



Federal Communications Commission
Washington, D.C. 20554

June 22, 2017

Bruce A. Olcott
Jones Day
51 Louisiana Ave. NW
Washington, DC 20001

Re: The Boeing Company, IBFS File No. SAT-LOA-20170301-00028 (Call Sign S2993)

Dear Mr. Olcott:

On March 1, 2017, The Boeing Company (Boeing) filed the above-captioned application for authority to construct, deploy, and operate a non-geostationary satellite orbit (NGSO) fixed-satellite service (FSS) system utilizing Ka-band and V-band frequencies. To aid in the Commission's evaluation of Boeing's application, please provide updated and additional information as detailed below.¹

1. Boeing requests that the Commission establish a different launch schedule for its satellite system, and proposes to launch its constellation in two distinct phases with initial deployment completed within six years, and final deployment completed after twelve years.² Boeing states that "initial deployment would include a sufficient number of satellites to satisfy the Commission's domestic geographic coverage requirement to provide service on a continuous basis throughout all fifty states, Puerto Rico and the U.S. Virgin Islands."³ Please clarify how many satellites Boeing plans to launch during the initial deployment.
2. In Table III-1 of its application, Boeing includes minimum gain-to-temperature ratio values for eighteen receiving beams, including beams G2L1 and G2R1.⁴ These two beams are not included in Schedule S. Please explain this inconsistency and, if warranted, include the necessary Schedule S information for these beams.
3. In its Schedule S attachment Boeing provides information for transmitting beams G0L0, G1L0, G0R0 and G1R0. In the associated antenna gain contour diagrams however, these same beams are labeled as receiving beams. Please either clarify that these beams are in fact transmitting beams, or correct the information in Schedule S, as appropriate.
4. Section 25.114(c)(4)(vi)(B) of the Commission's rules further requires that for space stations in non-geostationary satellite orbits (NGSO), the applicant specify for each unique orbital plane, the predicted antenna gain contour(s) for each transmit and receive antenna beam for one space station if all space stations are identical in the constellation. If individual space stations in the constellation have different antenna beam configurations, the applicant must specify the predicted antenna gain contours for each transmit and receive beam for each space station type and orbit or

¹ 47 CFR § 25.111(a).

² Boeing Application at 28-29.

³ Boeing Application at 28-29.

⁴ Boeing Application at 10.

orbital plane requested. In its application, Boeing defines a hybrid NGSO space segment consisting of 132 low-Earth orbit (LEO) and 15 highly inclined satellites in the range of GSO altitude operating in three distinct constellations.⁵ Although Boeing has provided a set of antenna gain contour diagrams, it is not entirely clear which beams may be associated with which type of satellite. Please confirm whether antenna contour diagrams labeled “IGSO” are associated with satellites in the high-altitude orbits and those labeled “V-Band Constellation” are associated with satellites operating in LEO. Otherwise, please clarify how each of the beams (including ISL beams as discussed below) may be associated with specific satellites in Boeing’s constellation. In addition, we ask whether those beams associated with the high-altitude sub-constellations may all be presumed to be representative of space stations in each of the three distinct sub-constellations (*i.e.*, the Americas constellation, the Europe/Africa/ Middle East constellation and the Asia-Pacific constellation.).⁶

5. Boeing states that its LEO satellites will have a primary coverage area defined by a 25° elevation footprint.⁷ Boeing does not state the specific coverage areas for satellites in the high-altitude orbit portion of the constellation. In the Schedule S beam pages, however, there are multiple descriptions applied to various beams’ service areas. Even if only the beams presumed to be associated with LEO constellation satellites (as described above) are examined, there are inconsistencies in the description of the coverage areas.⁸ Furthermore, the meanings of some of these service area descriptions are not entirely clear. The antenna gain contour diagrams provide no further clarification, as they include no descriptions in the fields for Service Area Number/Name. To assist the Commission in evaluation of Boeing’s application, please provide the following:

- Please verify that the service areas given in Schedule S for each beam are correct.
- Please clarify what is meant by the Service Area descriptions Boeing has provided. In particular, please clarify the meanings of “Visible Earth above 90° elevation angle”, “Spot Beam” and/or “Beam at Boresight.” Please also refer to the instructions for entry of Service Area descriptions in paragraphs 8.a.xvi and 10.a.xv in the Schedule S instructions for additional guidance.

6. Section 25.114(c)(4) specifies the information that must be provided in Schedule S for each space station transmitting and receiving antenna beam.⁹ In its application, Boeing does not include Schedule S information for any of the transmitting or receiving inter-satellite link (ISL) beams. Instead, Boeing provides certain ISL beam information in Table III-2 and III-3¹⁰ that includes many, but not all, of the parameters that are required by Schedule S. Although Boeing states that

⁵ Boeing Application at 12.

⁶ Paragraphs 8.a.xv.2 and 10.a.xiv.2 of the Schedule S instructions may provide guidance in responding to this question.

⁷ Boeing Application at 12.

⁸ For example, there are inconsistent descriptions used for beams L2L0, L3L0, L0L0, L1L0, L0R0, and L1R0. In addition to “Visible Earth above 25 deg elevation angle”, descriptions for beams’ service areas include “Beam at Boresight”, “Visible Earth above 90 deg elevation angle”, and “Spot Beam.”

⁹ 47 CFR § 25.114(c)(4)(i)

¹⁰ Boeing Application at 22-23.

the Commission's current filing requirements for NGSO FSS systems "do not permit including ISL beams within the Schedule S format,"¹¹ it is not clear what Boeing means by this statement, since Schedule S does permit inclusion of information for ISL beams. Accordingly, we request that Boeing update its Schedule S filing to include information on each representative transmit and receive ISL beam. In the alternative, should Boeing seek a waiver of section 25.114(c) it must specify why it cannot adequately represent its ISL transmitting and receiving beams in the current Schedule S and must also submit the complete information required by Schedule S in another format. In addition to channelization information (including center frequencies, bandwidth and link type), section 25.114(c)(4) requires provision of the following information:

- For each receiving beam: Beam ID; receiving beam frequencies; beam type; polarization; peak antenna gain; antenna pointing and rotational error; polarization alignment; G/T at maximum gain point; service area description; minimum G/T; and 3 dB beamwidth.
 - For each transmitting beam: Beam ID; transmitting beam frequencies; beam type; polarization; peak antenna gain; antenna pointing and rotational error; polarization alignment; maximum transmitting eirp and eirp density; service area description; 3 dB beamwidth and maximum power flux density values at the Earth's surface needed for compliance with section 25.208 of the Commission's rules.
7. Please clarify the following regarding Boeing's planned operation of ISLs between spacecraft in the separate constellations (*i.e.*, LEO and high-altitude orbit) within its system and between various other geostationary-orbit (GSO) satellites:
- Please provide information regarding the specific Ka-band GSO satellites with which Boeing proposes to communicate.
 - Boeing proposes to operate its Ka-band inter-satellite transmissions "via any number of Ka-band GSO satellites deployed around the world."¹² Will these transmissions occur only between Ka-band GSO satellites and Boeing's LEO spacecraft as suggested by Table III-2,¹³ or will they also occur between GSO satellites and Boeing's high-altitude orbit satellites?
 - Does Boeing propose to operate V-band inter-satellite links only between satellites in its own constellation? If so, will these links operate only between its LEO and high-altitude orbit satellites, or will there be LEO-to-LEO transmissions and/or inter-satellite transmissions between spacecraft in the high-altitude orbit constellations of Boeing's system?
8. Boeing proposes to operate its Ka-band ISLs on a non-conforming, non-interference basis relative to other users of the band.¹⁴ Please clarify the following with regard to these operations:

¹¹ Boeing Application at 21.

¹² Boeing Application at 20.

¹³ Boeing Application at 22.

¹⁴ Boeing Application at 21.

- Does Boeing seek to operate its V-band ISLs on a similar basis?
 - Boeing acknowledges that “portions of the 17.8-19.3 GHz band do not currently include an allocation for FSS, or, in some portions, a designation for NGSO FSS operations.”¹⁵ Boeing states further that “[it] is not requesting a waiver of the Commission’s Frequency Allocation Table for these ISL operations, however, because Boeing’s LEO satellites will not transmit and will only receive signals from GSO satellites that have been authorized by the Commission to operate in all or portions of this spectrum.”¹⁶ Boeing provides no specific justification as to why such waivers are not necessary for receiving space stations. Accordingly, please clarify Boeing’s rationale, including specific cites to the Commission’s rules or Commission precedent supporting this argument. In the alternative, please clarify whether Boeing plans to seek waivers of sections 2.106 and 25.202(a)(1) of the Commission’s rules, and/or the Ka-Band Plan¹⁷ for its ISL operations in these bands.
9. Article 22 of the ITU Radio Regulations specifies equivalent power flux-density (epfd) limits that are applicable in several frequency bands in which Boeing proposes to operate.¹⁸ These include epfd_{up} limits in the 27.5-28.6 GHz and 29.5-30 GHz bands. Please provide a showing demonstrating the Boeing satellite system’s compliance with the applicable epfd limits specified in Article 22 of the ITU Radio Regulations in these frequency bands.
10. Section 25.114(d)(14) of the Commission’s rules further requires that the applicant provide a description of the design and operational strategies that will be used to mitigate orbital debris.¹⁹ Please provide the following additional information and clarifications with respect to orbital debris mitigation:
- Please clarify, as described in section 25.114(d)(14)(ii), whether all fuel line valves will be left open after post-mission maneuvers.²⁰

¹⁵ Boeing Application at 21.

¹⁶ Boeing Application at 21.

¹⁷ See, *Redesignation of the 17.7-19.7 GHz Frequency Band, Blanket Licensing of Satellite Earth Stations in the 17.7-20.2 GHz and 27.5-30.0 GHz Frequency Bands, and the Allocation of Additional Spectrum in the 17.3-17.8 GHz and 24.75-25.25 GHz Frequency Bands for the Broadcast Satellite Service Use*, Report and Order, 15 FCC Rcd 13430, 13456-57, para. 55 (2000) (“18 GHz Band Order”). See also, *Redesignation of the 17.7-19.7 GHz Frequency Band, Blanket Licensing of Satellite Earth Stations in the 17.7-20.2 GHz and the 27.5-30.0 GHz Frequency Bands, and the Allocation of Additional Spectrum in the 17.3-17.8 GHz and 24.75-25.25 GHz Frequency Bands for Broadcast Satellite Service Use*, First Order on Reconsideration, 16 FCC Rcd 19808, 19822, para. 29 (2001).

¹⁸ ITU Radio Regulations, Article 22.

¹⁹ 47 CFR § 25.114(d)(14).

²⁰ 47 CFR § 25.114(d)(14)(ii).

- Please provide information, as described in section 25.114(d)(14)(iii), regarding the accuracy to which the NGSO space station orbital parameters will be maintained, including apogee, perigee, inclination, orbital altitude, and right ascension of the ascending node(s).²¹
- With regard to the LEO portion of Boeing's constellation, Boeing does not state whether the space stations will be launched into low-Earth orbits that are identical, or very similar, to an orbit used by other space stations. Please address this question, and if so, please include an analysis of the potential risk of collision and a description of what measures the space station operator plans to take, including coordination with other operators to avoid in-orbit collisions as required by section 25.114(d)(14)(iii).²²
- Boeing states that sufficient propellant will be reserved to perform the disposal maneuvers for the LEO portion of its constellation.²³ Boeing makes a similar statement that an appropriate amount of fuel will be reserved to move the high-altitude orbit satellites into an appropriate disposal orbit at end of life.²⁴ Please provide information, as described in section 25.114(d)(14)(iv), regarding the quantity of fuel (in kg) that will be left for each of these post-mission disposal maneuvers.²⁵
- Please specify what value of C_R was used in calculating the graveyard orbit altitude.²⁶
- With regard to the post mission disposal of the high-latitude orbit satellites in Boeing's proposed constellation,²⁷ please provide a statement and/or analysis with respect to the long-term stability or instability of post-mission storage orbit. Such analysis should address any measures, such as selection of orbital parameters that may affect the long-term evolution of orbital parameters, with particular attention to addressing any such evolution that would result in the satellites entering the geostationary protected region, *i.e.*, the area defined by the geosynchronous altitude, plus or minus 200 kilometers, and plus or minus 15 degrees from the equatorial plane, or the LEO protected region, *i.e.*, the area below 2000 km.
- Boeing states that following a lowering of the orbital altitude to 500 km, passive reentry of the LEO portion of its constellation will be realized resulting from drag within an estimated five years.²⁸ Please clarify whether Boeing will meet the reliability metric of 90 percent as described in the technical standards developed by NASA, and specify how high Boeing's deorbit reliability value is anticipated to be. Please clarify how many satellites will not be expected to achieve successful atmospheric reentry in five years following the end of the

²¹ 47 CFR § 25.114(d)(14)(iii).

²² 47 CFR § 25.114(d)(14)(iii).

²³ Boeing Application at 25.

²⁴ Boeing Application at 26.

²⁵ 47 CFR § 25.114(d)(14)(iv).

²⁶ Boeing Application at 26.

²⁷ Boeing Application at 26.


²⁸ Boeing Application at 25.

spacecraft mission, based on reliability targets. In addition, please calculate and provide an estimated probability of collision for each spacecraft during the disposal process using the NASA Debris Assessment Software (DAS).

- Boeing states that the risk of human casualties would be less than 1 in 10,000 in accordance with NASA-STD 8719.14, requirement 4.7-1.²⁹ Please provide that assessment. Please also provide a figure for the aggregate casualty risk from disposal of all satellites in the constellation.

To facilitate the Commission's timely evaluation of Boeing's application, we ask that you provide the requested information no later than **July 24, 2017**. Failure to do so may result in the dismissal of Boeing's application pursuant to Section 25.112(c) of the Commission's rules, 47 CFR § 25.112(c).

Sincerely,


Jose P. Albuquerque
Chief, Satellite Division
International Bureau

cc: Audrey L. Allison
Senior Director, Frequency Management Services
The Boeing Company
929 Long Bridge Drive
Arlington, VA 22202

Ronald Center
The Boeing Company
P.O. Box 3707
Seattle, WA 98124

²⁹ Boeing Application at 26.