March 13, 2024

Via ELS

Mr. Hung Le
Federal Communications Commission
45 L Street, NE
Washington, DC 20554

Re: Application File No. 1500-EX-CN-2023
Correspondence Reference Number 84048 (March 5, 2024)

Dear Mr. Le:

Thank you for your inquiry of March 5, 2024, regarding the space safety planning that Johns Hopkins University Applied Physics Laboratory (JHU APL) has undertaken in connection with its Polylingual Experimental Terminal (PExT) mission planned for launch later this year. We respond to each of your questions below.

Design Considerations. JHU APL implemented numerous measures to promote demisability of the PExT spacecraft. At the outset, JHU APL designed its PExT mission to limit the spacecraft's total mass. Doing so not only lowered the mission cost, but also reduced the total kinetic energy in orbit and, as a result, the total long-term collision hazard posed by this mission.

JHU APL then chose York Space Systems' standardized, 3-axis-stabilized S-class bus system because of the bus's flight-proven modular design and track-record of demisability. As a best practice, York has eliminated components with materials having high probability of survivability, such as titanium, and where these materials are required, ensures that reentry analysis is performed early in the process such that these results are considered when designing these components. JHU APL likewise designed components of the PExT mission antenna and other hardware with demisability in mind. When exposed to the convective and radiative heating associated with atmospheric reentry, the satellite bus and all system components on board are fully expected to experience net heat (heat input less heat lost by radiative cooling) in excess of the heat of ablation (the sum of the heat to raise the component to the melting point and the heat of fusion), which will result in those materials fully demising upon reentry.

JHU APL also sought to eliminate mission-related debris released during all phases of spacecraft deployment and operations through prudent engineering, such as avoiding the use of covers for lenses or sensors, pyrotechnic release hardware, and wraparound cables that might heighten space safety risks. In addition, JHU APL will have avoided the release of exhaust products from spacecraft operations because, as explained below, the spacecraft has no maneuvering capabilities. To enhance the likelihood of demisability further, JHU APL's mission engineering adopted a systemic approach to passivity that, as explained in greater detail in the attached Orbital Debris Assessment Report (ODAR), (1) identified all potential sources of stored energy remaining on a spacecraft late in its active life; (2) provided, for each source, a method of dissipating or rendering inert the stored energy in a benign manner; and (3) established a plan to activate each of these mechanisms at the end of the spacecraft's functional lifetime to achieve passivation. Taken together, these measures reflect JHU APL's strong emphasis on demisability and engineering best practices throughout the design process.

Design Alternatives**.** JHU APL considered various design alternatives prior to selecting the proposed system configuration as the optimum choice for a low earth orbit mission that needs to support a robust communications system using efficient power and thermal management throughout its limited period of operations. The size, weight, and power consumption of the experimental software defined radio systems on board the PExT mission are well-suited to the 2U configuration of the York Space System S-class satellite bus. Alternative systems were not as compact, nor as lightweight, nor as power efficient as the chosen design. Available alternatives for the PExT mission would have either decreased the likelihood of demisability or compromised mission performance, efficiency, or feasibility.

Propulsion System. The propulsion technology on board the PExT mission will not maneuver the PExT spacecraft and will not perform any other propulsive activities for the PExT mission. The propulsion components integrated into the PExT spacecraft are strictly to aid in the development of a novel, inert propulsion system that may be used in future missions. Incorporating the propulsion system on board the PExT mission will allow for the development of flight-qualified components and may reduce non-recurring engineering expenses associated with future propulsion system architecture designs.

Part 5 Compliance: Collision Risks with Large Objects**.** As an initial matter, JHU APL has assessed and limited the probability of collision between the PExT satellite and other objects ten centimeters or larger in diameter during the total orbital lifetime of PExT, including any de-orbit phases, to less than 0.001 (1 in 1,000). While the PExT satellite will not be equipped with an operable onboard propulsion system, JHU APL's DAS analysis shows that the risk of collision with large objects is 1.0408E-05, well under the 0.001 metric. Using a conservative approach, the longest possible estimated lifetime for the PExT spacecraft is 3.3 years, further reducing the potential for in-orbit collision risk. Finally, JHU APL documents PExT's compliance with each of the Commission rule provisions your correspondence identified in the following sections.

1. Inhabitable Spacecraft, 47 CFR § 5.64(b)(4)(i)(C)[1]

PExT will support NASA's International Space Station collision screening keep-out envelope restrictions, which are +/- 2 km radial, +/- 25 km local horizontal. This vehicle will use the Earth's atmospheric effects at low altitude to passively de-orbit the spacecraft. The PExT mission will follow the same section 5.64(b)(4)(i)(E) collision-mitigation protocol detailed below for purposes of avoiding inhabitable spacecraft.

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[1] 47 CFR § 5.64(b)(4)(i)(C) ("If at any time during the space station(s)' mission or de-orbit phase the space station(s) will transit through the orbits used by any inhabitable spacecraft, including the International Space Station, the statement must describe the design and operational strategies, if any, that will be used to minimize the risk of collision and avoid posing any operational constraints to the inhabitable spacecraft.").

2. Orbital Parameters, 47 CFR § 5.64(b)(4)(i)(D)[2]

PExT will be operating globally in Sun Synchronous Orbit (SSO) - 97.50° circular orbit, MLTAN 22:30 ± 30 min at an altitude of 515 ± 15 km. The PExT satellite is equipped with a non-maneuverable propulsion system that cannot support orbital maintenance. The diagram below captures the anticipated evolution of the SSO over time.

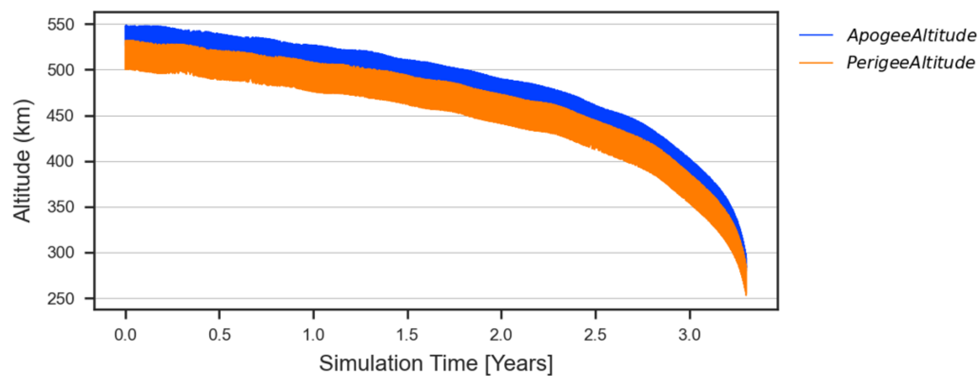

Figure 1 - Estimated orbit altitude over time with high fidelity force model in NASA GMAT R2022a

As demonstrated in Figure 1 of the ODAR, a copy of which is reproduced above, the PExT satellite has a maximum orbital life of 3.3 years. Earth's atmospheric drag will passively de-orbit the satellite within that time period, which further mitigates collision risk.

3. Certification, 47 CFR § 5.64(b)(4)(i)(E)[3]

JHU APL hereby certifies that upon receipt of a space situational awareness conjunction warning, JHU APL or contractors under its supervision who are charged with maintaining the spacecraft will review and take all possible steps to assess the collision risk and will mitigate the collision risk if necessary, including by, for example, contacting the operator of any active spacecraft involved

[2] 47 CFR § 5.64(b)(4)(i)(D) ("The statement must disclose the accuracy, if any, with which orbital parameters will be maintained, including apogee, perigee, inclination, and the right ascension of the ascending node(s). In the event that a system will not maintain orbital tolerances, *e.g.,* its propulsion system will not be used for orbital maintenance, that fact should be included in the debris mitigation disclosure. Such systems must also indicate the anticipated evolution over time of the orbit of the proposed satellite or satellites. All systems must describe the extent of satellite maneuverability, whether or not the space station design includes a propulsion system.").

[3] 47 CFR § 5.64(b)(4)(i)(E) ("The space station operator must certify that upon receipt of a space situational awareness conjunction warning, the operator will review and take all possible steps to assess the collision risk, and will mitigate the collision risk if necessary. As appropriate, steps to assess and mitigate the collision risk should include, but are not limited to: contacting the operator of any active spacecraft involved in such a warning; sharing ephemeris data and other appropriate operational information with any such operator; and modifying space station attitude and/or operations.").

in such a warning; sharing ephemeris data and other appropriate operational information with any such operator; and modifying space station altitude or operations.

4. Trackability, 47 CFR § 5.64(b)(5)(i)-(iii)[4]

The PExT system exceeds ten centimeters in its smallest dimension exclusive of deployed components and is entitled to a presumption of trackability under the Commission's Part 5 rules. JHU APL also will actively track PExT through on-board telemetry, which will include identification and navigation data. As for the additional tracking requirements NGSO systems must satisfy, JHU APL has investigated the existence of other satellites with near-identical orbit planes and altitudes and has not identified identical or near-identical space station orbits that create additional risk and require coordination based on an analysis of the existing U.S. Space Command Space Surveillance Network catalog. Moreover, the PExT satellite will be registered with the 18th Space Control Squadron for enhanced space domain awareness prior to deployment and that information will be updated with any anomalies through PExT's mission life. JHU APL's space debris avoidance program will also include: (1) an effective, timely response to data messages from the 18th Space Control Squadron that advise of conjunction risk; (2) use of a third-party debris tracking service to improve conjunction warning response; and (3) "full lifecycle" conjunction avoidance, from early operations after dispensing, to re-entry. In the event of a potential conjunction event in excess of permitted tolerances, JHU APL will assess the data quality of the orbit station of the secondary object from the U.S. Space Command Space Surveillance Network, from commercial data providers, or from the owner or operator of the secondary object, as appropriate, and calculate the probability of collision associated with the conjunction. If the probability of collision exceeds 1 in 100,000, PExT will evaluate risk-mitigation strategies, such as pointing or drag, to reduce the risk of conjunction and, where relevant, contact the operator of the second payload directly to coordinate a response.

Please contact me with any additional questions or information requests.

Sincerely,

Christopher Haskins

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[4] 47 CFR § 5.64(b)(5)(i)-(iii) ("A statement addressing the trackability of the space station(s). Space station(s) operating in low-Earth orbit will be presumed trackable if each individual space station is 10 cm or larger in its smallest dimension, exclusive of deployable components. Where the application is for an NGSO space station or system, the statement shall also disclose the following: (i) How the operator plans to identify the space station(s) following deployment and whether space station tracking will be active or passive; (ii) Whether, prior to deployment, the space station(s) will be registered with the 18th Space Control Squadron or successor entity; and (iii) The extent to which the space station operator plans to share information regarding initial deployment, ephemeris, and/or planned maneuvers with the 18th Space Control Squadron or successor entity, other entities that engage in space situational awareness or space traffic management functions, and/or other operators.").