Attachment D

E172B Orbital Debris Mitigation Plan

Eutelsat 172B Space Debris Mitigation Plan (prepared for the Federal Communications Commission)

ISSUE/REVISION: Issue 1, Rev. 1

ISSUE DATE: 31 May 2017

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CHANGE RECORD

Date	*Issue/rev*	*Pages affected*	*Description*
11/05/2017	1/0	All	First issue.
31/05/2017	1/1	4-8	Update version number of the AD.1. Incorporate editorial changes and add details about propellant tanks and collocation strategy with E172A.

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1. Introduction

This document describes the space debris mitigation plan for **Eutelsat 172B ("E172B")**, a French-licensed satellite owned by Eutelsat Asia Pte Ltd (referred to herein, together with its ultimate parent, Eutelsat Communications S.A., and intermediate entities, as "Eutelsat").

E172B was manufactured and supplied by Airbus Defense and Space based on the Airbus Eurostar 3000 EOR (Electric Orbit Raising) bus platform. The satellite is 3-axis stabilized and uses electrical propulsion for initial orbit raising and on-station control.

E172B is scheduled for launch in early June 2017 and the end of its operational life is not expected to be before 2032.

2. Related documents

2.1. Applicable Documents

1. EUTELSAT Space Debris Mitigation Plan. Issue 2.0. EUT_CTL_SAT_QMS_PLN_00021, 25 April 2017.
2. FCC. Orbital Debris Mitigation Standard Practices. FCC 04-130. June 21, 2004.

2.2. Reference Documents

1. European Code of Conduct for Space Debris Mitigation. Issue 1.0. 28 June 2004.
2. IADC Space Debris Mitigation Guidelines. IADC-02-01. Revision 1. September 2007.
3. Space Product Assurance. Safety. ECSS-Q-40A. 19 April 1996.
4. NASA Safety Standard. Guidelines and Assessment Procedures for limiting Orbital Debris. NSS 1740.14. Aug 1995.
5. ITU Environment Protection of the Geostationary Orbit. S.1003. 1993.
6. UNCOPUOS. Technical Report on Space Debris. 1999.

3. Eutelsat 172B operations

The E172B satellite strictly complies with requirements in the French Space Operations Act, as well as prevailing international best practices and standards, to minimize space debris.

Eutelsat operational procedures and the E172B satellite design limit the amount of debris released during normal operations and the probability of the space station becoming a source of debris by collisions with small debris or meteoroids that could cause loss of control and prevent post-mission disposal.

Eutelsat has assessed the amount of debris released in a planned manner and no intentional debris will be released during normal operations of the E172B satellite. A safe operational configuration of the satellite is ensured thanks to the hardware design and operational procedures.

Eutelsat minimizes the probability of the satellite becoming a source of debris by collisions with large debris or other operational satellites. Eutelsat assessed and determined that, other than the E172A satellite located at 172.0°E, there are no other satellites located at or sufficiently near E172B's planned orbital location that might result in overlap of satellite orbit control windows.

The licensee of the E172A satellite, ES 172 LLC, is a wholly owned subsidiary of Eutelsat. For the period when both the E172A and E172B satellites are co-located at the 172.0°E orbit location, Eutelsat will coordinate their flight profiles internally to maintain adequate separation distances and ensure there is no possibility of collision.[1]

E172B will be controlled within its orbit control window (172.0°E +/-0.1°) by standard routine periodic orbit correction maneuvers. In case of potential drift outside this window, correction maneuvers will be implemented to maintain satellite location within the window.

Eutelsat has assessed the probability of accidental explosions during and after completion of mission operations. Thanks to design safety margins and enough safety barriers, the probability of occurrence of accidental explosion of the E172B satellite is negligible.

The satellite design, which includes electric propulsion for on-station control, is such that high levels of thruster activity and orbit perturbation do not occur during normal operations.

4. Eutelsat 172B End-of-Life Disposal

According to French Space Operations Act, IADC guidelines and best practices and standards, any geostationary satellite at end-of-life ("EOL") shall be disposed to an orbit that ensures that the satellite will not re-enter the geostationary orbit ("GEO") protected region (GEO height +/- 200 km) in the long term. The post-mission disposal activities have been planned as follows:

1. The orbit of the satellite will be raised by 300 km to ensure that the satellite will not re-enter the GEO protected region. 1.8 kg of Xenon have been allocated and reserved with a confidence level of 99.7% to carry out the post-mission disposal maneuvers. During the satellite lifetime, Eutelsat will routinely monitor the propellant remaining in the propellant tanks. The FCC will be informed of any significant change to the above quantity of propellant.

   The minimum perigee height to avoid re-entering into the GEO protected region can be computed using the IADC formula applied to this satellite:

   $$\text{Delta\_H (km)} = 235 + 1000.(A/m)\text{eff} = 256 \text{ km}$$

   where the final term is the effective area/mass ratio of the satellite. Therefore, the planned 300 km above GEO height is sufficient to satisfy the 256 km requirement.

2. The satellite tracking, telemetry and control operations are planned to avoid interference and coordinated with potentially affected satellite networks.

[1] Eutelsat will apply a combined eccentricity and inclination vector separation method to ensure sufficient separation between the two satellites.

3. As part of the EOL activities, E172B energy sources will be rendered inactive such that debris generation will not result from the conversion or dissipation of energy sources onboard the satellite. For E172B, this involves the following:

   - Discharge the batteries during EOL operations and isolate them from the solar arrays to prevent further electrical energy storage.

   - Switch off the momentum wheels.

   - Deplete and eventually vent the propellant tanks, which allows depressurizing during passivation operations and results in only negligible residuals remaining in the tanks. In addition, the tanks are "leak before burst" designed. Therefore, the risk of break-up is negligible.

   - All pyrotechnic systems are fired at initial stage of life. Those systems do not generate any debris.

5. Notifications

EUTELSAT undertakes to provide the relevant bodies as required (UNCOPUOS, FCC, ITU, ANFR, etc.) with all appropriate notifications as required by law or regulations including but not limited to those concerning initial commencement of service, location, relocation, inclined orbit operations and EOL operations.