Eutelsat 115 West B

ATTACHMENT B

ORBITAL DEBRIS MITIGATION PLAN

The spacecraft manufacturer for the Eutelsat 115 West B satellite is Boeing Satellite Systems International, Inc. ("Boeing"). Eutelsat Americas/Boeing have incorporated the material objectives of §25.114(d)(14) of the Commission's Rules into the design of the satellite through the satellite's Technical Specifications, Statement of Work and Test Plans. This includes provisions to review orbital debris mitigation as part of the ongoing design reviews for the Eutelsat 115 West B satellite and to incorporate any related requirements, as appropriate, into its Test Plan, including a formal Failure Mode Verification Analysis ("FMVA") for orbital debris mitigation involving particularly the TT&C, propulsion and energy systems.

A.1.1 Spacecraft Hardware Design

Eutelsat Americas confirms that the satellite will not undergo any release of debris during its operation. Furthermore, all separation and deployment mechanisms, and any other potential source of debris are expected to be retained by the spacecraft.

Eutelsat Americas/Boeing have assessed and will limit the probability of the satellite becoming a source of debris by collisions with small debris or meteoroids of less than one gram in diameter that could cause loss of control and prevent post-mission disposal. Eutelsat Americas/Boeing have taken steps to limit the effects of such collisions through shielding, the placement of components, and the use of redundant systems.

Eutelsat Americas/Boeing will incorporate a rugged TT&C system with regard to meteoroids smaller than 1 gram through redundancy, shielding and appropriate separation of components. The TT&C system is equipped with near omni-directional antennas mounted on opposite sides of the spacecraft. These antennas are extremely rugged and capable of providing adequate coverage even if struck, bent or otherwise damaged by a small or medium sized particle. The omni-directional antennas, for both command and telemetry, are sufficient to enable orbit

raising. The command receivers and decoders and telemetry encoders and transmitters are located within the satellite's Faraday cage which provides shielding and are totally redundant and physically separated.

The propulsion subsystem is designed such that it will not be separated from the spacecraft after de-orbit maneuvers. It is protected from the effects of collisions with small debris through shielding. Moreover, propulsion subsystem components critical to disposal (e.g., propellant tank) are located deep inside the satellite, while other components, such as the thrusters, externally placed, are redundant to allow for de-orbit despite a collision with debris.

A.1.2 Minimizing Accidental Explosions

Eutelsat Americas/Boeing will assess and limit the probability of accidental explosions during and after completion of mission operations. The satellite will be designed to ensure that debris generation will not result from the conversion of energy sources on board the satellite into energy that fragments the satellite. The propulsion subsystem pressure vessel is designed with high safety margins. Tank pressures will be monitored by telemetry.

Relevant parameters of the satellite include:

(i) the mass of the xenon gas used on the spacecraft is 300 kg nominal, with a 320 kg maximum;

(ii) the volume of the tank on the spacecraft is capable of accommodating up to 450 kg of fuel, but the tank is typically filled up to a limit of 320 kg in order to maintain a 4:1 burst ratio;

(iii) the tank burst pressure specification is 7500 psi, but the tank has been successfully tested on a qualification model to a pressure of 9300 psi which demonstrates the specification is met with considerable margin; and

(iv) no gases (other than xenon) will be used on the spacecraft; the 702SP satellite model is an all-electric propulsion bus.

Xenon is used as the fuel source for thruster and station-keeping operations on the Eutelsat 115 West B satellite. Because Xenon is inert it requires far less end of life care and handling than bipropellant fuels. It is stored in a tank designed to leak before burst, and the residual pressure is

low enough that there is no way to have a catastrophic leak event. There is therefore no need to leave valves open post de-orbit and shutdown. The batteries will be left in a permanent state of discharge.

Once Eutelsat 115 WB reaches its disposal orbit, the mass of the xenon gas is projected to be approximately 4.2 kg and the pressure of the residual xenon gas in the tank is projected to be between 45 and 85 psi (well below the tank burst pressure specification of 7500 psi). (*See* Narrative Application for associated waiver request.)

A.1.3 Safe Flight Profiles

In consideration of current and planned satellites +/- 0.15° of Eutelsat 115 West B the following satellites were reviewed for overlapping station-keeping volumes:

- Mexsat 3 (Bicentenario) at 114.8° W.L. +/- 0.05°
- Eutelsat 115 West A (Satmex 5) at 114.9° W.L.; inclined 1.4°
- Viasat 1 at 115.1° W.L. +/- 0.05°
- XM4 at 115.2° W.L. +/- 0.05°
- XM1 at 115.2° W.L. +/- 0.05°

Only Mexsat 3 and Eutelsat 115 West A have overlapping station-keeping volumes. Eutelsat 115 West A, which is inclined 1.4°, is owned and operated by Eutelsat Americas and will be coordinated internally to eliminate the possibility of collision while co-located. Eutelsat Americas intends to relocate the Eutelsat 115 West A satellite after services are transitioned to Eutelsat 115 West B.

The station-keeping boxes of Eutelsat 115 West B and Mexsat 3 share an edge at 114.85° W.L. This should not be an issue as most satellite operators station-keep ***within*** their allocated volumes and do not touch the edges. Nevertheless, Eutelsat Americas will coordinate with the government of Mexico, the operator of Mexsat 3, to ensure appropriate separation is maintained and there is no possibility of collision.

Satmex will contract with the Massachusetts Institute of Technology, or other competent institution, to perform space situational awareness monitoring duties for Eutelsat 115 West B.

A.1.4 Post Mission Disposal Plan

At the end of the operational life of the Eutelsat 115 West B satellite, Eutelsat Americas will maneuver the satellite to a disposal orbit with a minimum perigee of 300 km above the normal GSO operational orbit. This proposed disposal orbit altitude is based on the following calculation, as required in §25.283:

Total Solar Pressure Area "A" = 75 m^2

"M" = Dry Mass of Satellite = 1697 kg

"C_R" = Solar Pressure Radiation Coefficient = 1.33

Therefore the Minimum Disposal Orbit Perigee Altitude:

= 36,021 km + 1000 x C_R x A/M

= 36,021 km + 1000 x 1.33 x 75/1697

= 36,079.78 km

= 293.8 km above GSO (35,786 km)

To provide margin, the nominal disposal orbit will be increased to 300 km. This will require 0.6 kg of Xenon propellant that will be reserved, taking account of all fuel measurement uncertainties, to perform the final orbit raising maneuvers.[1]

[1] The small quantity of fuel required is accounted for by the fact that the Eutelsat 115 West B satellite uses electric propulsion.