TABLE 1 TO § 180.960—Continued

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FEDERAL COMMUNICATIONS COMMISSION

47 CFR Part 25

[SB Docket No. 25–157; FCC 26–26; FR ID 345051]

Modernizing Spectrum Sharing for Satellite Broadband

AGENCY: Federal Communications Commission.

ACTION: Final rule.

SUMMARY: In this document, the Federal Communications Commission (Commission or we) adopts a Report and Order (Order) that revises the spectrum sharing framework for Geostationary Orbit (GSO) and Non-Geostationary Orbit (NGSO) systems that currently relies on NGSO systems complying with Equivalent Power Flux Density (EPFD) limits developed in the late-1990s. The consequence today of applying such EPFD limits in the United States is that operators must overprotect GSO systems, which in turn means that American households and businesses—most critically in rural and remote areas—do not receive the fastest space-based NGSO satellite broadband American innovation has available. Based on the technical record in this proceeding, the Order replaces the EPFD framework with modern, performance-based GSO protection criteria. The Order extends the Commission's framework for good-faith coordination and allow NGSO and GSO operators to bargain for appropriate interference protections through voluntary, private agreement. The Order further adopts technical backstops to protect GSO systems when coordination has not been reached.

DATES: These rules are effective July 13, 2026, except for the amendments to §§ 25.146(a)(3) (amendatory instruction 2) and 25.289(a)(2) (amendatory instruction 4), which are indefinitely delayed. The Commission will publish a document in the **Federal Register** announcing the effective date of these rule sections.

The incorporation of reference of certain material listed in this rule was approved by the Director of the Federal Register as of January 17, 2018.

FOR FURTHER INFORMATION CONTACT: Clay DeCell, Attorney Advisor, Satellite Programs and Policy Division, Space Bureau, at *clay.decell@fcc.gov* or at (202) 418–0803.

SUPPLEMENTARY INFORMATION: This is a summary of the Commission's Order, FCC 26–26, adopted April 30, 2026, and released May 1, 2026. The document is available for public inspection online at *https://docs.fcc.gov/public/attachments/FCC-26-26A1.pdf.* The document is also available for inspection and copying during business hours in the FCC Reference Center, 45 L Street NE, Washington, DC 20554. To request materials in accessible formats for people with disabilities, send an email to *FCC504@fcc.gov* or call the Consumer & Governmental Affairs Bureau at 202–418–0530 (voice), 202–418–0432 (TTY). ITU Regulations Article 22, Section II is referenced in the amendatory text of this document and was previously approved for 25.289.

Final Regulatory Flexibility Analysis

The Regulatory Flexibility Act of 1980, as amended (RFA), requires that an agency prepare a regulatory flexibility analysis for notice and comment rulemakings, unless the agency certifies that ''the rule will not, if promulgated, have a significant economic impact on a substantial number of small entities.'' Accordingly, the Commission has prepared a Final Regulatory Flexibility Analysis (FRFA) concerning the possible impact of the rule and policy changes contained in the Order on small entities. The FRFA is set forth in Section IV below.

Final Paperwork Reduction Act Analysis

The Order contains modified information collection requirements subject to the Paperwork Reduction Act of 1995 (PRA), Public Law 104–13. It will be submitted to the Office of Management and Budget (OMB) for review under Section 3507(d) of the PRA. OMB, other Federal agencies, and the general public are invited to comment on the modified information collection requirements contained in this document.

In the Order, we have assessed the effects of providing NGSO satellite system applicants an alternative to certifying compliance with EPFD limits in the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands for operations in the United States, by instead demonstrating that they will comply with certain GSO satellite network protection criteria. We find that doing so will serve the public interest and is unlikely to directly affect businesses with fewer than 25 employees.

Congressional Review Act

The Commission has determined, and the Administrator of the Office of Information and Regulatory Affairs, Office of Management and Budget, concurs that this rule is major under the Congressional Review Act, 5 U.S.C. 804(2). The Commission will send a copy of this Report and Order to Congress and the Government Accountability Office pursuant to the Congressional Review Act, see 5 U.S.C. 801(a)(1)(A).

Synopsis

I. Introduction

1. As satellite broadband rapidly matures into an integral and integrated communications technology, the Commission must aggressively update its rules to ensure Americans reap the abundance of innovation and investment by the space industry. In the Order, we revise the decades-old framework for how GSO and NGSO systems share spectrum. Our legacy rules have significantly limited the ability of operators to deliver high-speed, low-latency broadband services to consumers. Until now, NGSO operators' power levels have been restricted by EPFD limits developed in the late-1990s to protect GSO satellites. Such EPFD limits were based on theoretical designs for NGSO systems of that era, long before modern advancements were developed for the NGSO constellations currently in orbit. The consequence today of applying such EPFD limits in the United States is that operators must overprotect GSO systems. The cost of this government-imposed overprotection is that American households and businesses—most critically in rural and remote areas—do not receive the fastest space-based broadband American innovation has available.

2. The benefits of our changes today may total well over $2 billion, with capacity increases of 100% to 700% possible using the same number of in-orbit NGSO satellites. Allowing for more intensive spectrum use brings satellite broadband providers closer to the milestone of delivering *gigabit* service from space—a feat unimaginable only a few years ago. Such capability will bring greater competition to the broadband marketplace as space-based connectivity reaches speeds and latency similar to that of terrestrial fiber. And by reducing the number of satellites required to cover an area with a given capacity, our new framework will allow for lower unit costs to serve a geographic area, which in turn can reduce the price of broadband to consumers. In short, by removing an enormous regulatory constraint on NGSO systems, the Commission takes another step to unleash the American space industry to deliver for consumers.

3. Specifically, in the Order, we replace the EPFD framework with modern, performance-based GSO protection criteria that take account of the improved spectrum sharing possibilities that modern satellite technology has brought, including through use of adaptive coding and modulation (ACM). As the cornerstone of our new sharing regime, we extend our time-tested framework for good-faith coordination and allow NGSO and GSO operators to bargain for appropriate interference protections through voluntary, private agreement. We adopt the following technical backstops to protect GSO systems when coordination has not been reached:

- A long-term protection criterion of 3% time-weighted average throughput degradation for GSO satellite links using ACM;
- A short-term protection criterion of 0.1% absolute increase in link unavailability;
- A supplemental protection criterion of −10.5 dB interference-to-noise (I/N) for 80% of the time for GSO satellite links that do not use ACM, such as point-to-multipoint video transmissions; and
- A supplemental protection requirement for NGSO systems to observe a minimum 3-degree avoidance angle of the GSO arc.

4. Having taken a fresh look at today's satellite technology and operations, these new rules will promote more efficient and effective use of the shared spectrum, and support a more competitive market for satellite broadband and other in-demand services.

II. Background

5. *Overview.* The American space sector is booming. In the past few years alone, thousands of broadband-capable satellites have been launched into low-Earth orbit (LEO), connecting Americans with low-latency, high-speed services heretofore unavailable in many rural and underserved areas of the United States. By one estimate, the supply of high-throughput satellite capacity tripled between 2021 and 2023, with NGSO satellites accounting for over 90% of the net supply during that period, and projected to account for 97% of the increase in supply from 2023 to 2028. At the same time, GSO satellite operators have continued to deploy powerful, new satellites with enhanced capabilities. The space sector is helping bridge the digital divide.

6. These broadband satellite services rely on shared spectrum. In the most commonly used frequency bands, between 10.7 GHz and 30 GHz, NGSO systems share primary fixed-satellite service (FSS) allocations with GSO networks, and must also operate compatibly with broadcasting-satellite service (BSS) networks and stations in other services, including terrestrial services. NGSO FSS systems must comply with power limits expressed in EPFD to demonstrate that they meet their broader obligation not to cause unacceptable interference to GSO FSS and BSS networks. NGSO FSS systems must also meet separate power limits expressed in power-flux density (PFD) to protect terrestrial services. Within the 10.7–30 GHz range, EPFD downlink limits apply in the 10.7–12.7 GHz, 17.3–18.6 GHz, and 19.7–20.2 GHz bands in the United States. Applicants for NGSO FSS space station licenses, and non-U.S.-licensed satellite operators seeking access to the U.S. market, must certify that they will comply with the specified EPFD limits.

7. *EPFD History.* As reviewed in the *NPRM,* the current EPFD limits were developed in the late 1990s for the protection of GSO networks from then-proposed NGSO systems. They were adopted by the international community at the International Telecommunication Union's (ITU) World Radiocommunication Conference (WRC) in 2000, and subsequently incorporated into the Commission's rules. In 2019, the international community again considered sharing criteria among GSO and NGSO FSS systems, this time in the higher Q- and V-bands between 37.5 GHz and 51.4 GHz. WRC–19 did not adopt EPFD limits in these bands. Instead, given the expected use of ACM by GSO networks in these bands, it required NGSO FSS systems to meet certain long-term and short-term GSO protection criteria that incorporate a degraded throughput methodology.

8. *Current ITU Work.* WRC–23 considered a proposal from the Inter-American Telecommunication Commission (CITEL) co-signed by ten member states, including the United States, to review the EPFD limits under a future agenda item for WRC–27. While the proposed agenda item was not adopted, WRC–23 invited ITU–R to conduct technical studies on the EPFD limits and to inform WRC–27 of the results of the studies, without any regulatory consequences. These studies are being carried out in ITU–R Working Party (WP) 4A.

9. *Waivers.* On January 9, 2026, the Space Bureau granted SpaceX a waiver of the EPFD limits in the United States to operate pursuant to its satellite configuration used during real-world testing of an Nco of 8 and a GSO-arc avoidance angle of 4 degrees. On February 20, 2026, the Space Bureau granted Amazon a similar waiver for its NGSO system.

10. *NPRM.* On April 28, 2025, the Commission launched this proceeding by granting a SpaceX petition for rulemaking to review the decades-old spectrum sharing regime between GSO and NGSO systems in downlink frequency bands between 10.7 GHz and 30 GHz that are subject to EPFD limits, and to amend §§ 25.146 and 25.289 of the Commission's rules. The *NPRM* sought to develop a substantial technical record concerning modern and efficient spectrum sharing among NGSO FSS systems and GSO FSS and BSS networks in the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands, while ensuring that any rule changes do not affect the continued protection of other services. In response to the *NPRM,* 38 comments, 23 reply comments, and numerous *ex parte* presentations were filed.

III. Discussion

11. The voluminous record in this proceeding includes rarely available, real-world testing data assessing the impact of EPFD exceedances on operational GSO networks, along with technical and economic analyses and other comments. Based on this record, we conclude that technological advancements in the past three decades and the inherent issues in the EPFD limits themselves warrant the establishment of a new, performance-based spectrum sharing framework between GSO and NGSO systems in the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands. Leveraging the latest

satellite technology, the U.S. space industry can make better use of spectrum resources to substantially expand and improve the broadband services available in the United States, thereby furthering ''the policy of the United States to encourage the provision of new technologies and services to the public.''

12. As described below, we expect the modernized NGSO–GSO sharing framework to result in substantial benefits for American consumers, by enabling new NGSO systems to use more satellites to serve the same area, at potentially higher power, and over a wider portion of the visible sky. For example, when an NGSO system can employ eight satellites to provide service simultaneously in a given geographic area and frequency band, instead of being effectively limited to one satellite under current EPFD limits, and while continuing to protect GSO networks as supported by real-world testing, it immediately boosts capacity, which translates to faster broadband speeds for American consumers. Increasing the capacity available to any location can improve quality of service or allow competitors to provide the same quality of service with a smaller constellation, which could potentially lower prices to consumers. Expanded, low-latency satellite broadband at lower cost may also increase competition for broadband services in new areas, including some urban areas where prior satellite capacity constraints may have bounded consumers' willingness to switch. This, in turn, results in greater societal welfare benefits, with one study estimating welfare to increase by between $10 billion and $100 billion globally if EPFD limits were widely replaced.

13. We replace the outdated and wooden EPFD limitations with a modern framework that gives NGSO and GSO operators the flexibility to reach protection criteria through good-faith coordination. It is at once a fundamental change in regulatory design, but at the same time consistent with the primacy we place on good-faith coordination across many other contexts. As the Commission has emphasized, private coordination among satellite operators, based on real-world operating parameters, offers the best opportunity for efficient spectrum sharing. The current EPFD limits do not accommodate such coordination because they must be met regardless of any agreements between particular NGSO and GSO satellite operators. Our approach not only encourages good-faith coordination efforts; it requires them. And the new, performance-based protection criteria focus on what matters (*i.e.,* delivered service), allowing innovation in NGSO system designs which respect the new limits. Whereas EPFD limits categorically restricted an input, the approach we adopt today gives parties the flexibility to negotiate a more efficient outcome.

14. As a backstop to good-faith coordination, we adopt GSO protection criteria that take account of the improved spectrum sharing possibilities that modern satellite technology has brought, including through use of ACM. Specifically, we require NGSO satellites transmitting in the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands to protect co-frequency GSO networks using a long-term protection criterion of 3% time-weighted average throughput degradation. We adopt a short-term GSO protection criterion of 0.1% absolute increase in link unavailability. For GSO satellite links that do not use ACM, we adopt a long-term protection criterion of −10.5 dB I/N for 80% of the time. As an additional measure of protection for GSO networks, we require NGSO systems to observe a minimum 3-degree avoidance angle of the GSO arc. We decline to establish aggregate limits or other limits on NGSO systems at this time. These new backstop provisions will ensure that NGSO broadband services can reap the benefits of significantly more efficient spectrum sharing while ensuring that NGSO systems continue not to cause ''unacceptable interference'' to GSO FSS and BSS networks.

15. Below, we outline the public-interest benefits of our decision, based on the extensive record in this proceeding. We then explain why the purported costs of modernizing our sharing rules are overstated, speculative, and, in any case, mitigated by the suite of additional protections we adopt today. Finally, we resolve assorted issues of implementation and compliance.

A. Benefits of Modernized Sharing Rules

16. Dramatically boosting the capacity of NGSO broadband systems serves the public interest. Adding more system capacity is the most impactful way for NGSO operators to address their most acute and recurring technical challenge: providing 5G-quality data rates to a growing number of users during periods of peak congestion, without sacrificing on signal reliability. Enabling that level of performance makes satellite broadband a more compelling alternative for consumers in areas with limited competitive options. And it lowers barriers to entry and potentially stranded investments by reducing the need for new satellite launches and expensive infrastructure builds.

17. The record unambiguously demonstrates that legacy EPFD restrictions present perhaps the largest regulatory constraint on NGSO systems to deliver more capacity to consumers. As discussed below, we find that modernizing our NGSO–GSO sharing framework to boost NGSO capacity and reduce the necessary size of NGSO constellations will bring substantial public-interest benefits. We also note the broader macroeconomic benefits across America. One study, for example, has indicated that increases in NGSO system capacity of 74% to 180% could reduce average costs per unit of capacity of between 43% and 64%. The study further estimated increases in consumer welfare ranging from 11%, given a 10% reduction in price and a 25% increase in capacity, to 113%, assuming a 50% reduction in price and a 250% increase in capacity. And if revisions to the EPFD regime were adopted globally, they could result in welfare benefits to all customers ranging from $10 billion to $100 billion.

1. Boosting Capacity and Speeds

18. The ability of surging NGSO satellite deployments to meet the needs of Americans on the wrong side of the digital divide is limited by the design and operational restrictions placed on NGSO systems by the need to comply with EPFD limits. To meet these limits, NGSO operators have three primary strategies. First, NGSO operators limit the number of satellite beams that can serve any given location simultaneously using the same frequencies (*i.e.,* the number of co-frequency beams or Nco), limiting spectrum reuse and capacity. Second, NGSO operators implement wide ''avoidance angles'' of the GSO arc, which restrict satellites from transmitting when they are within a certain-degree separation from the transmission path of a GSO satellite. This technique increases the number of satellites NGSO operators need to provide full coverage and causes less efficient rerouting of network paths, which further reduces performance and increases latency. Third, NGSO operators reduce their power levels even outside the GSO-arc avoidance angle to ensure off-axis emissions remain below the EPFD limit, with lower power levels reducing data rates and leading to less robust connectivity for end users. In total, compliance with the current EPFD limits directly degrades the efficiency of spectrum use by NGSO systems.

19. The EPFD limits are coupled with the ITU's software and methodology for assessing compliance with those limits,

which can further restrict real-world NGSO operations. For example, the ITU software considers a relatively sensitive reference antenna pattern for GSO earth stations, resulting in a greater calculated EPFD into GSO earth stations and therefore greater restrictions on NGSO operations to fall below the EPFD limits as calculated with reference to this antenna pattern. In addition, the ITU software uses a worst-case geometry selection algorithm when choosing among available NGSO satellites to transmit to a given location. This assumes that the NGSO operator will always select the satellite with the worst-case geometry (often, the satellite closest to the GSO arc), although it is unlikely that an operator would rely on such an algorithm to conduct actual operations. Rather, satellite operators rely on a complex, global resource management system for assigning satellite capacity to their customers. In total, according to one study, the assumed EPFD of an NGSO system was substantially below the maximum allowed EPFD in Ka-band at almost all points when using the ITU methodology, and up to 30 dB below the limits for short-term interference in the upper portion of the Ka-band specifically. By restricting EPFD below even the limits themselves, NGSO capacity, coverage, and service are further reduced. Beyond stating that EPFD limits rely on conservative or disputed assumptions, commenters also argue the current ITU process invites ''regulatory gamesmanship.''

20. In contrast to legacy EPFD regulations, the record demonstrates substantial potential for enhanced NGSO service offerings under a modernized NGSO–GSO sharing framework. Analyses for current and planned Ku-band and Ka-band NGSO systems indicate that modernized sharing rules could deliver increases in NGSO system capacity of 100% to 700% in a given area in the United States, because NGSO operators would be able to increase the number of satellites operating simultaneously in a given area and a given frequency band from one to as many as eight. At the same time, a reduction in the GSO-arc avoidance angle would increase the number of satellites available to serve an earth station location and thereby increase coverage, potentially reducing the size and cost of NGSO systems.

a. Real-World Measurement Campaigns

21. This rulemaking has benefitted from rarely available, real-world measurement campaigns, which assessed the impact of the SpaceX Starlink NGSO system in different operational configurations on typical GSO network mass-market terminals. These real-world test results demonstrate the potential for enhanced NGSO operations, in excess of current EPFD limits, and the resulting impacts on typical GSO service links.

22. In one set of testing, SpaceX operated the Starlink system with GSO-arc avoidance angles resembling typical GSO separation arcs in Ku-band and Ka-band, *e.g.,* 2, 3, 4 and 6 degrees. The test setup included a high-precision spectrum analyzer connected to a mass-market GSO terminal from a major GSO operator. The average de-sense to the GSO link resulting from eight co-frequency beams with an avoidance angle of 4 degrees from the GSO arc was less than 0.1 dB, which translates to a degraded throughput of less than approximately 0.7%. In another set of testing, using a different location and GSO network, SpaceX demonstrated that, for the Starlink system similarly configured to use eight co-frequency beams and a 4-degree GSO-arc avoidance angle, the long-term de-sense of the GSO link was negligible and the increase in short-term link unavailability was approximately 0.05%. In two other sets of testing, with different locations and GSO networks, operating the Starlink system with up to eight co-frequency beams and a 4- or 4.5-degree GSO-arc avoidance angle similarly showed minimal long-term signal de-sense (and associated degraded throughput) to the GSO links. And a fifth set of testing provided similar results. Further, the increase in absolute unavailability in a test using a very small, 35 cm user terminal was 0.0005%. Notably, SpaceX has conducted measurements in Jordan with a GSO-arc avoidance angle of 3 degrees and an Nco of 6 for a 60 cm earth station receiving antenna. The average co-polarized de-sense from this test was approximately 0.17 dB, which corresponds to an I/N of approximately −13.9 dB.

23. The results of these five extensive, months-long test campaigns offer direct, real-world evidence that a currently operating NGSO system could, in comparison with its configuration needed to meet current EPFD limits, increase by 700% its number of satellites (*i.e.,* from 1 satellite to 8 satellites) operating simultaneously co-frequency in the same area while reducing its GSO-arc avoidance angle by 60%—from 10 degrees to 4 degrees—with resultant effects on typical GSO networks of less than 3% degraded throughput and 0.1% absolute increase in unavailability. While commenters note certain limitations of the SpaceX real-world testing—that it was only conducted in the Ku-band; that it does not reflect year-long rain fade effects; and that tested interference to a GSO earth station located in the center of the GSO beam, where the desired signal is strongest, would be lower than the interference to a GSO earth station located at the edge of the GSO beam, where the desired signal is weakest—no other commenter has presented alternative interference measurements on the record for consideration.

b. Simulations

24. Technical studies containing simulations further support the conclusion that NGSO systems could significantly improve capacity and coverage with limited effects on GSO networks. In one scenario analyzed for the Amazon system, for example, the NGSO system could operate at increased power levels, reduce its GSO-arc avoidance angle from 18 degrees to 3 degrees, and operate at an Nco of 4 (quadrupling its capacity in any given area), and the largest increase in unavailability for all ten studied GSO links would be 0.000000073%. The largest decrease in throughput was 1.27% for a customer terminal, with half of the ten links studied showing a decrease of 0.00956% or less. In another scenario analyzed for the Amazon system, the NGSO system could maintain its lower power level, reduce its GSO-arc avoidance angle to 2 degrees, and operate at an Nco of 8 (octupling the capacity), and the largest increase in unavailability would be 0.000001756%. At most, Amazon estimated GSO operators would experience a loss of 2.72% in throughput, with half of the ten links studied showing a throughput decrease of 0.175% or less. For SpaceX's Starlink, simulations of interference from the NGSO system into a 46 cm Ku-band user terminal in Oregon showed an absolute increase in unavailability of 0.0047%, assuming an Nco of 15 and a GSO-arc avoidance angle of 18 degrees, and a 0.0251% increase if the avoidance angle were reduced to 4 degrees. Another simulation attempted to replicate the results of the SpaceX real-world testing in Bogota, Colombia and found compliance with a 0.1% absolute increase in unavailability limit.

25. Simulations on the record assessing the capacity gains of degraded throughput rely on varying assumptions, which we examine later from a GSO coexistence perspective. For present purposes, the simulations presented support the conclusion that the EPFD limits greatly constrain NGSO capacity. We disagree with suggestions

that the combined record of rarely available, real-world measurement data and numerous simulations is an insufficient technical basis on which to adopt a degraded throughput methodology aligned with the Commission's NGSO–NGSO sharing framework and the international NGSO–GSO sharing framework in Q- and V-bands. As the studies show, even a simple change of Nco from one to two could double the capacity available in a given area, while meeting GSO protection criteria proposed on the record.

2. Connecting the Unconnected

26. Satellite connections have long been a lifeline for Americans in rural and remote areas, where rugged terrain, sparse population, and economic realities have often kept terrestrial networks out of reach. Today, satellites are an increasingly powerful tool in the combined efforts to close the digital divide. The Federal Government has directed billions in funding for broadband deployment and adoption, culminating in the $65 billion investment in the 2021 Bipartisan Infrastructure Law. Yet, in 2024, more than one third of Americans had only one provider of high-speed broadband or lacked access altogether.

27. This rulemaking has benefitted from the views and experiences of Americans living and working in rural and underserved areas, and those who advocate on their behalf, on the impact that modernization of the NGSO–GSO sharing framework could have for Americans on the wrong side of the digital divide. These citizens and non-profits note that in their communities, as in many rural areas, NGSO FSS satellites may offer the only viable broadband solution, enabling access to telehealth services, remote learning, digital job training, remote work opportunities, and emergency communications. These commenters argue that modernizing the NGSO–GSO sharing framework will enable NGSO providers to expand capacity, increase speeds, and improve service reliability, which are ''transformational improvements for the communities we serve.'' Rural voices on the record uniformly urge us to update the NGSO–GSO spectrum sharing rules, without delay.

28. NGSO satellite operators are investing heavily as uptake grows, and the potential for low-latency, gigabit satellite broadband is on the horizon. High-throughput satellite capacity has been forecast to grow nine-fold between 2023 and 2028, with NGSO constellations driving 97% of the net increase. And new NGSO satellite capacity is already being put to significant use—not only offering high-speed, low-latency broadband in rural areas, but also supporting critical industries, from aviation and shipping to manufacturing and agriculture, and providing network resiliency, delivering robust connectivity capable of supporting life-saving real-time communications. Yet supply constraints remain. It is imperative that we look at new ways to leverage the exploding growth of NGSO systems to aid the combined effort to expand access and competition in broadband and other services in the United States—starting with the most constraining regulatory requirement on NGSO broadband systems today.

3. Fostering New Competitive Entry

29. Modernizing the NGSO–GSO sharing regime would also bring particular benefits for new entrant LEO-satellite systems. With greater operational flexibility under revised sharing rules, new LEO systems would need smaller constellations and still have greater capacity to reach more customers, which would reflect a substantial reduction in launch costs, satellite costs, and costs of a new LEO constellation. For example, one analysis indicates that a constellation that would require 462 LEO satellites under existing EPFD rules to have a certain coverage could obtain the same coverage with updated rules with only 360 satellites. ICLE argues the EPFD limits impose ''significant market distortions'' that ''translate directly into higher costs per unit of capacity delivered to consumers, as operators must deploy more satellites and infrastructure to achieve the same service levels.'' Lower costs from a revised NGSO–GSO sharing framework would encourage new entry as well as lower prices for customers. In addition, greater capacity would make LEO broadband more competitive vis-à-vis fixed broadband and bring greater choice to consumers.

4. Maximizing Efficient Spectrum Use

30. In modernizing the spectrum sharing framework between GSO and NGSO satellite systems, we seek to achieve abundance and reject technically unnecessary restrictions borne from a zero-sum mindset. We are guided by the Commission's policy statement on spectrum management in doing so. This policy, when applied to the current rulemaking, favors efficiency over absolute protection guarantees. As most pertinent to this rulemaking, the Commission noted that:

- The electromagnetic environment is highly variable, and zero risk of occasional service degradation or interruption cannot be guaranteed.
- Services should plan for the spectrum environment in which they intend to operate, the service they intend to provide, and the characteristics of spectrally and spatially proximate operations. Planning should be ongoing and account for changes in spectrum operating environments.
- Radio transmitter and receiver system operators and equipment manufacturers should plan for and design error tolerant systems, using good engineering practices, to mitigate degradation from interference.
- Quantitative analyses of interactions between services that are fact-and evidence-based, sufficiently robust, transparent, and reproducible are needed to better inform spectrum management decision-making.

31. Our decision making in this proceeding squarely aligns with these principles and is supported by the best-available, real-world data presented in the record as set forth below. Further, when considering more intensive use of spectrum for new and innovative services, we are acutely aware that ''[a] uniform or absolute expectation of service availability could preclude the introduction of valuable new services in the RF [radiofrequency] environment and undermine the efficient use of spectrum resources.'' And we continue to expect proponents of interference claims ''to supply sufficiently complete, transparent, and reproducible quantitative analytical models of the interactions between radio services, with respect to transmitter and receiver performance characteristics and the RF environment.''

32. Even when considered in their own right, the current EPFD limits have raised significant concerns as to whether they constitute an efficient spectrum sharing regime for GSO and NGSO systems in the 10.7–12.7 GHz, 17.3–18.6 GHz, and 19.7–20.2 GHz bands. Most starkly, the differing treatment of Ka-band frequencies—where the EPFD limit in the upper portion of the band is substantially more restrictive than the EPFD limit in the lower portion of the band—is widely criticized in the record as technically unjustified. In addition, the overall methodology used to derive the current EPFD limits has been called into question, including the use of methodologies designed to address short-term interference to develop long-term EPFD limits, overly conservative modeling of rain attenuation, and the

inclusion of a large number of unstable links with negative link margin values in the set of GSO reference links used to derive the EPFD limits.

33. Compliance with the current EPFD limits results in spectrally inefficient, overprotection of modern GSO networks that exceeds the protection GSO operators afford each other. Indeed, the comparison with GSO–GSO protection is illustrative. As GSO satellites operate from fixed locations along the 360-degree GSO arc, a primary strategy for managing potential GSO–GSO interference is through orbital separation. Internationally, the GSO orbital separation provisions in the ITU Radio Regulations presume negligible interference beyond orbital separation of 6 degrees in the Ku-band and 8 degrees in Ka-band. The Commission's own orbital spacing policy for GSO FSS networks in these bands is based on two-degree spacing. Yet, as noted in one U.S. study submitted to ITU WP 4A, maintaining a level of GSO–GSO protection equivalent to the ITU EPFD limits would require significantly larger orbital separations—estimated as at least 25 and 46 degrees in the Ku- and Ka-bands, respectively. Thus, the ITU EPFD limits are 4 to 5 times more restrictive than equivalent GSO–GSO protections that guard against all but negligible levels of interference—and 12 to 23 times more restrictive than the Commission's equivalent separation rules.

34. Analyses on the record further quantify these current protection levels. According to one study modeling an NGSO system operating under current EPFD limits, short-term interference to a set of ten GSO reference links resulted in undetectable increases in absolute unavailability in both the lower and upper Ka-bands, while the maximum decrease in throughput in the lower Ka-band was 0.162%. Five of the other links showed throughput decreases of 0.0011% or less. In the upper Ka-band (where EPFD limits are significantly more restraining) the maximum decrease in throughput was 0.0148% with five of the other links having decreases of 0.000012% or less.

5. Encouraging Good-Faith Coordination

35. Beyond the improvements in technical efficiency of NGSO operations and attendant lower costs for consumers, a modernized NGSO–GSO sharing framework can encourage private negotiations where the current EPFD regime has prevented beneficial bargaining. While ITU Radio Regulations explicitly permit EPFD limits to be exceeded on the territory of an administration that so agrees, coordination between any particular NGSO and GSO operator does not affect the NGSO operator's obligation to demonstrate adherence to the EPFD limits at the ITU. Under revised NGSO–GSO sharing rules, private bargaining among GSO and NGSO operators will have greater relevance. And these benefits will be added to the significant improvements in NGSO system capacity and efficiency, with limited impact on GSO operations, and will combine with the explosive growth of the NGSO satellite industry (which further increases the benefits of efficiency gains) in comparison with the relatively stable, or declining, rate of growth of many GSO operations.

36. Other Commission precedent supports a requirement of good-faith coordination backstopped by performance-based interference metrics in the NGSO–GSO sharing context. Indeed, when recently considering protection requirements between NGSO FSS systems, which universally incorporate ACM, the Commission adopted a long-term protection criterion of 3% degraded throughput, and a short-term protection criterion based on the absolute increase in link unavailability (0.4%), and it declined to create aggregate limits on NGSO interference into other NGSO systems. Importantly, the Commission explained that notwithstanding its newly adopted default protection requirements, coordination among satellite operators in the first instance ''offers the best opportunity for efficient spectrum sharing.'' Similarly, when the Commission revised its two-degree orbital spacing rules for GSO satellites in 2015 it explicitly acknowledged the value of coordination agreements reached between GSO satellite operators and offered continued protection of coordinated operations even when they did not comply with default, two-degree spacing rules. In addition, there is no conflict between the comprehensive update to the NGSO–GSO sharing framework undertaken in this rulemaking based on a substantial technical record and the previous adoption—in the absence of any well-developed alternative—of ITU EPFD limits, including in the 17.3–17.8 GHz band, which reflected prior domestic alignment with ITU rules before a compelling reason to depart from those rules was developed.

37. We re-emphasize this fundamental principle—that private agreements, not heavy-handed regulation, lead to the most efficient satellite spectrum sharing outcomes—and firmly incorporate it into NGSO–GSO sharing in the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands. Unlike compliance with EPFD limits, which is assessed by the ITU BR and effectively replaces any coordination among GSO and NGSO operators in bands subject to EPFD limits, our default GSO protection criteria and framework will explicitly recognize and require good-faith coordination. This is facilitated by the fact that, while we adopt a default set of GSO reference links below to facilitate technical showings of compliance with the GSO protection criteria by NGSO applicants, the particular reference links are taken from particular satellite networks. We believe interference protections should ultimately be rooted in real-world interference realities. So when an NGSO operator completes coordination with a particular GSO network serving the United States, we will permit the NGSO operator to revise its technical compatibility showing by omitting the links of the GSO network with which coordination was completed. By doing so, we avoid the intractable barriers to coordination under the current regime while offering a transparent means for agreements between NGSO and GSO operators to be reflected in the authorized operating parameters of the NGSO system.

6. Keeping Pace With Technological Advancements

38. Satellite technology has advanced profoundly since EPFD limits were developed in the 1990s. Analog satellite transponders have been replaced by digital systems with onboard processors. Large, fixed beams have given way to smaller, steerable beams using phase array antennas. Adaptive coding and modulation techniques allow satellite links to be maintained despite interference (such as adverse weather) by varying throughput. Operators have incorporated dynamic beam pointing, uplink and downlink power control, and network protocols that provide greater resilience to environmental effects and interference. And on the earth station side, large dishes have given way to very small aperture terminals that allow for widespread, cost-effective connectivity.

39. These technological developments both allow NGSO systems to better control and limit interference into GSO networks and strengthen GSO operations' ability to adapt to changing interference environments. Fundamentally, they have enabled more intensive, compatible shared use of the spectrum. Indeed, the availability of ACM with expected GSO networks in the Q- and V-bands was a significant

factor that led the international community to decline EPFD limits in the Q- and V-bands and instead adopt an NGSO–GSO sharing framework incorporating a long-term GSO protection criterion of 3% degraded throughput.

7. Promoting U.S. Leadership Globally

40. In launching the *NPRM* in this proceeding, we concluded it was appropriate to begin our domestic review of the NGSO–GSO sharing regime without awaiting the outcome of ongoing deliberations at the ITU. Experience to date has reinforced that judgment. While individual member states, including the United States, have continued to contribute to the ongoing technical studies on the current Article 22 EPFD limits in ITU WP 4A, needless procedural roadblocks and delay tactics have repeatedly ground international technical discussions to a halt. Although some stakeholders have suggested deferring domestic action pending further ITU developments, we believe it is important to move forward in a timely manner to provide regulatory clarity and support connectivity for millions of Americans, even as the ITU process continues toward WRC–27.

41. At the same time, we believe our approach can promote global collaboration toward spectrum harmonization. We anticipate that the record developed in this proceeding, including technical analyses and, over time, real-world implementation outcomes, may serve as a useful reference point for the ITU's ongoing work. We also hope that the Commission's policy framework can contribute constructively to discussions leading up to WRC–27, as the international community explores approaches to NGSO–GSO sharing that enhance broadband performance, expand access in rural and remote areas, promote competition, and ultimately benefit consumers worldwide.

42. As we originally anticipated, this rulemaking has compiled an exceptional technical record—including real-world measurements and additional, detailed technical simulations not submitted to international fora—that enable us to make a forward-looking decision now in the best interests of Americans. While international deliberations may—and should—converge on a similar revision to the EPFD framework in the future, the ITU Radio Regulations explicitly recognize administrations' rights to exceed EPFD limits on their own territory in the meantime. And such exceedances are technically feasible without altering EPFD compliance in neighboring countries with use of narrow, spot beams and other modern NGSO satellite technologies. Our action will promote American leadership at a time of increasing global competition.

B. Modernized Sharing Rules for NGSO–GSO

1. Coordination Default and Degraded Throughput Backstop

43. We consider and ultimately reject countervailing arguments in favor of retaining the current EPFD limits. One argument is that GSO operations are uniquely prone to interference. SES, for example, asserts that the ''EPFD framework is necessary because GSO satellites operate at fixed orbital positions in a specific orbital arc and cannot maneuver or switch satellites to mitigate the interference caused by NGSO systems operating in shared frequency bands.'' However, the EPFD limits are not the only way to protect GSO networks from unacceptable interference, as shown by the international adoption of the degraded throughput methodology to protect GSO networks in Q- and V-bands. Eutelsat argues that EPFD limits are uniquely suited to protecting GSO operations, because ''EPFD limits mitigate [the] risks [of dynamic, time-varying interference caused by NGSO systems] by placing strict bounds on both peak and aggregate interference levels'' and ''appropriately protect high-value links to support diverse applications by differentiating EPFD limits according to terminal characteristics.'' However, the degraded throughput methodology also limits peak and aggregate interference (or short-term and long-term interference, in the terminology of a degraded throughput analysis) and accounts for differing terminal characteristics through a set of GSO reference links.

44. In addition, while Viasat argues that alternatives to EPFD limits are a hinderance to innovation by GSO operators, the degraded throughput methodology will allow continued innovation by protecting GSO operators from actual, unacceptable interference, as demonstrated by the NGSO applicant, while also significantly improving the efficiency of the NGSO system and use of the spectrum overall. Viasat also argues that calls for reform of the NGSO–GSO sharing framework are merely ''calls to hobble competition'' as they rest on ''deeply flawed claims that eliminating the EPFD limits would not expose existing and future GSO operations to unacceptable levels of interference.'' While it is unclear what level of interference Viasat would deem ''acceptable,'' especially considering its support of the extremely restrictive upper Ka-band EPFD limits, the repeated, months-long, real-world measurements submitted by SpaceX have demonstrated that EPFD limits can be exceeded without significant impact to currently operating GSO networks. Viasat further claims that any reforms to the NGSO–GSO sharing framework ''would frustrate efforts by GSO operators to introduce innovative service offerings.'' To the extent this means the future deployment of earth station terminals particularly susceptible to interference that require the levels of protection offered by the upper Ka-band EPFD limits, the burdens on NGSO systems from such unequal spectrum sharing have not been justified. Viasat and other commenters also argue that the significant recent growth in NGSO systems is proof that EPFD limits are not unduly constraining. But the fact of such growth—spurred by technological advances and the inherent benefits of lower latency and potentially broader coverage derived from NGSO satellite constellations, especially in LEO—does not negate any of the benefits of NGSO–GSO sharing reform.

45. SES argues that eliminating EPFD protections would shift the burden of interference mitigation onto GSO operators and the Commission in administering a new framework. However, NGSO operators would still have a unilateral requirement to protect GSO networks under a degraded throughput framework the Commission is already administering in the NGSO–NGSO sharing context. SES also raises concerns that, without EPFD limits in place, NGSO operators may tilt the competitive landscape in their favor and eventually monopolize shared spectrum bands. Yet as long as NGSO systems have a one-way requirement to protect GSO networks, and not claim protection from them, it is impossible for NGSO systems to monopolize the shared spectrum. SES further argues that moving away from the EPFD regime would devalue GSO service assets potentially to the point of stranding those assets, and discourage future GSO investments and innovation. SES provides no economic evidence in support of this strong claim, nor does it contend that the use of the degraded throughput methodology in Q- and V-bands has foreclosed future GSO use of those bands. We believe that under appropriate protection criteria in a degraded throughput framework GSO networks can continue to grow and provide valuable services.

46. Commenters also present technical simulations showing

exceedances of proposed protection criteria. For example, analyses of the Amazon system assuming an Nco of 16 and a GSO-arc avoidance angle as low as 2 degrees indicate exceedances of the proposed threshold limits at certain locations. An analysis of the Starlink system at a GSO network earth station in Lima, Peru, assuming an Nco of 8 and a GSO-arc avoidance angle of 4 degrees, also indicates exceedances of a 0.1% absolute increase in unavailability. Additionally, Eutelsat presents simulations in which the Starlink system, when using an EPFD-compliant configuration of an Nco of 1 and a GSO-arc avoidance angle of 18 degrees, would nonetheless exceed the thresholds of 3% degraded throughput and 0.1% absolute increase in unavailability for the four analyzed GSO links in Ku-band—thus indicating that the current EPFD limits may be *less* protective than the proposed new protection criteria, a conclusion not suggested by any other commenter and contrary to the real-world testing summarized above. Ultimately, compliance with the GSO protection criteria we are adopting must be demonstrated by the NGSO applicant. If certain NGSO operational parameters are not currently feasible while meeting those criteria for the set of GSO reference links, then they will not be permitted. Thus, simulations showing exceedances for certain NGSO operational parameters at certain locations do not undermine our conclusion that significant capacity and service improvements are possible under performance-based GSO protection criteria, as demonstrated by real-world testing and technical simulations.

47. Commenters also present simulations showing exceedances of proposed protection criteria that demonstrate the interplay between short-term and long-term interference protections. For example, studies of the Starlink system in Ka-band assuming an Nco of 40 and a GSO-arc avoidance angle of either 18 degrees or 4 degrees found less than a 0.1% absolute increase in unavailability at non-ACM GSO network user terminal locations in Oregon (0.016% and 0.03%, respectively), Utah (0.041% and 0.056%, respectively), Oklahoma (0.071% and 0.098%, respectively), Alabama (0.030% and 0.032%, respectively), and New Mexico (0.046% and 0.095%, respectively); and exceedances of the 0.1% limit in New York (0.104% and 0.171%, respectively). For the Amazon system, studies assuming an Nco of 16 and a GSO-arc avoidance angle of either 6 degrees or 2 degrees in Ka-band showed compliance with a 0.1% absolute increase in unavailability limit for user terminals in Oregon (0.025% and 0.038%, respectively) and Alabama (0.01% and 0.035%, respectively); mixed results—compliance with an avoidance angle of 6 degrees and exceedances at 2 degrees—for earth stations in Oklahoma (0.024% and 0.566%, respectively), New York (0.03% and 0.39%, respectively), and New Mexico (0.01% and 1.37%, respectively); and exceedances for an earth station in Utah (0.14% and 1.47%, respectively). However, in all these cases for both the Starlink and Amazon systems, the separate long-term limit proposed for non-ACM GSO links such as these, −10.5 dB I/N for 80% of the time, was exceeded. Because both long-term and short-term limits would need to be met at all locations, the effect of the −10.5 dB I/N long-term limit would further reduce the expected short-term absolute increases in unavailability in all cases, even where a 0.1% short-term limit was met with a wide margin. With ACM networks, analyses for the Amazon Ka-band system, for example, similarly indicate that the proposed long-term protection criteria of 3% throughput degradation is the limiting factor even when a short-term 0.1% absolute increase in unavailability limit is met.

48. Having concluded that existing EPFD limits are needlessly prescriptive, outdated, and overprotective of GSO operations, and that they unreasonably constrain services by innovative new NGSO systems, we turn to their replacement. For FSS systems using ACM, we conclude—again—that the performance-based metrics of throughput degradation and increase in absolute unavailability represent efficient and appropriate protection criteria. Indeed, when recently establishing protection criteria for NGSO–NGSO sharing in bands including the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands, the Commission likewise set long-term and short-term protection thresholds using these metrics. The Commission did so because, for ACM satellite systems, the degraded throughput methodology reflects modern technology, results in efficient spectrum sharing, and is readily administrable. The same reasoning now applies to the NGSO–GSO sharing context. Even the ITU, when more recently establishing protections for GSO networks from NGSO systems in bands between 37.5 GHz and 51.4 GHz, chose a degraded throughput methodology, not EPFD limits. In contrast, pursuing merely different EPFD limits would sacrifice the benefits of performance-based metrics and needlessly delay reform, as parties proposing the development of new EPFD limits do not themselves propose definitive limits for adoption.

49. A degraded throughput methodology does not make enforceability more difficult than the current EPFD regime. As noted below, under our modernized framework, NGSO applicants will be required to submit transparent technical analyses of how they would meet the GSO protection criteria, which will be subject to public and Commission review. In contrast, the current ITU compliance assessments have been noted as ''opaque'' and encouraging ''gamesmanship.'' Nor is the degraded throughput analysis unduly complex given its benefits, as it is already used by satellite operators to assess NGSO–GSO interference. Nor would GSO operators lose the ability to control their service quality. As we discussed in response to similar concerns in the NGSO–NGSO sharing context, the interference criteria must be met at all analyzed locations. Since the worst-case locations will drive NGSO operators' determinations of appropriate system parameters and any mitigation measures, the actual degradations in throughput, absolute increases in unavailability, and I/N levels will be less than the protection criteria in many circumstances. And studies on the record confirm these differing impacts. Thus, earth station equipment that is used for high-availability applications, and that is less sensitive to sidelobe interference than the most sensitive user terminals to be protected, will experience real-world effects significantly below the protection criteria. In a similar vein, Eutelsat raises concerns that the degraded throughput methodology inappropriately allows a gateway link to be degraded as much as a user link, although impacts to gateway links can impact service to numerous customers at once. Again, this is a theoretical concern that is unlikely, if ever, to occur in reality, because the NGSO system must be configured to cause no more interference than the most protective criteria for a GSO link, and because larger, gateway earth station antennas are inherently less susceptible to sidelobe interference than smaller user terminals and therefore will receive less, often substantially less, interference than the thresholds.

2. Long-Term Interference Backstop

50. We adopt a 3% time-weighted average degraded throughput threshold as the long-term interference metric that NGSO systems must comply with for the protection of GSO networks using ACM in the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands.

51. Consistent with the Commission's decision making in the NGSO–NGSO sharing context for modern satellite systems using ACM, we conclude that adopting this value best furthers our goals of allowing for competitive new and improved services by NGSO operators while providing adequate protection of GSO networks. First, this value has been thoroughly developed, debated, and adopted for the protection of GSO networks using ACM in the Q- and V-bands internationally, as well as for the protection of NGSO systems using ACM in bands including the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands. Second, the 3% value is the only degraded throughput value proposed, analyzed, and supported on the record. Third, the 3% throughput-degradation threshold limits the interference allowed at any analyzed GSO network earth station location, not the expected average of interference across all locations. Since the worst-case scenarios will drive the overall NGSO system parameters necessary to guarantee protection of the most sensitive link, actual interference will be less than 3% in many circumstances. Importantly, GSO satellite operators will be able to further reduce this level of throughput degradation for given customers by the use, or continued use, of appropriate earth station equipment that is less sensitive than the most sensitive links to be protected, considering geographic and other factors. And, GSO operators may coordinate directly with NGSO operators regarding accommodation of particular use cases, and we will require good-faith coordination efforts by both GSO and NGSO operators in the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands. Finally, analysis on the record indicates that a 3% degraded throughput threshold is achievable by current and planned NGSO systems, and could enable significantly greater spectrum use and cost savings by NGSO systems in comparison to the current EPFD limits.

52. We find that objections expressed in the record with respect to the well-established 3% degraded throughput limit for ACM systems are technically unpersuasive. Despite its past support for a 3% threshold for ACM systems in the NGSO–NGSO context, Viasat argues that such a threshold would ''leave GSO networks and their end users exposed to significant interference risks.'' Viasat's supporting study, however, focuses on the interplay between a roughly 3% degradation in throughput and the impact on non-performance-affecting static ''reserve capacity''—a hypothetical concept contemplated in the 1990s that is ill-defined and does not reflect how actual ACM systems operate. The study indicates that ACM systems, which are specifically designed to better handle intermittent interference, will experience substantially more interference and worse performance than non-ACM systems. We believe that months of real-world testing are a better indicator of actual interference impacts than studies relying on the ''reserve capacity'' concept.

53. Eutelsat expresses concern that, even with a 3% time-weighted average throughput degradation threshold, throughput losses will exceed 3% at times. Eutelsat argues that if ''a customer experiences a 13.62% degradation for 1% of a 24-hour period, that means they experience about 15 minutes a day of massively degraded service,'' which is ''especially problematic for enterprise level or business-to-business customer links.'' This worst-case analysis, however, which could not be replicated by one other commenter, assumes that both the GSO and the NGSO customer would need the full capacity of all the spectrum at issue on all available satellites for that full 15 minutes at the same times, and that Eutelsat chooses an earth station antenna that is particularly susceptible to interference for its enterprise customer. As noted above, GSO operators can reliably reduce their expected interference through appropriate earth station antenna choice and network design. We need not devise general interference limits based on a combination of unlikely events and worst-case scenarios. Further, as a long-term protection criterion, the change in time-weighted average throughput has already been adopted internationally for the protection of GSO networks using ACM from NGSO systems in the Q- and V-bands. To the extent that an NGSO system complying with the long-term and short-term protection criteria still presents a realistic risk of such interference spikes to a GSO network, that possibility can be discussed during good-faith coordination between the operators.

3. Short-Term Interference Backstop

54. We adopt a 0.1% absolute increase in link unavailability as the short-term GSO interference metric. For the reasons discussed below, we conclude that this 0.1% value, which is more protective than the alternative 0.4% value proposed on the record and adopted in the NGSO–NGSO sharing context, will provide adequate protection of GSO networks while offering substantially improved opportunities for efficient spectrum sharing with NGSO systems. Indeed, we expect the real-world short-term impact to be less than this 0.1% value in many instances given not only varying GSO network antenna performance but also technical studies indicating that it is the long-term protection criteria we are adopting that are the limiting factor, since it is the most restrictive protection criterion that will govern NGSO operational characteristics.

55. As an initial matter, as in the NGSO–NGSO sharing context, we considered both a *relative* measure of increase in link unavailability and an *absolute* measure of increase in unavailability. We again conclude that the use of an absolute increase in link unavailability as the short-term interference metric provides a more reliable measure of short-term interference that is not as susceptible to significant fluctuations as a relative increase metric would be. This is because, for satellite links with a high baseline availability, the relative measure of increase can prove incredibly sensitive. For example, if a GSO link with a baseline availability of 99.99% were reduced to 99.98%, this would represent an absolute change of only 0.01% but a relative change of 100%; while the same, relative 100% increase in unavailability for a GSO link with a baseline availability of 99.5% would represent a 50-times larger or 0.5% absolute change. Especially given the lower value of 0.1% increase that we are adopting in the NGSO–GSO sharing context in comparison with the 0.4% increase permitted in the NGSO–NGSO sharing context, we conclude that the absolute measure of unavailability will provide sufficient protection without the volatility and potential for extremely limiting protection requirements under a relative increase in unavailability metric.

56. We also find that the 0.1% unavailability increase criterion will adequately protect GSO networks. Indeed, it may approximate the maximum short-term interference a GSO satellite operator in Ku-band would expect from another GSO satellite operating 6.5 degrees away on the GSO arc, a distance at which no coordination between the GSO operators would be required under the ITU Radio Regulations because the interference is

expected to be negligible. Moreover, like the long-term interference metric adopted above, this short-term interference metric will limit the increase in link unavailability at any analyzed location. Since the worst-case locations will drive NGSO operators' determinations of appropriate system parameters and any mitigation measures, the actual increase in unavailability will be less than 0.1% in many circumstances. And importantly, GSO operators can realistically increase the availability of their links by choosing earth station equipment that is less sensitive to interference than the most sensitive GSO links being protected. In addition, GSO operators may coordinate directly with NGSO operators regarding any particular use cases. We also conclude that adopting a 0.1% absolute increase in unavailability metric will simultaneously support competitive new and expanded NGSO services because analyses on the record indicate it can accommodate current and planned NGSO systems.

57. Further, we note that, while the Commission does not guarantee privately negotiated service levels of GSO operators, we believe that concerns on the record about maintaining high availability GSO links are overstated. First, the 0.1% limit is inherently protective. Even the most sensitive GSO reference link, which typically represents a small, mass-market user terminal rather than an enterprise-level customer demanding high availability, could maintain a link availability near 99.9% in the presence of an operational NGSO system. Second, actual enterprise-level customers or others negotiating for high availability services will experience significantly less—perhaps exponentially less—reduction in unavailability than 0.1%. This is because the operating parameters of the NGSO system will be driven by the need to protect the most vulnerable GSO link, and because the inherent design of GSO links predicated on maintaining high availability renders them less susceptible to interference from NGSO systems, for example by use of earth station antennas with higher main-beam gain and lower sidelobes. Third, as we explained in the NGSO–NGSO context, we expect that any cumulative, real-world effects of two or more NGSO systems will likely be less than a simple multiplication of the 0.1% limit by the number of NGSO interferers—even for the most sensitive GSO link—because doing so fails to account for mitigation techniques or other spectrum-sharing measures that may be applied by the NGSO systems to reduce interference to each other, and accordingly reduce their overall aggregate impact to GSO networks. Accordingly, our adoption of a 0.1% limit on absolute increase in unavailability considers the real-world implications of the limit in order to achieve an efficient and reasonable balance between expanded NGSO services and continued, competitive GSO services, rather than imposing arbitrary constraints on NGSO systems to guarantee a theoretical level of GSO service premised on simple, worst-case interference assumptions. We also consider the interplay of the 0.1% limit with our long-term protection criteria. As indicated in simulations, even NGSO system configurations that result in a 0.01% short-term impact to non-ACM GSO links, or a 0.03% impact to ACM GSO links, could exceed the applicable long-term limits of −10.5 dB for 80% of the time or 3% time-weighted average degraded throughput, and therefore the short-term impact would be reduced even further to comply with the long-term criteria. In this way, our choice of long-term GSO protection criteria, especially a limit of −10.5 dB for 80% of the time for GSO networks not using ACM, further addresses concerns raised about short-term impacts to GSO networks, and in particular to non-ACM networks.

4. Interference Backstop for GSOs Without ACM

58. As we move towards performance-based protection metrics for NGSO–GSO spectrum sharing in the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands, we recognize that there are continuing GSO satellite operations that do not employ ACM because of the nature of the service they are providing—for example, video transmissions to geographically diverse areas of the country that cannot adapt to changing interference environments in particular areas—and for which a degraded throughput limit would be inappropriate. These GSO satellite services are more prominent in Ku-band, especially BSS, but also exist in Ka-band as well. For the protection of non-ACM GSO satellite links we adopt a protection threshold of −10.5 dB I/N for 80% of the time.

59. With an I/N threshold of −10.5 dB, the level of interference that a Ku-band GSO satellite would experience from an NGSO system is approximately equivalent to that of two GSO Ku-band satellites that are separated by approximately 6.5 degrees. As noted above, under the ITU coordination procedures, Ku-band GSO satellite networks that are separated by more than 6 degrees are not required to coordinate with each other because of the presumed negligible interference effects. In addition, a −10.5 dB I/N limit for 80% of the time was assumed to be protective of FSS and BSS networks in the portions of the Ka-band (24.65–25.25 GHz and 27–27.5 GHz) during international studies with International Mobile Telecommunications (IMT) systems prior to WRC–19. And, the −10.5 dB I/N limit has been validated through real-world testing.

60. The long-term limit of −10.5 dB I/N for 80% of time will work in tandem with the 0.1% absolute increase in unavailability short-term limit to protect non-ACM GSO operations. While some commenters argue that a short-term metric alone is the most relevant for assessing interference to non-ACM links, we believe that including an additional, long-term interference metric will provide additional protection to GSO video distribution links without being overly constraining on NGSO operators, as it is supported by the largest NGSO operator in Ku-band, where non-ACM links are more prevalent.

61. We will require the −10.5 dB I/N for 80% of time limit to be met for non-ACM links in both Ku-band and Ka-band. While the record indicates the remaining non-ACM GSO networks are generally concentrated in Ku-band, non-ACM GSO networks are also deployed and providing video service to customers using Ka-band and at least for these networks, the choice of not using ACM is a result of the video distribution type of service being provided, not due to the use of older or less advanced earth station equipment alone. Noting that the only specific proposal on the record for the long-term protection of non-ACM GSO links is the −10.5 dB I/N limit, we will, as with our short-term limit and long-term ACM limit described above, apply this equally to GSO operations in the Ku-band and Ka-band.

5. GSO-Arc Avoidance Angle

62. Above, based on an exceptional technical record, we adopted protection criteria for modern GSO networks that will enable substantial improvements in spectrum use by NGSO systems, resulting in higher capacity and lower costs, using performance-based metrics that accommodate the gold standard of efficient satellite spectrum management—coordination. Nonetheless, we recognize that moving towards a modernized, degraded-throughput based spectrum sharing framework is a significant shift from the EPFD protections that GSO operators had been accustomed to receiving in the

10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands in the United States.

63. Therefore, in addition to the specific protection criteria described above, we will require NGSO systems in the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands to observe a 3-degree GSO-arc avoidance angle with respect to any operational co-frequency GSO satellite serving the United States. This angle, which was one of the angles used during the SpaceX real-world testing campaign, approximately reflects the widest main-beam width of GSO satellite earth station antennas currently listed and protected under ITU EPFD limits. Since NGSO operations near the GSO arc typically represent the greatest interfering scenario for a GSO network earth station, observing this 3-degree GSO-arc avoidance angle will provide an additional layer of assurance that NGSO satellite transmissions will not fall within the main beam of the receiving victim earth station and therefore the resulting increase in interference will be minimal. At the same time, it will facilitate NGSO deployment.

64. In the NGSO–NGSO sharing context, the Commission adopted protection criteria for NGSO systems authorized through an earlier processing round and required later-round applicants to demonstrate compliance with those limits if coordination agreements with the earlier-round operators had not yet been reached. While those technical demonstrations were pending before the Commission, however, NGSO operators are permitted to begin operating on a non-interference basis. In this instance, a minimum GSO-arc avoidance angle will achieve a similar balance of encouraging immediate services to the public and providing protection of other operators. Thus, we will allow NGSO satellite applicants to submit technical demonstrations of compliance with the GSO protection criteria, and begin operating on an unprotected, non-interference basis even if those technical demonstrations remain pending and not yet acted on by the Commission, provided they operate consistent both with the operational parameters reflected in the technical demonstrations and the 3-degree GSO-arc avoidance angle.

65. We note that the minimum 3-degree GSO-arc avoidance angle represents an additional layer of protection for GSO networks that may restrict NGSO systems more than is strictly necessary. Although an avoidance angle may not sufficiently protect GSO networks on its own, because it does not account for other key variables such as transmit power and the number of co-frequency satellites transmitting to the same location at the same time, it should provide an added level of assurance to GSO network operators should NGSO systems need to begin operating while their technical demonstrations of compliance with the protection criteria remain pending. With greater experience implementing the new NGSO–GSO sharing framework, we may re-visit this requirement.

6. GSO Reference Links

66. To accompany the protection criteria above, we adopt a set of GSO reference links reflecting typical and widespread GSO operations in the United States, contained in Appendix B to the Order. Reference links are used by an NGSO operator to demonstrate that it will comply with the long-term and short-term interference metrics. Reference links provide transparency and regulatory certainty for both GSO and NGSO operators as to the types of operations that will be protected to the threshold levels.

67. As an initial matter, the GSO reference links we adopt include 328 links provided in the record and drawn from both ITU data and the Commission's licensing databases and filtered according to a filtering methodology. After review, we find these links are reasonably representative of a variety of widespread GSO operations and appropriate as an initial set of links to be tested against. While some commenters urge the Commission to seek further comment on development of GSO reference links, the Commission specifically did so in the *NPRM,* and those parties criticizing the GSO reference links provided on the record, without offering a set of links of their own, do not provide an alternative for consideration at this time.

68. In addition to the 328 links, Amazon performed an analysis of 3,944 Ka-band GSO links taken from the Commission's licensing database and selected four of the most sensitive links among these, which Amazon states are protectively representative of 97.6% of the links studied. Using a smaller set of the most sensitive links—which drive the interference analysis in any event—could well be a simpler and more efficient means of demonstrating compliance with the protection criteria. However, for our initial set of GSO reference links, we include a broader collection of links that may provide GSO operators greater confidence in the results of the compatibility demonstrations.

69. In adopting these reference links, we recognize the diversity of operating parameters that may inform the protection of small earth station terminals, such as those used in Earth Stations in Motion (ESIMs). And we recognize that GSO networks, and NGSO systems, will continue to evolve. Accordingly, we delegate authority to the Space Bureau to revisit the baseline set of links we identify today, and to remove, revise, or add appropriate GSO links in the future, after seeking comment. We direct the Bureau to initiate such a focused proceeding within 15 days after release of the Order, and to adopt a decision within 60 days after close of that comment period. We note that operating NGSO systems may be required to adjust their operations to protect any new GSO reference links added in the future.

7. Aggregate Interference Limits

70. As we look towards more efficient spectrum sharing between GSO and NGSO systems, we find no technical basis in the record—or compelling justification—to create and adopt aggregate limits on interference from NGSO systems into GSO networks. Indeed, as we noted when recently declining to create aggregate limits on NGSO interference into other NGSO systems, a host of unresolved questions remain, including: as to the need for any aggregate limits given the ongoing and, at times, uncertain deployment of newly authorized NGSO constellations; the derivation of any proposed aggregate limits that avoids simplistic, worst-case assumptions and accounts for mitigation techniques or other spectrum-sharing measures that may be applied by the NGSO systems and reduce their overall aggregate impact; and the implementation of any aggregate limits among operational NGSO systems, an issue that remains unresolved internationally more than 25 years after aggregate EPFD limits were adopted.

71. Limiting new entry while we wait and see which NGSO FSS systems will deploy, out of a fear of future aggregate interference that may never arise, would artificially and unreasonably inhibit competition contrary to the public interest. More fundamentally, as we move towards performance-based metrics based on real-world data and realistic interference concerns, any aggregate limits would run the stark risk of piling worst-case assumptions on top of one another to the detriment of efficiency and real-world costs. Parties advocating aggregate limits have not submitted aggregate interference studies or modeling or otherwise shown that any such limits—and none are proposed

on the record—would be justified. Nonetheless, should a demonstrated need arise in the future, we may revisit the question of aggregate limits. And, of course, operators are free to discuss and agree upon ways to account for any aggregate interference effects during their good-faith coordination discussions.

C. Other Technical and Procedural Considerations

1. Terrestrial Operations

72. Modernizing the NGSO–GSO spectrum sharing framework can be accomplished without affecting the required protection levels of terrestrial operations. Within the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands subject to EPFD limits, NGSO systems must also adhere to PFD limits in the 10.7–11.7 GHz, 12.2–12.7 GHz, and 17.7–18.3 GHz band segments developed for the protection of co-primary fixed services. The EPFD limits and PFD limits address different geometries of the NGSO system's operation—the former addresses interference from NGSO operations near the GSO arc, whereas the latter addresses NGSO operations near the horizon. In addition, NGSO systems must meet PFD limits to protect terrestrial services in the 18.6–19.7 GHz portion of the Ka-band where EPFD limits do not apply.

73. We recognize that several terrestrial commenters propose a comprehensive re-evaluation of the protection afforded by current PFD limits—critiquing the assumptions about both fixed-service (FS) and FSS deployments underlying current limits, including FS deployments considered and the scale of NGSO satellite deployments; noting that, unlike Ka-band PFD limits, Ku-band PFD limits do not scale based on constellation size; seeking new demonstrations that NGSO systems complying with PFD limits will continue to protect terrestrial services from the risk of aggregate interference; and otherwise suggesting that the PFD limits adopted at WRC–2000 are outdated. Such comprehensive studies re-evaluating the Ku-band and Ka-band PFD limits may be warranted. However, the parties calling for such studies have neither begun them, provided necessary characteristics for them, or otherwise provided any technical basis for the conclusion that the current, required protection levels of terrestrial services are in fact inadequate, or that single-entry PFD limits should be newly evaluated based on potential aggregate interference. Accordingly, there is insufficient support in the record to indefinitely delay updating the NGSO–GSO sharing framework in bands overlapping terrestrial allocations and in which PFD limits will continue to apply, especially where the substantial technical record indicates that eliminating the EPFD limits will not result in unacceptable interference to GSO networks as described above.

74. We also note that expanding more efficient and intensive spectrum use in the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands is consistent with other Commission priorities, including in the Upper C-band, where the Commission has sought comment on repurposing at least 100 megahertz in the 3.98–4.2 GHz band from FSS use to next-generation wireless services and relocating some GSO FSS operations to other available FSS spectrum. Regarding the potential relocation of some high-availability services from C-band to Ku-band, in which rain fade plays a larger role in link design, we note that the combination of adaptive power control, appropriate earth station selection and link design, and our modest 0.1% absolute increase in unavailability metric will mean GSO satellite operators will face significantly lower than even a 0.1% change in unavailability at earth stations designed to support high availability links. For the protection of video distribution links specifically, we have adopted a limit of −10.5 dB I/N not to be exceeded 80% of the time, which will provide an extra layer of protection for these links in addition to the short-term absolute change in unavailability criterion. Further, at least 20 megahertz of C-band spectrum are proposed to remain for satellite services requiring C-band transmission characteristics under even the broadest repurposing of the band for which comment was sought in the Notice of Proposed Rulemaking. Accordingly, we reject arguments that revising the NGSO–GSO sharing framework will jeopardize any portion of an Upper C-band transition.

2. Radio Astronomy

75. Modernizing the NGSO–GSO sharing framework will also not affect ongoing obligations of NGSO licensees to successfully coordinate with radio astronomy service (RAS) sites. Indeed, the record details the close coordination and data sharing between RAS and NGSO satellite systems pursuant to Footnote US131 of the Table of Frequency Allocations. Given this successful record of coordination to date, we continue to expect that the obligation on NGSO licensees operating in the 10.7–11.7 GHz band to complete coordination with RAS prior to commencing operation will ensure the continued protection of RAS sites. Furthermore, requirement of coordination for any related fixed infrastructure (*e.g.,* gateways) within the National Radio Quiet Zone (NRQZ) pursuant to § 1.924 accommodates coordination requirements for the federal facilities within the NRQZ. As NGSO licensees have different operating parameters, the general coordination requirement provides flexibility to adapt to specific scenarios. Accordingly, there is no basis in the record to adopt additional, specific technical requirements regarding the operational means NGSO systems may employ to protect RAS sites as agreed in coordination, or to require new studies or aggregate interference analyses at this time, or to simply convert existing single-entry PFD limits to aggregate limits, as some RAS commenters have suggested. It should be noted that for the specific case of NGSO's providing Supplemental Coverage from Space, the FCC Report and Order did note that SCS licenses would be considered on a case-by-case basis and encouraged applicants to conduct outreach and work with appropriate federal agency contacts (NSF for radio astronomy) in advance of submission of license applications to the Commission, including conducting Monte Carlo analyses of potential impacts to radio astronomy systems using their specific configurations, as appropriate. Should any difficulties arise in the future during coordination discussions among NGSO operators and RAS site operators the Commission may assist in finding a solution agreeable to all parties involved.

3. Cross-Border Considerations

76. The ITU Radio Regulations provide that EPFD limits may be exceeded on the territory of any country whose administration has authorized such operation, and doing so in the United States, to the benefit of American consumers, is fully consistent with our international and cross-border obligations. From a practical standpoint, modern NGSO systems are capable of keeping the energy from their downlink beams from spilling over into the territory of adjacent countries by using narrow beams with sharp roll-off while continuously monitoring and controlling the amount of power and location of the beams on the ground. The customer terminals associated with these systems also employ narrow beams with suppressed sidelobes that continuously track NGSO satellites at specific elevations, resulting in minimal exposure outside the main beam of the antenna. Thus, modern NGSO satellite systems have the technical capability to

exceed the EPFD limits within the territory of the United States while respecting the EPFD limits on the territory of adjacent countries that have not authorized exceedances of the limits. We will continue to require such international compliance from NGSO satellite systems notified by the United States, without requiring any additional measures or specific cross-border agreements to implement the updated NGSO–GSO sharing framework in the United States.

4. Implementation and Technical Demonstrations of Compatibility

77. In implementing the modernized NGSO–GSO sharing framework, the Commission's recently adopted degraded throughput framework in the NGSO–NGSO sharing context provides a ready example that we may draw from. Specifically, in 2024, the Commission adopted spectrum sharing requirements for NGSO FSS systems authorized in a later processing round to protect NGSO FSS systems authorized in an earlier processing round. As we are adopting here, the Commission adopted a long-term protection criteria of 3% time-weighted average throughput degradation and short-term protection criterion based on the absolute increase in link unavailability. In the NGSO–NGSO sharing context, prior to commencing operations, an NGSO FSS licensee or market access recipient must either certify that it has completed a coordination agreement with any operational NGSO FSS system licensed or granted U.S. market access in an earlier processing round, or submit for Commission approval a compatibility showing which demonstrates by use of a degraded throughput methodology that it will not cause harmful interference to any such system with which coordination has not been completed. Such compatibility showings must contain a demonstration that the later-round system will cause no more than 3% time-weighted average degraded throughput of the link to the earlier-round system, for links with a baseline link availability of 99.0% or higher at a C/N threshold of 0 dB; and a demonstration that the later-round system will cause no more than 0.4% absolute change in link availability to the earlier-round system using a C/N threshold value of 0 dB, for links with a baseline link availability of 99.0% link availability or higher. While a compatibility showing remains pending before the Commission, the submitting NGSO FSS licensee or market access recipient may commence operations on an unprotected, non-interference basis with respect to the operations of the system that is the subject of the showing.

78. We believe that carrying over this implementation framework from the NGSO–NGSO context, where it was rigorously debated, will facilitate technical showings in the NGSO–GSO sharing context as well because NGSO operators will be familiar with its application. This implementation framework also includes adopting the same C/N threshold for ACM links and the specific C/(N+I) threshold from the GSO reference link database for non-ACM links, assumptions about additional sources of interference, rain-fade model flexibility using the rainfall rates from the GSO reference link database, ability to use information received through any coordination discussions, a set of parameters and assumptions to facilitate the compatibility analysis, and flexibility for NGSO operators in adopting mitigation techniques to ensure compliance with the protection thresholds. As part of this framework, NGSO applicants and operators would be required to submit a compatibility demonstration which shows that their results and proposed operational configuration (including key parameters such as Nco, GSO-arc avoidance angle, and power levels) will meet the protection criteria for all of the approved GSO reference links. Further, NGSO operators will be required to share relevant technical information, including the compatibility demonstration, as needed by the GSO operators in assessing interference or for performing their own technical analysis that can aid in the coordination. Thus, through coordination, GSO operators would be able to receive the most up-to-date and technically precise details of NGSO system operations for use in their own assessments, without involving Commission resources or incentives towards protracted disputes. The Commission, however, would be available if assistance is needed in coordination or to resolve real-world interference concerns.

79. We note that the latest developments in modeling NGSO and GSO systems may be used in the compatibility analyses. We also note that we will also consider arguments by NGSO satellite applicants and operators that, because of successful coordination with one or more GSO network operators, certain of the GSO reference links included in the set of standard reference links may no longer need to be demonstrated as protected because equivalent links are not used by any remaining GSO operators serving the United States with whom coordination has not yet been reached.

5. Transition to New Rules

80. An immediate transition to the modernized NGSO–GSO sharing framework will offer immediate benefits without jeopardizing legacy services. Today, as discussed above, NGSO services are unreasonably constrained by EPFD limits based on decades-old proposed systems, assumptions, and methodologies, which results in protection levels for GSO networks significantly higher than the protection they expect from other co-primary GSO networks. Updating this framework to a set of protection criteria based on degraded throughput for ACM networks, absolute increase in unavailability, and an I/N limit for non-ACM networks, will adequately protect ongoing GSO operations while uncapping significant new NGSO capacity. Further delaying the transition to a modernized sharing framework, including for up to 18 years or through grandfathering provisions, would sacrifice the immediate economic and other benefits of the new framework. As supported by real-world testing, the new rules can be implemented without introducing unacceptable interference to GSO networks. Retaining the existing EPFD limits, even temporarily, would have a concrete and substantial impact on NGSO deployment and the ability of NGSO operators to deliver innovative new services to customers within the United States.

81. We will apply all rule changes adopted in the Order to current NGSO licensees and market access grantees, pending applicants and petitioners, as well as future applicants and petitioners. With respect to pending applications, applicants do not gain any vested right merely by filing an application, and the simple act of filing an application is not considered a ''transaction already completed'' for purposes of this analysis. Applying our new rules and procedures to pending space station applications will not impair the rights any applicant had at the time it filed its application. Nor will doing so increase an applicant's liability for past conduct. Similarly, with respect to current licensees and market access grantees, none of the actions we take here increase liability for past conduct, impair rights a party possessed when he acted, or impose new duties with respect to transactions already completed. Rather, all of these actions take effect in the future, after the rules become effective. Accordingly, applying these rule changes to existing licenses and grants of market access will not

upset any grantee's reasonable expectations.

6. Additional Frequency Bands and Other Issues

82. While the record provides ample basis to revise the NGSO–GSO sharing framework in the 10.7–12.7 GHz, 17.3–18.6 GHz, and 19.7–20.2 GHz bands of focus in this rulemaking, it does not provide a basis for action in other bands. Indeed, no NGSO system proponent advocates changes in additional frequency bands at this time, and commenters addressing other bands either request that we explicitly decline any changes in C-band, or raise issues in other bands that are beyond the scope of this rulemaking. Accordingly, we limit our actions to those areas of demonstrated need regarding NGSO operations in the 10.7–12.7 GHz, 17.3–18.6 GHz, and 19.7–20.2 GHz bands in the United States.

7. Alternative Sharing Frameworks and Sunsetting

83. While we are modernizing the NGSO–GSO sharing framework based on the best available data today, we recognize that future revisions may be warranted to further refine this framework and maximize the benefits to American consumers. While some commenters propose to sunset the GSO protection criteria requirements and move towards a framework of coordination only between GSO and NGSO systems, or coordination with a ''safe harbor'' GSO-arc avoidance angle requirement, we believe that encouraging coordination under the new protection criteria that we are adopting will offer immediate benefits and provide a new record of experience on which we could re-consider GSO–NGSO sharing in the future. Accordingly, we decline to adopt any alternative NGSO–GSO sharing frameworks at this time.

D. Costs and Benefits

84. We have carefully reviewed the record in this proceeding, including all studies submitted therein. We conclude that the benefits of the changes we adopt today exceed the costs. Our evaluation of costs and benefits are contained in Section V below.

IV. Final Regulatory Flexibility Analysis

85. As required by the Regulatory Flexibility Act of 1980, as amended (RFA), an Initial Regulatory Flexibility Analysis (IRFA) was incorporated in the *NPRM.* The Federal Communications Commission (Commission) sought written public comment on the proposals in the *Further NPRM,* including comment on the IRFA. No comments were filed addressing the IRFA. This Final Regulatory Flexibility Analysis (FRFA) conforms to the RFA.

A. Need for, and Objectives of, the Rules

86. The *NPRM* in this proceeding launched a much needed review of the long-standing spectrum sharing regime between GSO and NGSO satellite systems operating in the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands. The decades-old spectrum sharing regime constitutes the primary restrictive regulatory requirement on NGSO satellite systems currently deploying at breakneck speed. Innovation in the satellite industry has witnessed new NGSO satellite operators launching thousands of satellites in the short span of a few years, and these operators are beginning to offer high-speed, low-latency broadband services. The *NPRM* sought to develop a substantial technical record concerning modern and efficient spectrum sharing among NGSO FSS (Fixed Satellite Service) systems, GSO FSS, and BSS (Broadcast Satellite Service) networks in the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands, while ensuring that any rule changes continue to safeguard and maintain the protection of co-frequency terrestrial services.

87. In response to the record developed from the *NPRM,* the Order replaces the outdated framework of EPFD limits on NGSO systems with modern protection criteria that take account of the improved spectrum sharing possibilities that modern satellite technology has brought, including through use of adaptive coding and modulation. Specifically, the Order requires NGSO satellites transmitting in the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands to protect co-frequency GSO networks using a long-term protection criteria of 3% time-weighted average throughput degradation as a long-term interference protection criterion. The Order adopts a short-term GSO protection criterion of 0.1% absolute increase in link unavailability. For GSO satellite links that do not use ACM, such as point-to-multipoint video transmissions, we adopt a protection criterion of −10.5 dB interference-to-noise (I/N) for 80% of the time. As an additional measure of protection for GSO networks, we require NGSO systems to observe a minimum 3-degree avoidance angle of the GSO arc. We decline to establish aggregate limits or other limits on NGSO systems at this time. Having taken a fresh look at today's satellite technology and operations, these new spectrum sharing rules will promote more efficient and effective use of the shared spectrum, and support a more competitive market for satellite broadband and other in-demand services while uncapping the potential of satellite constellations that were unthinkable when the current regime was developed, to the ultimate benefit of American consumers.

B. Summary of Significant Issues Raised by Public Comments in Response to the IRFA

88. There were no comments filed that specifically addressed the proposed rules and policies presented in the IRFA.

C. Response to Comments by the Chief Counsel for Advocacy of the Small Business Administration

89. Pursuant to the Small Business Jobs Act of 2010, which amended the RFA, the Commission is required to respond to any comments the Chief Counsel for Advocacy of the Small Business Administration (SBA) filed in this proceeding, and provide a detailed statement of any change made to the proposed rules as a result those comments. The Chief Counsel did not file any comments in response to the proposed rules or policies in this proceeding.

D. Description and Estimate of the Number of Small Entities to Which the Rules Will Apply

90. The RFA directs agencies to provide a description of, and where feasible, an estimate of the number of small entities that may be affected by the adopted rules. The RFA generally defines the term ''small entity'' as having the same meaning as the terms ''small business,'' ''small organization,'' and ''small governmental jurisdiction.'' In addition, the term ''small business'' has the same meaning as the term ''small business concern'' under the Small Business Act. A ''small business concern'' is one which: (1) is independently owned and operated; (2) is not dominant in its field of operation; and (3) satisfies any additional criteria established by the SBA. The SBA establishes small business size standards that agencies are required to use when promulgating regulations relating to small businesses; agencies may establish alternative size standards for use in such programs, but must consult and obtain approval from SBA before doing so.

91. Our actions, over time, may affect small entities that are not easily categorized at present. We therefore describe three broad groups of small entities that could be directly affected

by our actions. In general, a small business is an independent business having fewer than 500 employees. These types of small businesses represent 99.9% of all businesses in the United States, which translates to 34.75 million businesses. Next, ''small organizations'' are not-for-profit enterprises that are independently owned and operated and are not dominant in their field. While we do not have data regarding the number of non-profits that meet that criteria, over 99 percent of nonprofits have fewer than 500 employees. Finally, ''small governmental jurisdictions'' are defined as cities, counties, towns, townships, villages, school districts, or special districts with populations of less than fifty thousand. Based on the 2022 U.S. Census of Governments data, we estimate that at least 48,724 out of 90,835 local government jurisdictions have a population of less than 50,000.

92. The rules adopted in the Order will apply to small entities in the industries identified in the chart below by their six-digit North American Industry Classification System (NAICS) codes and corresponding SBA size standard. Based on currently available U.S. Census data regarding the estimated number of small firms in each identified industry, we conclude that the adopted rules may impact a substantial number of small entities. Where available, we also provide additional information regarding the number of potentially affected entities in the identified industries below.

Regulated industry (footnotes specify potentially affected entities within a regulated industry where applicable)	NAICS code	SBA size standard (million)	Total firms	Total small firms	% Small firms
Satellite Telecommunications	517410	$44	332	195	58.73
All Other Telecommunications	517810	40	1,673	1,007	60.19

E. Description of Economic Impact and Projected Reporting, Recordkeeping, and Other Compliance Requirements for Small Entities

93. The RFA directs agencies to describe the economic impact of adopted rules on small entities, as well as projected reporting, recordkeeping and other compliance requirements, including an estimate of the classes of small entities which will be subject to the requirement and the type of professional skills necessary for preparation of the report or record.

94. The Order defines specific metrics for long-term interference and short-term interference that must be used in compatibility analyses demonstrating that a NGSO FSS system operating in the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands in the United States will adequately protect co-frequency GSO networks. The Order adopts a long-term interference metric for GSO networks using ACM of 3% degraded throughput threshold and a 0.1% absolute increase in link unavailability as the short-term interference metric, along with a protection criterion for GSO networks not using ACM of −10.5 dB interference-to-noise (I/N) for 80% of the time and a 3-degree minimum GSO-arc avoidance angle, based on the technical record developed in this proceeding. The Commission concludes that establishing a protection metrics consistent with the technical evidence in the record provides the benefit of a clear standard for new NGSO operators, and a benchmark that parties can use to negotiate any alternative protections mutually agreed to in coordination.

95. The adopted protection criteria will impact information NGSO system applicants are required to report to the Commission, and small NGSO system applicants may incur compliance costs as a result of the Order. Specifically, NGSO system applicants may need to hire professionals or expend staff time on familiarization and implementation of the rules adopted in the Order. However, because of the costs involved in developing and deploying an NGSO satellite constellation in these bands, the Commission anticipates that few, if any, NGSO operators affected by this rulemaking would qualify under the SBA definition of ''small entity,'' and therefore small entities are not likely to have to hire professionals, or incur any compliance costs as a result of the Order.

F. Discussion of Steps Taken To Minimize the Significant Economic Impact on Small Entities, and Significant Alternatives Considered

96. The RFA requires an agency to provide, ''a description of the steps the agency has taken to minimize the significant economic impact on small entities . . . including a statement of the factual, policy, and legal reasons for selecting the alternative adopted in the final rule and why each one of the other significant alternatives to the rule considered by the agency which affect the impact on small entities was rejected.''

97. The Order amends rules that are applicable to space station operators requesting a license or grant of U.S. market access from the Commission. Specifically, the Order adopts changes to the spectrum sharing requirements among GSO and NGSO satellite systems operating in the United States in the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands, and specifies details of the technical demonstration that NGSO space station applicants in these bands must submit to show that they will not cause harmful interference to co-frequency GSO space station licensees and market access grantees. The technical demonstration of compatibility is based on a degraded throughput methodology, assessing absolute increase in link unavailability, and an I/N limit.

98. The Commission specifically considered, and declined, to adopt: a short-term interference criterion of 0.4% absolute increase in unavailability, an alternative of coordination or compliance with a GSO-arc avoidance angle only, or a sunset provision, because such proposals would provide less protection to GSO networks while not being shown to be technically necessary for the expansion of NGSO systems. The Commission also considered, but declined, to create new aggregate interference limits as none were proposed on the record.

G. Report to Congress

99. The Commission will send a copy of the Order, including this Final Regulatory Flexibility Analysis, in a report to Congress pursuant to the Congressional Review Act. In addition, the Commission will send a copy of the Order, including this Final Regulatory Flexibility Analysis, to the Chief Counsel for the SBA Office of Advocacy and will publish a copy of the Order, and this Final Regulatory Flexibility Analysis (or summaries thereof) in the **Federal Register**.

V. Regulatory Impact Analysis

A. Executive Summary

1. Summary

100. In the Order, the Commission modernizes the spectrum sharing regime between GSO and NGSO satellite systems operating in the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands.

The Order replaces EPFD limits on NGSO systems with performance-based GSO protection criteria. It also requires good-faith coordination efforts by both GSO and NGSO operators in the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands. We adopt the following technical backstops to protect GSO systems when coordination has not been reached:

- A long-term protection criterion of 3% time-weighted average throughput degradation for GSO satellite links using adaptive coding and modulation (ACM);
- A short-term protection criterion of 0.1% absolute increase in link unavailability;
- A supplemental protection criterion of −10.5 dB interference-to-noise (I/N) for 80% of the time for GSO satellite links that do not use ACM, such as point-to-multipoint video transmissions; and
- A supplemental protection requirement for NGSO systems to observe a minimum 3-degree avoidance angle of the GSO arc.

101. This economically significant regulatory action is submitted to the Office of Information and Regulatory Affairs (OIRA) for interagency review. The regulatory impact analysis (RIA) presents an assessment of the regulatory compliance costs and benefits associated with this action and is consistent with Executive Order 12866. Comparing the performance-based GSO protection criteria with other alternative policy options, Commission Staff concludes that the adoption of these proposed rules will result in significant benefits that outweigh the associated costs. This rule is considered a deregulatory action under Executive Order 14192.

2. Table of Benefits and Costs

102. *Summary of Benefits and Costs.* Based on Staff analysis, the net present value of benefits—after netting out costs of doing business and compliance—over five years would be $1.6 billion to $19.9 billion using a 3% annual discount rate or $1.4 billion to $17.1 billion using a 7% annual discount rate. Given these net benefit estimates, Staff finds that the overall benefits of the regulatory action outweigh the total costs.

	Year	Method 1				Method 2			
		Present value (3% discount)		Present value (7% discount)		Present value (3% discount)		Present value (7% discount)	
		Lower bound	Upper bound	Lower bound	Upper bound	Lower bound	Upper bound	Lower bound	Upper bound
Benefits ($ Billion)	2026	$0.5	$0.6	$0.5	$0.6	$0.2	$0.3	$0.2	$0.3
	2027	1.3	1.6	1.2	1.5	0.3	0.4	0.2	0.3
	2028	2.6	3.2	2.3	2.8	0.3	0.4	0.3	0.4
	2029	4.3	5.5	3.7	4.7	0.4	0.5	0.3	0.4
	2030	7.0	9.0	5.7	7.4	0.4	0.6	0.3	0.4
	Total	15.7	19.9	13.5	17.1	1.6	2.2	1.4	1.8
Quantifiable Costs ($ Thousands)	2026	112	112	107	107	112	112	107	107
	2027	13	13	12	12	13	13	12	12
	2028	13	13	11	11	13	13	11	11
	2029	12	12	11	11	12	12	11	11
	2030	12	12	10	10	12	12	10	10
	Total	162	162	152	152	162	162	152	152
Qualitative Costs	Costs from negotiating agreements induced by new spectrum sharing framework.								
Net Gain ($ Billions)	Total	15.7	19.9	13.5	17.1	1.6	2.2	1.4	1.8

B. Need for Regulatory Action

103. Wireless telecommunications devices function by transmitting signals over the electromagnetic spectrum, a finite public resource managed by the FCC. To promote efficient use of the spectrum and to minimize harmful interference, the FCC allocates spectrum into various bands. It designates some bands for exclusive, licensed use, while requiring shared use of other bands based on technical and other rules to mitigate harmful interference. In the most commonly used frequency bands used by satellite operators, between 10.7 GHz and 30 GHz, NGSO systems share primary fixed-satellite service (FSS) allocations with GSO networks, and they must also operate compatibly or coordinate with other federal and non-federal users of these bands.

104. NGSO FSS systems must comply with, among other rules, power limits expressed in EPFD to demonstrate that they do not cause unacceptable interference to GSO FSS and Broadcasting Satellite Service (BSS) networks. As NGSO operators supply data to a growing number of users, however, the record has shown that EPFD restrictions present a significant and growing regulatory constraint on NGSO systems seeking to meet consumer capacity needs, particularly during periods of peak congestion. Technological advances in the past three decades and the inherent issues in the EPFD limits warrant the establishment of a new, performance-based spectrum sharing framework between GSO and NGSO systems in the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands. By adopting the rules in the Order, the Commission would enable the U.S. space industry to make better use of spectrum resources. Specifically, the rules would enable NGSO systems to use more satellites to serve the same area, at potentially higher power, and over a wider portion of the visible sky while continuing to protect GSO networks as supported by real-world testing. This would immediately boost capacity, translating to faster broadband speeds for American consumers.

C. Background on NGSO–GSO Sharing

105. Broadband satellite services rely on shared spectrum. In the most commonly used frequency bands, between 10.7 GHz and 30 GHz, NGSO systems share primary fixed-satellite service (FSS) allocations with GSO networks and must also operate compatibly with BSS networks and stations in other services, including terrestrial services. NGSO FSS systems must comply with power limits expressed in EPFD to demonstrate that they meet their broader obligation not to cause unacceptable interference to GSO FSS and BSS networks. NGSO FSS systems must also meet separate power

limits expressed in power-flux density (PFD) to protect terrestrial services. Applicants for NGSO FSS space station licenses, and non-U.S.-licensed satellite operators seeking access to the U.S. market, must certify that they will comply with the specified EPFD limits.

106. The current EPFD limits for the protection of GSO networks were developed in the late 1990s, adopted internationally in 2000, and subsequently incorporated into the Commission's rules in 2000 and 2017. In 2019, the international community required NGSO FSS systems operating in the higher Q- and V-bands between 37.5 GHz and 51.4 GHz to meet certain long-term and short-term GSO protection criteria that incorporate a degraded throughput methodology. The World Radiocommunication Conference (WRC) 2019 (WRC–19) did not adopt EPFD limits in these bands. WRC–23 considered, but ultimately did not adopt, a proposal to review the EPFD limits under a future agenda item for WRC–27. Instead, ITU–R Working Party 4A is studying EPFD limits and will report findings at WRC–27.

107. On April 28, 2025, the Commission, in response to a petition for rulemaking by SpaceX, released an NPRM that proposed to revise the spectrum sharing regime between GSO and NGSO systems in downlink frequency bands between 10.7 GHz and 30 GHz that are subject to EPFD limits, and to amend §§ 25.146 and 25.289 of the Commission's rules. The *NPRM* sought to develop a substantial technical record concerning modern and efficient spectrum sharing among NGSO FSS systems and GSO FSS and BSS networks in the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands that could increase efficient use of the spectrum while protecting other services.

D. Regulatory Action

108. The Order establishes a new, performance-based spectrum sharing framework between GSO and NGSO systems in the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands. The new GSO protection framework would require good-faith coordination between GSO and NGSO operators. Where good-faith coordination fails, the rule would require NGSO satellites transmitting in the 10.7–12.7, 17.3–18.6, and 19.7–20.2 GHz bands to protect co-frequency GSO networks using a long-term protection criteria of 3% time-weighted average throughput degradation. The Order adopts a short-term GSO protection criterion of 0.1% absolute increase in link unavailability. For GSO satellite links that do not use ACM, the Order would adopt a protection criterion of −10.5 dB interference-to-noise (I/N) for 80% of the time. As an additional measure of protection for GSO networks, the Order would require NGSO systems to observe a minimum 3-degree avoidance angle of the GSO arc. To accompany these protection criteria, the Order adopts a realistic set of GSO reference links reflecting typical and widespread GSO operations in the United States. These GSO reference links are based on the set of 328 links provided in the record and drawn from both ITU data and the Commission's licensing databases.

E. Benefits

109. By modernizing the spectrum sharing framework between GSO and NGSO satellite systems, the rules adopted in the Order should deliver substantial economic benefits to American households, satellite competitors, and other stakeholders. As discussed in detail in the Order, these rules should increase capacity and broadband speeds, foster new competitive entry, and promote U.S. leadership globally. They should also strengthen the ability of NGSOs to serve as a lifeline to Americans in rural and remote areas. The record of this proceeding reflects broad support for modernizing satellite spectrum sharing. Commenters point out that, with greater operational flexibility under revised sharing rules, new NGSO systems would need smaller constellations and still have greater capacity to reach more customers, which would reflect a substantial reduction in launch costs, satellite costs, and costs of a new low-Earth orbit (LEO) constellation. Those lower costs should encourage new entry as well as lower prices for customers. The revised rules are also anticipated to support innovation through the availability of higher-throughput, lower-latency connectivity in rural and underserved areas. Accordingly, Staff is unpersuaded by arguments that the benefits of revising the EFPD limits are uncertain, speculative and overstated.

110. Certain commenters submitted studies concerning the benefits, with one providing quantitative estimates. An analysis by Harold Furchtgott-Roth suggests that the effects of moving away from the outdated EPFD rules would increase NGSO system capacity by 74% to 180%, which could reduce average costs per unit of capacity by 43% to 64%. The study further estimated that this would increase annual global consumer welfare by $1.62 billion to $16.2 billion, translating to a net present value increase in global welfare ranging from $10 billion to $100 billion. A second study submitted by the Phoenix Center posited that a rising relative willingness to pay for NGSO broadband—even without growth in the overall satellite market—implies that today's spectrum sharing- rules are too restrictive and should shift toward greater accommodation of NGSO systems. The intuition of the model presented in the study is that, as NGSO demand has grown far faster than demand for GSO services, an efficient regime must evolve to reflect this higher marginal valuation of NGSO connectivity. While the study did not provide quantitative estimates of benefits, Staff believes that the results of this study align with the steps we are taking today.

111. While Staff generally agrees with the conclusion of the Harold Furchtgott-Roth study, we find that the report does not adequately justify the assumptions underlying the consumer surplus calculations. For example, the report assumes price reductions ranging from 10% to 50% without providing a supporting rationale and provides no estimate of price elasticity of demand or passthrough rate, despite these assumptions being crucial in calculating consumer surplus. Furthermore, even setting aside methodological concerns with the consumer surplus calculations, it would still be necessary to appropriately scale any global consumer surplus estimates to derive a corresponding estimate of the change in domestic consumer surplus. If we assumed that U.S. consumers account for only one-quarter of the global benefits, the estimated annual benefits are reduced to approximately $405 million to $4.05 billion. If we conservatively take the lower bound estimate of $405 million, the corresponding net present value of benefits accruing over the next five years is $1.9 billion when using a discount rate of 3% and $1.7 billion when using a discount rate of 7%. Under these revised assumptions, the overall increase in benefits to U.S. consumers nevertheless remains substantial.

112. Commission Staff conducted a separate internal assessment of benefits. Staff based its analysis on the potential relationship between the increase in supply of satellite capacity discussed in the Order and the projected overall growth in the size of satellite data services market. Based on support in the record, Staff assumed an increase in capacity in the foreseeable future of between 500% and 700%. Staff related these assumed increases in capacity to industry analyst projections of the market value of U.S. satellite data services as well as the supply of satellite

capacity using two alternative methodologies. First, we assume that the supply of NGSO high throughput satellite (HTS) capacity is 500–700% greater than it would be in 2030 absent the rule changes and infer that market value will expand proportionally based on the preexisting relationship between satellite market value and capacity. Second, we assume that the industry analyst's projected growth of HTS satellite capacity from 2025 to 2030 is correct, but that some fraction of that capacity growth is due to the 500% to 700% increase in HTS NGSO capacity due to the Order and that the fraction of market value growth due to the Order is also the same. For both methods, Staff then assumes that NGSO operators will earn 58% in profits on the gain in market value, and we use this as our estimate of gains in producer surplus. Staff did not attempt to estimate consumer surplus so that our estimate of benefits, which consists of gains in producer surplus, is conservative. We describe the two methods in detail below.

113. According to January 2025 analyst estimates for the years 2024–2034, the value of U.S. satellite data services will grow from $3.40 billion to $19.53 billion at a CAGR of 19.1%. Based on a separate April 2024 report estimating NGSO and GSO HTS capacity in 2023 and 2028, NGSO and GSO capacity will grow between 2023 and 2028 at a compound annual growth rate (CAGR) of 59.1% and 22.2%, respectively, leading to a total HTS CAGR of 56.1%.

114. *Method 1:* First, Staff assumes that analyst projections do not anticipate the capacity increase that Staff attributes to the revised spectrum sharing rules, such that 2030 capacity would be 500–700% more than the initial projections. Staff then calculates the new CAGR of capacity implied by the new 2030 level of capacity and then use the new CAGR to estimate the increase in the value of U.S. data services for the years 2025–2030. The markets value gains are then converted to gains in producer surplus by multiplying by the profit margin of 58%. Staff treats the net present value (NPV) increase in producer surplus as a public benefit. Total HTS throughput CAGR is 124.2% to 137.5%, which is significantly larger than the original CAGR of 56.1% for every year from 2026 to 2030, resulting in $15.7 to $19.9 billion in NPV at a 3% discount rate or $13.5 billion to $17.1 billion NPV at a 7% discount rate.

115. *Method 2:* Second, Staff assumes that the industry analysts anticipate some sort of regulatory change to achieve the projected supply increase. In this scenario, Staff assumes that the Order is part of these anticipated regulatory changes, so that a fraction of the increase in capacity supply from 2025 to 2030 is attributable to the Order. Staff assumes that the Order will lead to an increase in NGSO HTS capacity of either 500% or 700% from 2025 to 2030. Based on the 2025 capacity of 60,009 Gbps, this is 300,045 Gbps or 420,063 Gbps, respectively. By comparison, a projection based on analyst reports indicates that total HTS capacity will increase by 560,846 Gbps from 2025 to 2030 (using a CAGR of 56.1%). This implies that either 300,045 Gbps/560,846 Gbps = 53.5% or 420,063/560,846 Gbps = 74.9% of growth is due to the Order. Staff then assumes the Order is responsible for the same fraction (either 53.5% or 74.9%) of the increase in satellite markets value each year between 2025 and 2030 and calculate the PV gain associated with that fraction of the increase in market value. After multiplying by the profit margin of 58%, this leads to a producer surplus gain in present value that is attributed to the Order ranging from $1.6 billion to $2.2 billion in benefits using a 3% discount rate, or $1.4 to $1.8 billion using a 7% discount rate.

116. Combining the results of the two approaches, Staff finds benefits ranging from $1.6 billion to $19.9 billion using a 3% discount rate and ranging from $1.4 billion to $17.1 billion using a 7% discount rate.

F. Costs

117. Staff accepts the findings of the Order that the rules adopted therein, including the long-term and short-term criteria for GSO satellite links using ACM, protection criteria for those that do not use ACM, and the minimum avoidance angle of the GSO arc will continue to provide sufficient protection to GSO operations from substantial interference, and therefore Staff concludes that they will not result in harm or substantial costs to GSO providers. Staff is therefore unpersuaded by arguments raised in a Brattle Group report submitted by Viasat, alleging that abandoning the long-standing EPFD framework would impose unacceptable interference costs on GSO operators, since, as the Order concludes, the performance-based GSO protection criteria that the Order adopts are sufficient to protect incumbent GSO operations and other incumbent users. Staff also is unpersuaded by Brattle's arguments that the new framework would undermine the property rights and market-driven approach of the EPFD framework. In contrast, the new framework would improve these aspects as it makes the use of coordination explicit and allows for mutually beneficial outcomes above and beyond those that would be required by our backstop performance criteria. Rather than reduce innovation and investment through greater regulatory uncertainty and interference risk, as Brattle claims, the new rules will continue to protect existing spectrum users, while encouraging investment through more efficient spectrum use. Staff also finds Brattle concerns about international coordination unfounded because it is legally feasible for an administration to exceed the ITU EFPD limits and technologically feasible for service providers to operate both under and above those limits in adjacent countries.

118. Staff identifies two categories of costs: (1) increases in expenditures needed to serve a larger pool of customers, and (2) costs of complying with the revised rules. The analysis in the benefits section accounts for the category 1 costs—*i.e.,* the costs to serve additional customers by multiplying estimated market value gains by an estimated profit margin. This amounts to subtracting incremental costs of serving new customers from incremental revenue. With respect to category 2, we recognize three kinds of potential costs of complying with the revised rules: familiarization costs, certification costs, and negotiation costs. Familiarization costs result from work that regulatees wishing to take advantage of the revised rules need to perform to familiarize themselves with the rule revisions. Certification costs are the labor costs that any NGSO operator wishing to take advantage of the new rules must incur in order to certify that it is using a degraded throughput methodology to avoid unacceptable interference. In the alternative, NGSO operators wishing to take advantage of the new rules may certify that they have a coordination agreement with any operational co-frequency GSO satellite network. Negotiation costs are costs that NGSO and GSO operators would need to incur to reach a coordination agreement. As there is a lack of information to estimate how frequent or long such negotiations would be, Staff is unable to quantity the costs of such negotiations. However, Staff concludes due to the relatively low number of negotiating partners in the industry coupled with the backstop option of a compatibility showing that associated costs would be relatively small compared to the volume of proposed benefits.

119. Staff estimates familiarization and certification costs by using needed

labor hours worked by engineers and attorneys to make sure that NGSO operators understand and comply with the new rules. Staff estimates that telecommunications aerospace engineers are compensated at a rate of $100.26/hour and telecommunications attorneys are compensated at $140.73/hour. Staff estimates that 26 NGSO constellations may be impacted by our rules, and conservatively assume that 26 NGSO regulatees will require familiarization and certification work. For familiarization, Staff assumes reading and understanding the order will take 6 engineer hours of work and 2 lawyer hours of work for each constellation, implying $23,000 of costs for NGSO operators. Because these rules replace existing rules, future entrants into NGSO FSS operators would not be expected to incur additional familiarization costs because they would need to familiarize themselves with only one set of rules prior to entry. For certification, we conservatively assume that each of the 26 NGSO constellations would wish to submit a § 25.146 compatibility showing and therefore incur the certification cost. Additionally, because the § 25.146 compatibility showing is different from what new applicants would need to submit to the ITU to certify compliance with EPFD limits outside the United States, we assume that new applicants would likewise incur the certification cost. In these cases, Staff estimates that 26 operators incur a one-time certification cost and that in future years, 4 new operators would incur the certification cost. For each operator, we assume that certification comprises of 24 hours of engineering work and 8 hours of legal work. Therefore, Staff estimates then that the first year will result in $92,000 in certification costs, and then every subsequent year will result in $14,000 in certification costs. Adding the one-time familiarization costs to the first year certification costs, we have $115,000 of costs in the first year of the new rules, followed by the $14,000 of annual certification costs. Staff then finds that total costs, including familiarization and certification, from 2026 to 2030, sum to $162,000 using a 3% discount rate, and $152,000 using a 7% discount rate, respectively.

G. Alternate Policies

1. Alternative A—No Action

120. Under this alternative, the Commission would decline to revise the current sharing framework based on EPFD and PFD limits. The differing treatment of Ka-band frequencies in the current rules—where the EPFD limit in the upper portion of the band is substantially more restrictive than the EPFD limit in the lower portion of the band—was widely criticized in the record as technically unjustified. In addition, the overall methodology used to derive the current EPFD limits has been called into question, including the use of methodologies designed to address short-term interference to develop long-term EPFD limits, overly conservative modeling of rain attenuation, and the inclusion of a large number of unstable links with negative link margin values in the set of GSO reference links used to derive the EPFD limits. For these reasons, as well as others identified in the record, Staff finds that the current limits were overly and unnecessarily restrictive.

121. Modern management practices allow more satellites to serve the same area, at potentially higher power, and over a wider portion of the visible sky. Failure to adopt newer standards would leave satellite spectrum underutilized relative to its potential economic and technological value. Without further action, the Commission would forgo an opportunity to promote more efficient use of spectrum, stimulate innovation, and bridge the digital divide.

2. Alternative B—Adopt Modern Performance-Based GSO Protection Rules as Bright-Line Rules To Replace Existing EPFD

122. Under this alternative, the Commission would replace the current sharing framework based on EPFD limits with performance-based GSO network protection requirements. These performance-based requirements would include: (1) a long-term protection criterion of 3% time-weighted average throughput degradation for GSO satellite links using ACM; (2) a short-term protection criterion of 0.1% absolute increase in link unavailability for GSO satellite links; (3) a protection criterion of −10.5 dB interference-to-noise (I/N) for 80% of the time for GSO satellite links that do not use ACM; and (4) an NGSO minimum 3-degree avoidance angle of the GSO arc. Given the overly conservative nature of the current sharing framework, these more modern and permissive requirements are an improvement over Alternative A, as they would result in an increase in satellite capacity, while protecting incumbent GSO providers. As discussed below, however, this alternative is inferior to the rules adopted, because it does not permit parties to negotiate a mutually beneficial coordination agreement that may be superior to what would exist from the mere application of the modern performance-based requirements described above.

3. Alternative C (Adopted Rules)—Introduce A Coordination-Based Framework With a Backstop of Modern Performance-Based GSO Protection Rules as a Default Protection Regime Should the Parties Be Unable To Agree

123. The Commission has emphasized that private coordination among satellite operators, based on real-world operating parameters, offers the best opportunity for efficient spectrum sharing. The current EPFD limits do not accommodate such coordination because they must be met regardless of any agreements between particular NGSO and GSO satellite operators. Commission precedent also supports a requirement of good-faith coordination backstopped by performance-based interference metrics.

124. If the parties cannot agree on a coordination plan, then the performance-based GSO network protection requirements set forth in Alternative B would apply as a default protection requirement. Alternative C is superior to Alternative B, because it enables parties to negotiate a mutually beneficial coordination agreement if such an agreement is superior to what would result from the application of the performance-based GSO network protection requirements. Given this, the parties must be at least as well off under Alternative C compared to Alternative B.

H. Justification Determination

1. Benefits Exceed Costs

125. Staff finds that the changes adopted in the Order will generate large broad-based benefits to the public that exceed the relatively low compliance costs. Moving away from restrictive and outdated requirements will enable new uses and capabilities for NGSO satellites. Staff estimates large benefits in the form of increases in producer surplus from expanded economic activities in satellite telecommunications services. These activities will take the form of increased satellite deployment, expanded service and new innovations in technology that will spur economic activity and help close the digital divide. Staff estimates net benefits—after netting out compliance costs—ranging from $1.6 billion to $19.9 billion using a 3% discount rate and $1.4 billion to $17.1 billion using a 7% discount rate.

2. Highest Net-Benefit Alternative

126. Based on the record and economic analysis, Staff finds that

Alternative C—the coordination framework with default performance-based, bright-line rules offers the greatest net benefit among the three alternatives considered. This combination of encouraging coordination among parties buttressed by backstop protection requirements should the parties be unable to agree, generates the most protection of GSO satellite operations without hindering mutually beneficial coordination between GSO and NGSO satellite operators.

3. Small Entity Impacts

127. The rules adopted by the Commission in the Order will benefit many small entities by giving them greater access to satellite-based communication services, while imposing few direct compliance costs on small entities. The RFA, generally defines the term ''small entity'' as having the same meaning as under the Small Business Act. In addition, the term ''small business'' has the same meaning as the term ''small business concern'' under the ''Small Business Act.'' A ''small business concern'' is one which: (1) is independently owned and operated; (2) is not dominant in its field of operation; and (3) satisfies any additional criteria established by the SBA. We divide small entities into two industries—identified in the chart below—that could be directly affected by our actions, satellite telecommunications and other telecommunications.

Regulated industry (footnotes specify potentially affected entities within a regulated industry where applicable)	NAICS Code	SBA size standard (million)	Total firms	Total small firms	% Small firms
Satellite Telecommunications	517410	$44	332	195	58.73
All Other Telecommunications	517810	40	1,673	1,007	60.19

128. The adopted modern sharing rules replace an outdated, spectrally inefficient sharing framework, and will promote more efficient use of spectrum, stimulate innovation, and bridge the digital divide. Small entities that use or provide input for these services will benefit. Out of the existing small satellite telecommunications providers, few if any are satellite operators, given the high fixed costs of deploying and operating satellites, and thus subject to the rules. We conclude that little to no compliance costs will be imposed on small entities. Additionally, the Commission considered alternative proposals and weighed their benefits against their potential costs to small businesses and other entities. On balance, the adopted rules will result in significant economic benefits for small entities.

4. Impacts on Disadvantaged Populations

129. The new adopted sharing framework should help disadvantaged populations, such as the extremely rural, who lack current access to telecommunications services. More utilization of spectrum stimulated by the new rules is likely to result in expanded coverage by satellites telecommunications services. Coverage might then extend to areas that were economically unprofitable, such as areas with very low population densities. Other disadvantaged groups are likely to face the same benefits as the general population as the benefits are likely broad-based. As for costs, we expect them to entirely take the form compliance costs for satellite service providers and not the general public. As a result, disadvantaged populations are unlikely to incur disproportionate costs.

VI. Ordering Clauses

130. *It is ordered,* pursuant to Sections 4(i), 7(a), 303, 308(b), and 316 of the Communications Act of 1934, as amended, 47 U.S.C. 154(i), 157(a), 303, 308(b), 316, that the Order *is adopted,* the policies, rules, and requirements discussed herein *are adopted,* and part 25 of the Commission's rules *is amended* as set forth in the final rules.

131. *It is further ordered* that the Order *shall be* effective 60 days after publication in the **Federal Register**, except that §§ 25.146(a)(3) and 25.289(a)(2), which may contain new or modified information collection requirements, will not become effective until the Office of Management and Budget completes review of any information collection requirements that the Space Bureau determines is required under the Paperwork Reduction Act. The Commission directs the Space Bureau to announce the effective date for §§ 25.146(a)(3) and 25.289(a)(2) by publication of a document in the **Federal Register**.

132. *It is further ordered* that the Commission's Office of Secretary *shall send* a copy of the Order, including the FRFA, to the Chief Counsel for the Small Business Administration (SBA) Office of Advocacy.

133. *It is further ordered* that the Commission's Office of the Managing Director, Performance Program Management, *shall send* a copy of the Order in a report to be sent to Congress and the Government Accountability Office pursuant to the Congressional Review Act, *see* 5 U.S.C. 801(a)(1)(A).

List of Subjects

47 CFR Part 25

Administrative practice and procedure, Incorporation by reference, Satellites.

Federal Communications Commission.

Marlene H. Dortch,

Secretary.

Final Rules

For the reasons discussed in the preamble, the Federal Communications Commission amends 47 CFR part 25 as follows:

PART 25—SATELLITE COMMUNICATIONS

■ 1. The authority citation for part 25 continues to read as follows:

Authority: 47 U.S.C. 154, 301, 302, 303, 307, 309, 310, 319, 332, 605, and 721, unless otherwise noted.

■ 2. Delayed indefinitely, amend § 25.146 by adding paragraph (a)(3) to read as follows:

§ 25.146 Licensing and operating provisions for NGSO FSS space stations.

(a) * * *

(3) For operation in the United States in the 10.7–12.7, 17.3–18.6, or 19.7–20.2 GHz bands, an NGSO FSS applicant may, as an alternative to certifying that it will comply with equivalent power-flux density limits in these bands, apply the following procedure: Prior to commencing operations, an NGSO FSS applicant must either certify that it has completed a coordination agreement with any operational co-frequency GSO satellite network, or submit for Commission approval a compatibility showing which demonstrates by use of a degraded throughput methodology

that it will not cause unacceptable interference to any such system with which coordination has not been completed.

(i) Compatibility showings must contain the following elements:

(A) A demonstration that the NGSO system will cause no more than 3% time-weighted average degraded throughput of any GSO reference link that uses adaptive coding and modulation;

(B) A demonstration that the NGSO system will cause no more than 0.1% absolute change in link availability to any GSO reference link;

(C) A demonstration that the NGSO system will cause no more than −10.5 dB I/N for 80% of time for any GSO reference link that does not use adaptive coding and modulation; and

(D) A certification that the NGSO system will use a minimum GSO-arc avoidance angle of 3 degrees with respect to any operational co-frequency GSO space station serving the United States.

(ii) While a compatibility showing remains pending before the Commission, the submitting NGSO licensee or market access recipient may commence operations on an unprotected, non-interference basis with respect to the operations of any co-frequency GSO network with which coordination has not been completed.

* * * * *

■ 3. Revise § 25.289 to read as follows:

§ 25.289 Protection of GSO networks by NGSO systems.

(a) *Unacceptable interference.* Unless otherwise provided in this chapter, an NGSO system licensee must not cause unacceptable interference to, or claim protection from, a GSO FSS or GSO BSS network.

(1) An NGSO FSS licensee operating in compliance with the applicable equivalent power flux-density limits in Article 22, Section II of the ITU Radio Regulations (incorporated by reference, § 25.108) will be considered as having fulfilled this obligation with respect to any GSO network.

(2) [Reserved]

(b) *Coordination.* GSO and NGSO satellite operators must coordinate in good faith the use of commonly authorized frequencies in the 10.7–12.7, 17.3–18.6, or 19.7–20.2 GHz bands in the United States.

■ 4. Delayed indefinitely, further amend § 25.289 by adding paragraph (a)(2) to read as follows:

§ 25.289 Protection of GSO networks by NGSO systems.

(a) * * *

(2) An NGSO FSS licensee authorized pursuant to § 25.146(a)(3) will be considered as having fulfilled this obligation with respect to any GSO network.

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