-Earth) (outside the United States only); and 1429-1470 MHz, 1710-1785 MHz, 1850-1920 MHz, 1920-1980 MHz, 2000-2020 MHz, 2305-2320 MHz, and 2500-2570 MHz (Earth-to-space) (outside the United States only).

xx. SCS operations in the 1910-1915 MHz (Earth-to-space) and 1990-1995 MHz (space-to-Earth) bands are allocated on a secondary basis in the U.S. Table of Allocations, 47 CFR § 2.106(a). Accordingly, SpaceX must accept harmful interference from and not cause harmful interference to any services, including Federal operations, operating on a primary basis in the 1910-1915 MHz and 1990-1995 MHz bands. *See* 47 CFR § 2.105(c)(2).

yy. When conducting direct-to-cell operations in the 1429-2690 MHz (space-to-Earth and Earth-to-space) band outside the United States, SpaceX shall not cause harmful interference to, and shall not claim protection from harmful interference caused by, a station operating in accordance with the provisions of the Constitution, the Convention, and the ITU Radio Regulations.³⁴⁷

zz. SpaceX's SCS operations in the 1910-1915 MHz and 1990-1995 MHz bands shall not cause harmful interference to other countries' operations and SpaceX must address and eliminate any harmful interference cases immediately. SpaceX must comply with all existing rules and limits in the 1910-1915 MHz and 1990-1995 MHz bands to protect incumbent users.

aaa. When conducting SCS operations outside the United States in the 1429-2690 MHz band, SpaceX shall operate in accordance with the cooperative arrangements with local terrestrial providers to protect services allocated under Safety-of-Life, Radio Astronomy, Space Research, Radionavigation Satellite, Aeronautical Radionavigation, Earth-Exploration Satellite, and Space Operations.

bbb. SpaceX shall only operate SCS in the 1910-1915 MHz (Earth-to-space) and 1990-1995 MHz (space-to-Earth) bands pursuant to the terms of its lease arrangement with T-Mobile.

ccc. SpaceX must cease SCS throughout the affected GIA and frequencies if SpaceX's lease with T-Mobile that allows for the use of the 1910-1915 MHz and 1990-1995 MHz bands terminates or if T-Mobile's underlying license(s) no longer covers the entire relevant GIA.

ddd. SpaceX's SCS operations must comply with the emission limitations set forth in section 25.202(k)(1) of the Commission's rules, 47 CFR § 25.202(k)(1).

eee. For operations in the 1910-1915 MHz and 1990-1995 MHz bands in the United States, SpaceX shall observe a maximum PFD based on the field strength limits identified in section 25.208(w) of the Commission's rules, 47 CFR § 25.208(w). SpaceX's SCS in the United States and direct-to-cell operations outside the United States remain subject to bilateral agreements that ensure terrestrial licensees meet a particular signal level limit at the relevant international border, including field strength and PFD limits, unless the relevant administrations agree to alternative limits along with, in some cases, a

³⁴⁷ *See* ITU Radio Regulation No. 4.4 (stating that “[a]dministrations of the Member States shall not assign to a station any frequency in derogation of either the Table of Frequency Allocations in this Chapter or the other provisions of these Regulations, except on the express condition that such a station, when using such a frequency assignment, shall not cause harmful interference to, and shall not claim protection from harmful interference caused by, a station operating in accordance with the provisions of the Constitution, the Convention and these Regulations”); *see also* SCS R&O, paras. 224-36.

coordination requirement for stations placed within a certain distance of the border.

fff. For SCS in the United States and direct-to-cell operations outside the United States, SpaceX may only operate on a non-harmful interference basis to cross-border operations. Under such circumstances, SpaceX may only exceed PFD limits where it has been authorized pursuant to an approval from the regulatory authority of the appropriate border country and after providing documentation of such approval to the Commission. Cross-border coordination and any negotiated technical parameters must be mutually acceptable to all involved, including U.S. counterpart agencies who oversee or regulate spectrum use in other countries.

ggg. For SCS within the United States and direct-to-cell operations outside the United States, SpaceX shall engage in coordination with in-band, out-of-band, and cross-border spectrum users.

hhh. For SCS operations in the United States, SpaceX shall ensure that all practicable steps shall be taken to protect the radio astronomy service from harmful interference.

iii. Prior to commencing SCS operations in the 1990-1995 MHz (space-to-Earth) and 1910-1915 MHz (Earth-to-space) bands, SpaceX must coordinate with NSF to ensure a mutually acceptable agreement to mitigate the impact of its satellites on ground-based radio, optical and infrared astronomy sites.³⁴⁸ This coordination shall include locations of earth stations to preferentially avoid key U.S. radio observatories, and SpaceX is encouraged to minimize the impact on astronomical laser closure windows (NSF ESM office: esm@nsf.gov).

jjj. Prior to conducting any direct-to-cell operations with earth stations outside the United States, SpaceX must ensure that all of its operations are duly authorized by the country in which such communications will occur, and that it will satisfy all terms and conditions of any foreign license or authorization, including but not limited to any transmit power, out of band emission, geographic, or other limits. Such operations must also be consistent with the parameters specified in SpaceX's ITU filings.

kkk. Prior to conducting any direct-to-cell operations with earth stations outside the United States, SpaceX must certify to the Space Bureau and OIA that it has obtained all necessary authorizations from the relevant country prior to initiation of communications with earth stations in that country. The certification must include steps that were taken to address harmful interference concerns and that provision of direct-to-cell will not result in harmful interference to operations that are in conformity with the ITU Radio Regulations in other countries. The certification must also be accompanied by a demonstration specifying the measures that SpaceX will take to eliminate any harmful interference immediately, in the event that it is notified of harmful interference resulting from such direct-to-cell operations. The Space Bureau and Office of International Affairs will review such certification and demonstration and will jointly notify SpaceX if such documentation is acceptable or if additional documentation is required.

lll. Prior to conducting space-to-Earth direct-to-cell operations in 2300-2395 MHz within radio line-of-sight of any NASA Deep Space Network facility outside the United States, SpaceX must certify to the Space Bureau that it has completed successful coordination with NASA.

mmm. SpaceX may only communicate with earth stations licensed by rule pursuant to section 25.115 of the Commission's rules, 47 CFR § 25.115. To be licensed by rule pursuant to 47 CFR § 25.115, a device, among other things, must meet all applicable equipment authorization or equipment certification requirements outlined in 47 CFR § 25.115 and part 2 of the Commission's rules. A device that does not have all applicable equipment authorizations or certifications, or loses such equipment authorizations or certifications, does not qualify as licensed by rule and cannot be communicated with for the purposes of SCS within the United States.

³⁴⁸ SpaceX also continues to be subject to the broader condition regarding coordination of its operations with NSF to address potential impacts to optical astronomy. See *infra* condition 89gggg.

nnn. Operations in the 137.0-138.0 MHz and 148.0-150.05 MHz bands are limited to telemetry, tracking, and command (TT&C) operations on no more than 450 satellites at any one time.

ooo. Operations in the 137.0-138.0 MHz and 148.0-150.05 MHz bands are limited to those earth stations coordinated with U.S. federal operators. SpaceX shall provide the FCC with an updated list of coordinated earth stations within ten business days following any changes to that list.³⁴⁹

ppp. SpaceX's operations in the 137.0-138.0 MHz and 148.0-150.05 MHz bands are subject to the same technical limitations as the operations of Swarm Technologies Inc.³⁵⁰ in these frequencies, except as further limited in this Order.

qqq. SpaceX's operations in the 137.0-138.0 MHz and 148.0-150.05 MHz bands are limited to channels centered at 137.055 MHz, 137.145 MHz, 137.8463 MHz, 137.8763 MHz, and 137.9663 MHz (space-to-Earth) and 148.2825 MHz, 148.3125 MHz, 148.3425 MHz, 148.3725 MHz, 148.4025 MHz, 148.4325 MHz, 148.4625 MHz, 148.4925 MHz, 148.5225 MHz, 148.5525 MHz, 148.6625 MHz, 148.6925 MHz, 148.7225 MHz, and 149.9250 MHz (Earth-to-space).

rrr. Operations in the 137.0-138.0 MHz band (earth-to-space) must conform to ITU-R Resolution 660 that states the power flux-density at any point on the earth's surface produced by a space station of NGSO systems used for short duration missions shall not exceed $-140 \text{ dB(W)/(m}^2 \cdot 4 \text{ kHz)}$

sss. During orbit-raising, including launch and early orbit phase operations, and deorbit of its satellites, SpaceX must operate on a non-harmful interference basis, *i.e.*, SpaceX must not cause harmful interference and must accept any interference received. In the event of any harmful interference under this grant, SpaceX must immediately cease operations upon notification of such interference and inform the Commission, in writing, of such an event. SpaceX must file a report with the Commission every thirty days including the total number of satellites currently conducting launch and early orbit phase operations, and the number of those satellites that are currently located below 400 km.

ttt. SpaceX must operate consistent with the technical specifications provided to the Commission, including any supplemental specifications, in connection with this application, as amended, for its Gen2 Starlink constellation, including operational altitude, antenna beam patterns; GSO avoidance angle; physical characteristics; frequencies used for satellite communications, including outside the United States; and other technical information. Should SpaceX wish to alter these technical specifications, it must apply for a license modification from the Commission, and SpaceX may not begin operations with modified parameters until such modification is granted.

uuu. SpaceX shall maintain full control of its satellites at all times and shall operate its satellites in accordance with any existing coordination agreements.

vvv. SpaceX must provide a semi-annual report, by January 1 and July 1 each year, covering the preceding six-month period, respectively, from June 1 to November 30 and December 1 to May 31. The report should include the following information:

- i. The number of conjunction events identified for Starlink satellites during the reporting period, and the number of events that resulted in an action (maneuver or coordination with another operator), as well as any difficulties encountered in connection with the collision avoidance process and any measures taken to address those difficulties.
- ii. Satellites that, for purposes of disposal, were removed from operation or screened from further deployment at any time following initial deployment, and identifying whether this

³⁴⁹ A list of earth stations already coordinated with federal agencies is attached as Appendix A to this grant.

³⁵⁰ See *Swarm Technologies, Inc., Application for Authority to Deploy and Operate a Non-Voice, Non-Geostationary Low-Earth Orbit Satellite System in the Mobile-Satellite Service*, Memorandum Opinion, Order and Authorization, 34 FCC Rcd 9469 (IB 2019).

occurred less than five years after the satellite began regular operations or were available for use as an on-orbit replacement satellite,

- iii. Satellites that re-entered the atmosphere,
- iv. Satellites for which there was a disposal failure, i.e., a satellite that loses the capability to maneuver effectively after being raised from its injection, including a discussion of any assessed cause of the failure and remedial actions. For each such satellite, SpaceX shall report an estimated orbital lifetime for the satellite following the failure, and for the Gen2 Starlink constellation the cumulative number of failed satellite object years,
- v. Identification of any collision avoidance system outages or unavailability, either on a system-wide basis or for individual satellites. An “outage” would include any individual satellite anomaly that results in a satellite not achieving targeted risk mitigation via maneuver.

www. In the event of satellite failures resulting in more than 100 post-failure object years, SpaceX may not deploy any additional satellites until the Commission has approved a license modification that includes an updated orbital debris mitigation plan addressing reduction in the failure rate or mitigation of the risk of satellite failures.

xxx. SpaceX must maintain satellite orbits so as to operate all of its satellites at or below 580 km.

yyy. SpaceX must communicate and collaborate with NASA to ensure that deployment and operation of its satellites does not unduly constrain deployment and operation of NASA assets and missions, supports safety of both SpaceX and NASA assets and missions, and preserves long-term sustainable space-based communications services.³⁵¹ SpaceX must report on the progress of its communications and collaboration efforts to the Commission in its regular reports specified in condition vvv.

zzz. SpaceX must operate in such a way as to minimize risk of collision with, and avoid operational constraints to, any inhabitable space stations, including the International Space Station.

aaaa. SpaceX must file a report to the Commission within ten days following the operation of any Gen2 Starlink satellites authorized for regular operations in the 340 km, 345 km, 350 km, and/or 360 km shells at or above 385 km for purposes other than transiting to a higher altitude. This report must include the satellite or satellites operating at or above 385 km, the reason for the operations at or above 385 km, and the duration of the operations at or above 385 km.

bbbb. SpaceX may not deploy any satellites authorized for its Gen2 system directly to their operational altitude.³⁵²

cccc. SpaceX must comply with Resolution 8 of WRC-23 and therefore must provide the Commission, by March 15, 2025, the required information for each deployed Gen2 Starlink satellite, identified by NORAD tracking number, for submission to the ITU.

dddd. In accordance with Resolution 8 of WRC-23, in order to count its satellites for the successive ITU milestones, SpaceX must maintain orbital tolerances of +/-30 km altitude and +/-2 degrees inclination.

eeee. Upon receipt of a conjunction warning from the 18th Space Control Squadron or other source, SpaceX must review and take all possible steps to assess the collision risk and mitigate collision

³⁵¹ See *SpaceX Gen2 First Partial Grant*, 37 FCC Rcd at 14952-53, para. 135bb. Language change from the initial ordering clause is to avoid any confusion with respect to FAA’s role in launch collision avoidance.

³⁵² See *id.* at 14927-28, para. 91.

risk if necessary. As appropriate, steps to assess and mitigate should include, but are not limited to: contacting the operator of any active spacecraft involved in such warning; sharing ephemeris data and other appropriate operational information with any such operator; modifying spacecraft attitude and/or operations.

ffff. SpaceX must continue to coordinate and collaborate with NASA to promote a mutually beneficial space environment that would minimize impacts to NASA's science missions involving astronomy.

gggg. SpaceX must coordinate with NSF to achieve a mutually acceptable agreement to mitigate the impact of its satellites on optical ground-based astronomy. SpaceX must submit an annual report to the Commission, by January 1st each year covering the preceding year containing the following information: (1) whether it has reached a coordination agreement with NSF addressing optical astronomy; and (2) any steps SpaceX has taken to reduce the impact of its satellites on optical astronomy, including but not limited to darkening, deflecting light away from the Earth, attitude maneuvering, and provision of orbital information to astronomers for scheduling observations around satellites' locations. SpaceX must also provide this report to NTIA, NASA, and NSF.

hhhh. SpaceX must follow its commitment to work with the scientific community to explore methods to collect observational data on formation of alumina from satellite reentry, to implement reasonable methods that are discovered to the extent practicable, and to report findings from these measurements taken to the Commission, as part of its annual report specified in condition gggg.

iiii. This authorization is subject to modification to bring it into conformance with any rules or policies adopted by the Commission in the future. Accordingly, any investments made toward SpaceX's Gen2 operations, including but not limited to any operations in bands authorized in this Order, assume the risk that operations may be subject to additional conditions or requirements as a result of any future Commission actions. This includes, but is not limited to, any conditions or requirements resulting from any action in the proceedings associated with IB Docket 22-271 and IB Docket 18-313,³⁵³ WT Docket 20-443,³⁵⁴ WT Docket 20-133,³⁵⁵ IB Docket 21-456,³⁵⁶ GN Docket 22-352,³⁵⁷ And GN Docket 23-65.³⁵⁸

jjjj. All operations of the Gen2 Starlink system must also comport with any additional terms and conditions contained in the *SpaceX Gen2 First Partial Grant*, the *SpaceX E-band Partial Grant*, the *SpaceX Gen2 Beacon Order*, the *SpaceX First V-band Modification Grant*, and the *SpaceX SCS*

³⁵³ See generally *Orbital Debris in the New Space Age, Report and Order and Further Notice of Proposed Rulemaking*, 35 FCC Rcd 4156 (2020); *Space Innovation; Mitigating Orbital Debris in the New Space Age*, Second Report and Order, FCC 22-74 (2022).

³⁵⁴ See generally *Expanding Flexible Use of the 12.2-12.7 GHz Band*, Notice of Proposed Rulemaking, 36 FCC Rcd 606 (2021).

³⁵⁵ See generally *Modernizing and Expanding Access to the 70/80/90 GHz bands, et al.*, Notice of Proposed Rulemaking, 35 FCC Rcd 6039 (2020).

³⁵⁶ See generally *Spectrum Sharing Rules for Non-Geostationary Orbit, Fixed-Satellite Service Systems; Revision of Section 25.261 of the Commission's Rules to Increase Certainty in Spectrum Sharing Obligations Among NGSO FSS Systems*, Order and Notice of Proposed Rulemaking, 36 FCC Rcd 17871 (2021).

³⁵⁷ See generally *Expanding Use of the 12.7-13.25 GHz Band for Mobile Broadband or Other Expanded Use*, Notice of Inquiry and Order, FCC 22-80 (rel. Oct. 28, 2022).

³⁵⁸ See generally *Single Network Future: Supplemental Coverage from Space*, Notice of Proposed Rulemaking, FCC 23-22 (Mar. 17, 2023).

*Modification Partial Grant.*³⁵⁹

90. IT IS FURTHER ORDERED that SpaceX is subject to the rules regarding the sharing of ephemeral data in section 25.146(e) of the Commission's rules, 47 CFR § 25.146(e).

91. IT IS FURTHER ORDERED that this authorization is also subject to the following requirements:

- a. Applicable to SpaceX Gen2 satellites:
 - i. SpaceX must post a surety bond in satisfaction of 47 CFR §§ 25.165(a)(1) & (b) no later than December 31, 2022,³⁶⁰ and thereafter maintain on file a surety bond requiring payment in the event of a default in an amount, at minimum, determined according to the formula set forth in 47 CFR § 25.165(a)(1); and
 - ii. SpaceX must launch 50% of the maximum number of proposed space stations, place them in the assigned orbits, and operate them in accordance with the station authorization no later than December 1, 2028, and SpaceX must launch the remaining space stations necessary to complete its authorized service constellation, place them in their assigned orbits, and operate each of them in accordance with the authorization no later than December 1, 2031. 47 CFR § 25.164(b).³⁶¹
- b. Applicable to SpaceX operations in the V-band³⁶²:
 - i. SpaceX must post a surety bond in satisfaction of 47 CFR §§ 25.165(a)(1) & (b) no later than December 19, 2018,³⁶³ and thereafter maintain on file a surety bond requiring payment in the event of a default in an amount, at minimum, determined according to the formula set forth in 47 CFR § 25.165(a)(1); and
 - ii. SpaceX must launch 50 percent of the maximum number of proposed space stations with V-band capabilities, place them in the assigned orbits, and operate them in accordance with this grant no later than November 19, 2024, and must launch the remaining space stations necessary to complete its authorized V-band system, place them in their assigned orbits, and operate them in accordance with the authorization no later than November 19, 2027. 47 CFR § 25.164(b).
- c. Failure to post and maintain a surety bond will render this grant null and void automatically, without further Commission action.
- d. Failure to meet the milestone requirements of 47 CFR § 25.164(b) may result in SpaceX's authorization being reduced to the number of satellites in use at the milestone date. Failure to comply with the milestone requirements of 47 CFR § 25.164(b) will also result in forfeiture

³⁵⁹ See generally *SpaceX Gen2 First Partial Grant*; *SpaceX E-band Partial Grant*; *SpaceX First V-band Modification Grant*; *SpaceX SCS Modification Partial Grant*.

³⁶⁰ SpaceX has satisfied this part of the condition by posting the surety bond for its Gen2 satellites operating in the Ku-, Ka-, and E-band frequencies. See *Bond of Space Exploration Holdings LLC*, ICFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105 (filed Dec. 30, 2022).

³⁶¹ We note that the *NGSO FSS Order* modified section 25.164(b) to offer additional flexibility and requires launch and operation of 50% of an authorized system within six years of grant and the remaining satellites within nine years of grant.

³⁶² See *SpaceX First V-band Modification Grant*. The separate milestones applicable to SpaceX's V-band operations are consistent with SpaceX's original V-band authorization.

³⁶³ SpaceX has satisfied this part of the condition by filing of its surety bond in accordance with the condition on its original V-band authorization on December 3, 2018. See *Bond of Space Exploration Holdings, LLC*, ICFS File No. SAT-LOA-20170301-00027 (filed Dec. 3, 2018).

of SpaceX's surety bond. SpaceX must either demonstrate compliance with each of the milestone requirements or notify the Commission in writing, within 15 days after the specified deadline, if the particular requirement was not met. 47 CFR § 25.164(f).

92. IT IS FURTHER ORDERED that SpaceX's requests for waiver of the Commission's rules due to various limitations in the Schedule S software ARE GRANTED.

93. IT IS FURTHER ORDERED that the request of SpaceX for a waiver of the U.S. Table of Frequency Allocations, section 2.106, for operation of gateway links in the Ka-band and E-band IS DISMISSED.

94. IT IS FURTHER ORDERED that the request of SpaceX for waivers of sections 25.112(a)(3) and 25.112(b), which provided that we dismiss applications that request authority to operate space stations in bands not allocated internationally for the requested operations, IS DISMISSED AS MOOT.

95. IT IS FURTHER ORDERED that the request of SpaceX for a waiver of section 25.202(k)(1), which establishes an OOBE limit for SCS, IS DEFERRED.

96. IT IS FURTHER ORDERED that the request of SpaceX for a waiver of the U.S. Table of Frequency Allocations, section 2.106, for operations in the 1910-1915 MHz and 1990-1995 MHz bands IS DISMISSED AS MOOT.

97. IT IS FURTHER ORDERED that the request of SpaceX for a waiver of the Commission's processing round rules, sections 25.156(d)(1) and 25.157, IS DISMISSED AS MOOT regarding the 1910-1915 MHz and 1990-1995 MHz bands.

98. IT IS FURTHER ORDERED that the request of SpaceX for a waiver of sections 25.102(a) and 25.115(a)(1)(i) regarding blanket earth station licensing IS DISMISSED AS MOOT.

99. IT IS FURTHER ORDERED that the Petition to Deny or Dismiss filed by DISH and the Informal Objection filed by Omnispace ARE DENIED.

100. IT IS FURTHER ORDERED that the Petition for Reconsideration filed by DISH IS DISMISSED AS MOOT.

101. IT IS FURTHER ORDERED that the Petition for a Protective Order filed by EchoStar is DISMISSED AS MOOT.

102. IT IS FURTHER ORDERED that the EchoStar Petition to Deny Amended Waiver Request and AT&T Petition to Deny ARE DEFERRED.

103. This grant is without prejudice to any future action taken in connection with the SpaceX Gen2 Starlink constellation, call signs S2992 and S3069.

104. This grant does not alter the license term for the SpaceX Starlink Gen2 satellite system.

FEDERAL COMMUNICATIONS COMMISSION

Julie M. Kearney
Chief
Space Bureau

APPENDIX A
List of Earth Stations Coordinated with Federal Operators

1. Sussex, NJ, Call Sign E190858
2. Wailuku, HI, Call Sign E190859
3. Piti, Guam, Call Sign E191406
4. Draper, UT, Call Sign E210061
5. Aasiaat, Greenland
6. Awarua, New Zealand
7. Azores, Portugal
8. Goonhilly, United Kingdom
9. Leeheim, Germany
10. Mauritius
11. St. Helena
12. Wagin, Australia
13. Yass, Australia