JONES DAY

51 LOUISIANA AVENUE, N.W. • WASHINGTON, D.C. 20001.2113
TELEPHONE: +1.202.879.3939 • FACSIMILE: +1.202.626.1700

DIRECT NUMBER: (202) 879-3630
BOLCOTT@JONESDAY.COM

May 10, 2017

VIA ELECTRONIC FILING

Jose P. Albuquerque
Chief, Satellite Division
International Bureau
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

Re: The Boeing Company
IBFS File Nos. SAT-LOA-20160622-00058 and SAT-AMD-20170301-00030
Call Sign: S2966

Dear Jose:

On behalf of The Boeing Company ("Boeing"), we hereby respond to the questions raised in your letter dated April 11, 2017.[1]

1. *Boeing describes the amendment as primarily for the purpose of lowering the nominal altitude for the NGSO system.*[2] *Section 25.114(d)(14) of the Commission's rules requires that the applicant provide a description of the design and operational strategies that will be used to mitigate orbital debris, including ascertaining the probability of the space station becoming a source of debris by collisions with large debris or other operational space stations, and a statement detailing the post-mission disposal plans for the space*

[1] Letter from Jose P. Albuquerque, Chief, Satellite Division, to Bruce A. Olcott, Jones Day, IBFS File Nos. SAT-LOA-20160622-00058 and SAT-AMD- 20170301-00030 (April 11, 2017).

[2] *See* The Boeing Company, Amendment to Application for Authority to Launch and Operate a Non-Geostationary Low Earth Orbit Satellite System in the Fixed Satellite Service, File No. SAT-AMD-20170301-00030, Narrative at 1 (filed Mar. 1, 2017) ("*Boeing Amendment*").

station at end of life.[3] *The previous information provided by Boeing regarding this risk of collision was predicated on orbital parameters that were changed in the amendment.* [4]

a. *Please confirm that the information on the accuracy to which the space stations' orbital parameters will be maintained, including apogee, perigee, inclination, orbital altitude, and right ascension of the ascending node(s), has not changed from that provided in Boeing's letter to the Commission dated September 16, 2016.*[5]

Boeing hereby confirms that the relative accuracy to which the orbital parameters will be maintained, as discussed in our letter of September 16, 2016 ("*2016 Letter*"), apply as stated to the amended constellation operating at the lower altitudes.

b. *The orbital debris analysis in Boeing's original application estimated that each satellite would need to perform 1.6 collision avoidance maneuvers per vehicle-year.*[6] *Boeing further elaborated on the assumptions made in this analysis in its letter to the Commission dated September 16, 2016.*[7] *Please clarify whether this analysis remains accurate based upon Boeing's new orbital parameters, or provide an updated analysis if needed.*

The analysis approach reflected in Boeing's 2016 Letter uses the predicted density of orbital debris in the orbital space environment, which is a function of altitude and increases as the altitude is lowered below 1200 kilometers. With the increased density of the orbital debris at 1030 to 1082 kilometers, Boeing expects the average number of maneuvers to roughly double to 3.3 per vehicle per year. This increase is still well within each vehicle's delta-v fuel allocation for collision avoidance maneuvers.

---

[3] 47 CFR § 25.114(d)(l4)(iii)-(iv).

[4] *See* The Boeing Company Application for Authority to Launch and Operate a Non-Geostationary Low Earth Orbit Satellite System in the Fixed Satellite Service (S2966), SAT-LOA-20160622-00058, Narrative at 33-34 (June 22, 2016) ("*Boeing Application*").

[5] Letter from Bruce A. Olcott, Counsel to The Boeing Company, Jones Day, to Jose P. Albuquerque, Chief, Satellite Division, FCC at 8-9 (September 16, 2016) (on file in IBFS File No. SAT-LOA-20160622-00058) ("*2016 Letter*").

[6] *See Boeing Application* at 34.

[7] *See 2016 Letter* at 7.

c. *Please provide an analysis of collision risk, assuming rates of satellite failure resulting in the inability to perform collision avoidance procedures of 10, 5, and 1 percent. This analysis should include a study performed assuming all failures occur at the mission altitude, but may also include additional studies specifying alternative assumptions concerning the orbital locations (such as injection altitude) at which failures might occur.*

As Boeing has previously explained, Boeing will maintain a high level of reliability through inherent redundancy in critical de-orbit subsystems, including in propulsion, mechanisms, sensors, spacecraft computer and the power subsystems. As such, Boeing fully expects that the probability of a failed satellite to be less than the 10 percent, 5 percent, or even 1 percent metrics suggested by this question. An updated analysis was performed to assess collision probabilities with orbital debris in the event of a complete vehicle failure when operating at the revised operational altitudes. Boeing used NASA Orbital Debris Program Office Debris Assessment Software ("DAS") to calculate the probable orbital debris impact rate with a failed vehicle for objects that are larger than 10 centimeters. In the unlikely event of a 1 percent failure rate of Boeing's 2,956 vehicles, it is estimated that the probability of impact with any of the failed vehicles is 0.00268 per year, or less than 2.7 percent per decade.

d. *Please provide an analysis of collision risk for satellites during the passive disposal phase, i.e., after all propellant is consumed. Please provide this analysis for a worst case (all satellites at 500 km perigee). The analysis may include an anticipated range of orbits if Boeing believes such alternatives would be more representative. Please include an assessment of how many conjunctions and/or collision avoidance maneuvers might be required of the International Space Station (ISS), assuming it is in operation throughout the period in which the Boeing satellites would transit the ISS orbit.*

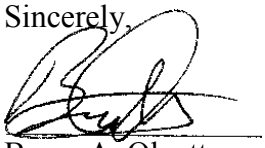
As a result of the amended lower nominal operational altitudes, Boeing has revised its NGSO constellation de-orbit plan to lower the NGSO vehicle disposal altitude from 500 kilometers to 330 kilometers. This new altitude will position the post-mission vehicles well below the International Space Station's current altitude of 400 kilometers. At this altitude and below, Boeing will continue to adjust the orientation of the vehicle to either maximize or minimize the area in order to use drag to maneuver around any piece of tracked debris or any operational spacecraft. The orbital lifetime for Boeing's spacecraft at this revised disposal altitude will be less than three months. The probability of a single spacecraft collision with a piece of orbital debris that is larger than 1 centimeter during this period at this altitude is estimated to be less than 3e-5, or less than 0.003 percent.

2. *In the Certifications Questions portion of its amended Schedule S, Boeing responds "No" to the question asking whether the applicable power flux-density levels of Section 25.208 are met, and/or whether the appropriate technical showing is provided with the application.*[8] *Please clarify Boeing's "No" response to this question.*

As Boeing indicated in its amended Application, Boeing plans to operate its NGSO system in a manner that fully complies with the applicable power flex density ("PFD") limits indicated in Section 25.208 of the Commission's rules. Therefore, Boeing's response to this question in Schedule S should have been changed to "yes" in order to be consistent with Boeing's amended Application.

Thank you for your attention to this matter. Please contact the undersigned if you have any questions.

Sincerely,



Bruce A. Olcott
Counsel to The Boeing Company

[8] *See Boeing Amendment*, Schedule S at 200.