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September 11, 2006

Mr. John Kennedy
Office of Engineering and Technology
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

Re: Experimental Application of ORBCOMM, File No. 0108-EX-PL-2006 – Orbital Debris Mitigation Report Responding to Request of August 10, 2006; Reference Number 4484

Submitted Electronically via the OET Filing System

Dear Mr. Kennedy:

In response to your request of August 10, 2006, attached is the information on orbital debris mitigation for ORBCOMM's U.S. Coast Guard Demonstration Satellite as specified in Section 5.63(e) of the Commission's Rules, 47 C.F.R. § 5.63(e). By this letter, ORBCOMM demonstrates that its experimental satellite complies with the Commission's orbital debris requirements and guidelines. Please contact the undersigned if you have any additional questions.

Sincerely,

/s/
Stephen L. Goodman
Counsel for ORBCOMM

cc: K. Kensinger

ORBCOMM U.S. Coast Guard Demonstration Satellite
Experimental Application File No. 0108-EX-PL-2006
Orbital Debris Mitigation Plan

In accordance with Section 5.63(e) of the Commission's Rules, following is the orbital debris mitigation information in support of ORBCOMM's pending experimental application for the U.S. Coast Guard Demonstration Satellite (File No. 0108-EX-PL-2006).

(1) ORBCOMM has assessed and limited the possibility of any debris released in a planned manner during normal operations. There are no intentional releases of any objects during any phase of the mission, including deployment, operations, nor disposal. There are no shrouds or lens caps to be removed upon deployment, and no shrapnel is generated during separation from the launch vehicle.

ORBCOMM understands and appreciates that small debris and meteoroids have the potential of colliding with and doing damage to the spacecraft, and the satellite bus structure was designed with this in mind. No components critical for bus functionality – including maneuvering – are externally exposed. Internal components are provided with physical protection either by the bus structure (approximately 3 mm thick aluminum plating) or by thermal insulation that would serve to break up any small debris or meteoroid upon impact. Any resulting debris or vapor continuing into the interior of the spacecraft is unlikely to do damage to major components.

ORBCOMM believes that a conservative estimate of debris size that may threaten the satellite's ability to conduct a disposal maneuver is 2 cm. In order to assess the likelihood of any such collisions, ORBCOMM utilized NASA's Debris Assessment Software (DAS v1.5.3) which is publicly-available. The target operational orbit of 920 km altitude (circular) and 83 deg inclination was inputted into the model, along with the average cross-sectional area of 1.52 m^2, and the resulting annual probability of collision is $9x10^{-5}$. Based on this result, ORBCOMM believes the risk is negligible that impacts with small debris will render the spacecraft unable to conduct its disposal maneuver.

(2) ORBCOMM believes there is virtually no possibility for its spacecraft to accidentally explode on-orbit. All components involved in the retention and control of energy sources have strong heritages, and energy sources will be minimized or depleted upon disposal of the spacecraft. These sources include ammonia gas fuel for propulsion, NiMH batteries, and momentum wheels. All remaining fuel will be consumed in conducting the disposal maneuver, leaving the fuel tank with very little pressure and no potential for chemical combustion. The battery pressure will be minimized, and momentum wheels will be de-spun.

(3) ORBCOMM understands that other sizable objects exist in low Earth orbit, and that there is some small possibility of physical collision with large objects, which would generate additional orbital debris. In order to assess the likelihood of any such collisions, ORBCOMM again used NASA's Debris Assessment Software. The resulting annual probability of collision for the operational orbit is $9.8x10^{-6}$.

ORBCOMM believes that this modeling demonstrates that the probability of catastrophic collision over the life of the satellite mission is extremely small, and it therefore does not constitute a significant risk of further contributing to the debris environment.

The ORBCOMM system is comprised of relatively small satellites in non-geostationary orbit. Similar to ORBCOMM's current spacecraft (some of which have been operating for over a decade), there will be no active collision avoidance monitoring or maneuvering, and no active coordination with other operators to avoid collision.

Further, because there are no mission requirements to do so (nor any Commission requirements to do so, unlike requirements for geostationary satellites), orbital parameters will not be maintained to any prescribed accuracy. During the operational life of the satellite, the orbit altitude is expected to decay less than 10 km. The inclination shall remain stable at approximately 83 deg, and the eccentricity will exhibit small oscillations about its nominal value of zero. The ascending node and true anomaly will obviously take on all possible values as they secularly and continuously precess.

(4) ORBCOMM recognizes that responsible disposal of post-mission hardware is the most practical and effective means of preserving the orbital environment for future use. This is, in fact, the principal reason driving the inclusion of a propulsion system on this ORBCOMM spacecraft. Upon completion of its mission, the satellite will be shifted to a different orbit, decreasing its perigee to facilitate a more rapid, uncontrolled reentry into the atmosphere. Of its initial 2.8 kg of ammonia fuel, 97% is budgeted for disposal maneuvering. The apogee and perigee altitudes following this maneuver are expected to be approximately 920 km and 585 km, respectively.

ORBCOMM believes the orbital lifetime of the hardware, once the disposal maneuver is completed, will be less than 25 years. In order to assess this expected orbital lifetime, ORBCOMM again utilized NASA's DAS software. Using an average cross sectional area of 1.52 m^2, mass of 80 kg, and initial altitude of 920/585 km, atmospheric reentry is predicted to occur within 24.8 years of the disposal maneuver.

Upon reentry, ORBCOMM believes that the satellite will largely disintegrate and burn up, although some of the more dense internal components may survive and strike the

Earth. ORBCOMM has performed a casualty analysis using the guidelines disclosed in Public Notice DA 04-1724, Report No. SPB-208, "Clarification of 47 C.F.R. Sections 25.143(b), 25.145(c)(3), 25.146(i)(4) and 25.217(d) Regarding Casualty Risk Assessment for Satellite Atmospheric Re-entry." While the actual mass surviving reentry will be far less, we have assumed for the sake of conservatism and simplicity that the entire spacecraft will survive reentry. With this presumption, the equation this document provides for casualty area reduces to the following:

$$\text{Ave Casualty Area} = [(\text{Cross-sectional area of person})^{1/2} + \text{Cross-sectional area of debris})^{1/2}]^2,$$

where the cross-sectional area of a person was taken to be a circular footprint with a radius of 1m, and the average cross-sectional area of the satellite is 1.52m^2. The casualty area then becomes 9.0m^2. The clarification document then suggests that the casualty probability can be computed from the following (presuming a single debris object):

$$\text{Probability of Casualty} = [(\text{Ave Casualty Area}) \text{ x } (\text{Ave Population Density})].$$

The inclination of the orbit bounds the percentage of the Earth's surface over which the satellite may reenter. At 83 deg inclination, the possible landing area is 5.07x1014 m^2, or very nearly the entire globe. Coupling this with an estimate of the current global population of roughly 6 billion yields a casualty probability of approximately $1\text{x}10^{-4}$. ORBCOMM believes this presents a negligible casualty risk.