

TO: Brian O'Connor, NASA Headquarters AA for Safety and Mission Assurance
Wayne Frazier, NASA Headquarters Flight Assurance
FROM: Granville Paules
SUBJ: EO-1 Orbital Debris Status per NSS 1740.14
DATE: 11/22/04

Dear Brian/Wayne,

This memorandum is to inform you of our strong desire to continue flying the Earth Observing One (EO-1) spacecraft beyond the point where it would exceed the maximum allowable **disposal** period per the guideline reflected in NSS 1740.14, **Guideline 6-1, Option a**.

EO-1 was launched in November 2000 as a one-year technology demonstration mission. It is in a circular polar orbit following one minute behind the Landsat-7 spacecraft. Prior to launch, an orbital debris analysis was performed and a nominal uncontrolled re-entry altitude was computed (610km X 700km) to comply with the 25-year maximum **disposal** period. Recently the **disposal** analysis has been revisited because EO-1 is still on-orbit, fully functional, and is a candidate for supplying a major part of the Landsat gap filler data required by NASA over the next 4-5 years. NASA has a legal requirement to "ensure Landsat data continuity" while, at the same time, we seek to meet our established disposal requirements. Presently Landsat-7 is experiencing difficulties and a Landsat follow-on mission is in formulation. In the meantime, we must provide a "gap filler" capability from existing resources until the Landsat follow-on mission is operational. We seek a course for EO-1 that enables us to support Landsat data continuity in the near-term but will re-enter EO-1 as soon as that role is completed.

The EO-1 fuel balance is such that de-orbit maneuvers can be accomplished anytime this year to stay within the **disposal period** maximum of 25 years. However, to stay one minute behind Landsat-7 requires annual inclination precession compensation maneuvers that are usually performed in early October by both missions to control the Mean Local time drift and maintain flight on the World Reference System (WRS-2) grid. The Delta-I maneuvers use most of the fuel burned during the fiscal year.

It is essential to keep EO-1 one minute behind Landsat-7 to optimize its gap filling utility. We have worked with Nicholas Johnson of the **Orbital Debris Program Office at JSC** and Scott Hull of the **GN&C Systems Engineering Branch at GSFC** to re-evaluate the **disposal** profile for the EO-1 spacecraft. The results of those analyses are that:

- The EO-1 Debris Survivability Casualty Area (5.9m^2) will continue to remain well within the international standard of 1 in 10,000 probability of causing significant injury to one person.
- Using a cross-sectional area as 6.2933 m^2 (which equates to $0.0115\text{ m}^2/\text{kg}$ for **Area-to-Mass** ratio), the calculated values of orbital lifetime for various initial conditions are as follows:

Disposal start to occur before	Perigee x Apogee	Uncontrolled disposal duration
Oct 2005	600x700	20.4 yrs (within Guideline)
Oct 2006	620x700	25.8 yrs (exceeds guideline by 0.8 years)

Oct 2007	650x700	28.1 yrs (exceeds guideline by 3.1 years)
Oct 2008	670x700	34.9 yrs (exceeds guideline by 9.9 years)
Oct 2009	680x700	35.6 yrs (exceeds guideline by 10.6 years)

Each of these potential de-orbit scenarios moves the EO-1 spacecraft out of the way of the morning constellation of satellites and puts it in a precessing orbit that does not cause future close encounter concerns with the other satellites. **Preserving enough fuel for this maneuver requires that EO-1 conduct a disposal maneuver no later than in October 2009.**

There is no increased likelihood of EO-1 exploding or otherwise causing additional debris or on-orbit contamination to be generated due to the possibility of taking longer to reenter. Therefore, other than the increased duration of the **disposal** profile, no additional risk is anticipated due to a decision to keep EO-1 on orbit beyond its guideline maximum. **It is to be noted that all EO-1 systems are presently operating within specifications and there are no operating trends that indicate any serious degradation of any life-limiting components. Therefore, it is expected that all life-limiting components should work through September 2009.**

We strongly desire to allow EO-1 to exceed the guideline and continue one minute behind Landsat-7 for the Delta-I that will occur next October 2005 and possibly beyond that date as the utility of EO-1 to perform part of the Landsat-7 gap filling role is demonstrated. Should this role fail to materialize, we would be willing **to conduct a disposal maneuver for** EO-1 at the next opportunity.

Please let me know if you have any concerns as to this course of action.