

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

In the Matters of	)	
	)	
Mitigation of Orbital Debris in the New Space Age	)	IB Docket No. 18-313
	)	
Mitigation of Orbital Debris	)	IB Docket No. 02-54 (Terminated)
	)	

**REPLY COMMENTS OF AMAZON.COM, INC.**

May 6, 2019

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Amazon.com, Inc. (“Amazon”) submits these reply comments in response to the Federal Communications Commission’s (“FCC” or “Commission”) *Notice of Proposed Rulemaking* in the above-captioned proceedings.<sup>1</sup> The *NPRM* seeks to improve and clarify the Commission’s orbital debris rules for the space industry.

**I. INTRODUCTION**

Amazon supports the Commission’s focus on orbital debris rules that foster space safety and encourage the responsible deployment of space technologies. The satellite industry has changed since the Commission last established orbital debris rules in 2004, and we are confident the industry will continue to experience rapid changes in the coming years. Amazon welcomes the opportunity to collaborate with the FCC, satellite operators and others to address orbital debris mitigation and other space policies.

In response to the comments already submitted, Amazon submits these reply comments in support of: (i) applying risk standards on a per-satellite, rather than per-system, basis; and (ii)

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<sup>1</sup> *Mitigation of Orbital Debris in the New Space Age; Mitigation of Orbital Debris*, Notice of Proposed Rulemaking and Order on Reconsideration, FCC 18-159 (rel. Nov. 19, 2018) (“*NPRM*”).

establishing performance-based maneuverability standards for satellites operating above a certain altitude.

## **II. RISK STANDARDS SHOULD APPLY ON A PER-SATELLITE BASIS RATHER THAN ON AN AGGREGATE, SYSTEM-WIDE BASIS.**

At multiple points in the *NPRM*, the Commission seeks comment on whether to adopt certain risk standards on a per-satellite basis, or on an aggregate, system-wide basis.<sup>2</sup> Any risk standards that the Commission adopts should apply on a per-satellite basis. To do otherwise would result in different standards for each satellite operator depending on the number of satellites that it seeks to launch and operate, thus leading to an uneven regulatory environment that could deter, and in some cases preclude, operators of large constellations from deploying new, innovative systems. As a result, space innovation would suffer and consumers around the globe would forego the benefits these systems would have provided.

Multiple commenters in the record aptly recognize that applying the proposed standards and metrics on an aggregate basis would impose disproportionate and often insupportable requirements on operators, leading to an inconsistent regulatory environment.<sup>3</sup> Applying the

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<sup>2</sup> Specifically, the *NPRM* seeks comment on whether to adopt aggregate versus per-satellite standards with respect to four different proposed requirements for NGSO applicants to: (1) “demonstrate that the probability that their spacecraft will collide with a large object during the orbital lifetime . . . will be no greater than 0.001,” *NPRM* ¶ 26; (2) certify that “the probability of accidental collision with small objects that would cause loss of control and prevent post-mission disposal is less than 0.01,” *id.* ¶ 27; (3) provide a metric for probability of successful deorbit, *id.* ¶ 46; and (4) “provide a statement indicating the actual calculated human casualty risk” for post-mission disposal that uses uncontrolled atmospheric re-entry, *id.* ¶ 62.

<sup>3</sup> See, e.g., Comments of the Boeing Company, IB Docket No. 18-313, at 10-11 (filed Apr. 5, 2019) (“Boeing Comments”); Comments of Space Exploration Technologies Corp., IB Docket No. 18-313, at 15-16 (filed Apr. 5, 2019) (“SpaceX Comments”); Letter from Anne E. Sweet, NASA Representative to the Commercial Space Transportation Interagency Group Human Exploration and Operations Mission Directorate, Launch Services Office, to Marlene H. Dortch, Secretary, FCC, IB Docket No. 18-313, at 6 (filed Apr. 4, 2019).

proposed standards and metrics on an aggregate basis could result in individual satellites being less safe than constellations because operators with smaller constellations would be subject to a lower per-satellite threshold or standard than those with larger systems. As a result, multiple NGSO systems that collectively operate the same number of satellites as a single large constellation would each be held to a lower standard, even though the number of satellites operating—and the need to mitigate orbital debris risks—would be the same as between the group of small constellations and the one large constellation.<sup>4</sup>

To the extent the Commission is concerned about the risk of collisions at altitudes containing a relatively high number of spacecraft, the relevant metric is not the size of an individual operator’s constellation, but the overall density of the operating altitude. Indeed, the risk of a collision results from the totality of objects (spacecraft and debris) at a given altitude, and such risk is shared by the entire spacecraft population at a given altitude. Avoiding collisions is not the sole province of a constellation; this responsibility falls on all spacecraft operating at dense altitudes. Thus, altitudes and even specific orbits in space that are congested should represent zones where all spacecraft satisfy risk standards appropriately reflecting the increased hazard a collision would represent to spaceflight generally. Under such a density-based approach, new systems would be subject to per-satellite risk standards that appropriately reflect the operating environment.

### **III. THE COMMISSION SHOULD ESTABLISH STANDARDS FOR MANEUVERABILITY.**

The *NPRM* recognizes the importance of satellite maneuverability to safe space operations, and seeks comment on whether the FCC “should . . . require all NGSO satellites planning to operate

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<sup>4</sup> See SpaceX Comments at 15-16.

above a particular altitude to include propulsion capabilities reserved for station-keeping and to enable collision avoidance maneuvers[.]”<sup>5</sup> To ensure satellites are capable of changing their trajectory to avoid collisions, the Commission should heed the ample support in the record for imposing a maneuverability standard above a certain altitude—specifically 400 km.

Satellite maneuverability is a keystone of good space stewardship. As one commenter observed, “[a] simple yet fundamental responsibility of every satellite operator is the ability to track and control the trajectories of their assets.”<sup>6</sup> Many commenters therefore support a requirement that spacecraft be designed to be maneuverable.<sup>7</sup> While commenters disagree about whether propulsion capabilities are necessary to ensure adequate maneuverability,<sup>8</sup> one commenter

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<sup>5</sup> *NPRM* ¶ 34.

<sup>6</sup> Comments of WorldVu Satellites Limited, IB Docket No. 18-313, at 11 (filed Apr. 5, 2019) (“OneWeb Comments”).

<sup>7</sup> *See, e.g., id.* (“All spacecraft must be trackable and any spacecraft deployed above the [International Space Station] should include maneuvering capabilities in order to obtain a license or U.S. market access from the Commission.”) (emphasis in original); Comments of the Duke Science Regulation Lab, IB Docket No. 18-313 at 18 (filed Apr. 5, 2019) (advocating for requirements that “satellite operators . . . ensure that their launched objects meet . . . design specifications[.]” including “[m]aneuverability to enable satellites to avoid collision with debris”); Comments of ORBCOMM INC., IB Docket No. 18-313, at 11 (filed Apr. 5, 2019) (“ORBCOMM Comments”) (“ORBCOMM suggests that the Commission require ‘maneuverability’ sufficient for collision avoidance and de-orbiting at the end of life.”); Comments of Iridium Communications Inc., IB Docket No. 18-313, at 7 (filed Apr. 5, 2019) (“Iridium Comments”) (“The Commission should adopt 400 km as the upper altitude at which space stations without propulsion should be permitted to operate.”); Comments of Telesat Canada, IB Docket No. 18-313, at 6 (filed Apr. 5, 2019) (“Telesat believes that NGSO spacecraft in orbits above 400 km should be designed to be capable of performing timely and effective collision avoidance[.]”); Comments of the Aerospace Corporation, IB Docket No. 18-313, at 10 (filed Mar. 7, 2019) (“A new system should demonstrate that it can avoid a collision as it transits a manned object’s altitude without requiring that system to maneuver.”).

<sup>8</sup> *Compare, e.g.,* Comments of Maxar Technologies Inc., IB Docket No. 18-313, at 13 (filed Apr. 5, 2019) (“Maxar Comments”) (to “fully participate in active collision avoidance,” satellites in orbits above 400 km “must have propulsive capability to perform collision avoidance maneuvers”) *with* Boeing Comments at 19 (opposing “the adoption of a blanket rule that all NGSO satellites that would operate above a certain altitude must have propulsion capabilities” in favor of

correctly notes that “[n]on-propulsive methods of maneuvering satellites remain largely experimental and it is unclear whether they are capable of effectively reducing collision risk.”<sup>9</sup>

Amazon recommends that the Commission establish a performance-based standard and it therefore seems productive to discuss what performance metrics would be appropriate for such a maneuverability standard. Given the advanced notice of potential collisions and distances often required to avoid such conjunctions, Amazon suggests that an appropriate performance-based standard would be requiring satellites to be capable of maneuvering at least 5 km within 48 hours of receiving a conjunction warning. Although propulsion techniques would meet such a maneuverability standard, the benefit of it being performance-based is that it would not preclude emerging technological alternatives if their efficacy in avoiding conjunctions within typical warning times can be assured.

Furthermore, many commenters recommend that the Commission establish a threshold based on the altitude of operations, above which an NGSO system must be designed with maneuverability capability.<sup>10</sup> The record shows support for selecting 400 km as the appropriate threshold given that the International Space Station operates at this approximate altitude.<sup>11</sup> Amazon agrees with these commenters that 400 km would be a reasonable threshold for a maneuverability requirement.

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regulations which “allow NGSO satellite applicants to provide demonstrations that the techniques that they propose to employ (potentially including drag) are adequate to enable responsive maneuvers”).

<sup>9</sup> Iridium Comments at 6.

<sup>10</sup> See *e.g.*, *id.*; ORBCOMM Comments at 11.

<sup>11</sup> See OneWeb Comments at 11; Maxar Comments at 13; Iridium Comments at 6; Comments of Integrity Applications, IB Docket No. 18-313, at 3-4 (filed Dec. 17, 2018).

#### IV. CONCLUSION

Amazon shares the Commission's interest in maximizing space safety and appreciates the Commission's focus on how innovative changes in the global commercial satellite industry affect this objective. To this end, the Commission should ensure that any new orbital debris rules are consistent with the principles and proposals stated herein.

Respectfully submitted,

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