National Reconnaissance Office

6 January 1999
NROD 82-6
Acquisition Management

SUBJECT: National Reconnaissance Office Space Debris Mitigation Policy

A. SYNOPSIS. This directive prescribes policy and organizational responsibilities for minimizing space debris generated by National Reconnaissance Office (NRO) systems and for mitigating the effects of such debris when its creation cannot be avoided. This directive supersedes NRO Directive 83-1a, NRO Satellite End-of-Life Policy, dated 22 July 1997.

B. AUTHORITY. The PDD/NSC-49/NSTC-8, National Space Policy.

C. REFERENCES.

1. The NROD 82-2, NRO Acquisition Management--Directive 7, 6 August 1997.

2. National Aeronautics and Space Administration (NASA)/Department of Defense (DoD) Space Debris Mitigation Guidelines, 31 October 1997 (Appendix A).

3. The NRO Instruction (NROI) 82-2, NRO Satellite Debris Mitigation--Design Guidelines.

4. The NROI 82-3, NRO Satellite Debris Mitigation--End-of-Life.

D. PURPOSE. To establish consistency with NASA/DoD Space Debris Mitigation Guidelines (see Appendix) and to provide direction and guidance for all NRO directorates, offices, and field elements regarding NRO space debris mitigation policy.

E. APPLICABILITY. This directive applies to all NRO directorates, offices, and field elements for NRO programs/ projects that might generate space debris. It applies to spacecraft for which the NRO has acquisition or operational

authority. It does not apply to launch vehicles, upper stages, or their components.

F. DEFINITION. The term "debris" as used in this directive refers to man-made debris and includes both debris in orbit and that which survives reentry. Specifically, it refers to objects released in the course of NRO space operations and to NRO spacecraft that have reached the end of their useful lives or which otherwise have met the criteria for deactivation, deorbit, or disposal.

G. GENERAL. The NRO shall ensure that its space operations are conducted in a manner that minimizes the risk to public health and safety; minimizes the risk to other spacecraft; protects U.S. reconnaissance technology, sources, and methods; protects the public's investment in national reconnaissance satellites; and supports preservation of the space environment.

H. RESPONSIBILITIES.

1. All NRO programs and projects with orbital operations shall comply with all of the debris mitigation objectives specified in this policy directive and associated instructions. This includes employment of rigorous engineering and operational approaches in designing systems to minimize debris generation and planning for disposal of each spacecraft at the end of mission life.

2. The NRO Operations Support Facility (OSF) shall be responsible for developing and coordinating procedures for real-time deorbit notification as required by applicable international treaties. This responsibility includes coordinating deorbit sensor support and reentry location determination in accordance with the Reports Control Manual procedures. The OSF, in coordination with the Program Offices and in accordance with established procedures, shall assist in selection of orbits to reduce the probability of collision, and shall coordinate search and recovery efforts for satellite debris thought to have survived reentry. On-orbit support for avoiding collisions is provided by the OSF Watch to NRO satellite programs. The OSF shall also coordinate relevant external analysis resources support required by the Program Offices.

3. The NRO Office of Policy shall be responsible for coordinating and updating this policy directive and shall ensure appropriate representation of the NRO in national and international debris-policy fora.

4. The System-of-Systems Architect shall include debris mitigation considerations that may have mission implications (e.g., scheduling of follow-on systems due to disposal plans and requirements) in all architectural analyses.

5. The Office of Architectures, Assessments, and Acquisition shall conduct independent assessments at disposal decision points (see NROI 82-3, H-2).

I. IMPLEMENTATION.

1. As part of the NROD 82-2, NRO Acquisition Management - Directive 7 Integrated Program Summary and Independent Program Assessment process (reference C.1.), the development of each new system (and of each major upgrade to existing systems) shall include a debris mitigation assessment that:

a. Identifies program compliance with the space debris mitigation objectives stated in this policy directive and associated implementation instructions.

b. Identifies any areas of non-compliance, and trade-offs among cost, debris mitigation, and operational effectiveness associated with those areas of non-compliance.

2. In addition to I.1., above, and in accordance with NROI 82-2 NRO Satellite Debris Mitigation--Design Guidelines and NROI 82-3 NRO Satellite Debris Mitigation--End-of-Life, all NRO programs and projects with orbital operations shall:

a. Assess and minimize the amount of debris planned for release during normal operations.

b. Assess and minimize the probability of accidental explosion during and after completion of mission operations.

c. Assess and minimize the probability of operational space systems becoming sources of debris by collisions with man-made objects or meteoroids.

d. Plan for, consistent with mission requirements, cost-effective disposal procedures for spacecraft and other payloads at the end of their mission lives to minimize effects on future space operations.

H. WAIVER. Any decision to deviate from this policy shall be based on a risk/benefit analysis and shall require the approval of DNRO.

/signed/
Keith R. Hall
Director

Attachment:
Appendix - NASA/DoD Orbital Debris Mitigation Practices Guidelines

OPR: Policy
This directive supersedes NRO Directive 83-1 (22 July 1997)

APPENDIX

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION/DEPARTMENT OF DEFENSE ORBITAL DEBRIS MITIGATION PRACTICES GUIDELINES

A. Control Of Debris Released During Normal Operations

Programs and projects will assess and limit the amount of debris released in a planned manner during normal operations.

In all operational orbit regimes: Spacecraft and upper stages should be designed to eliminate or minimize debris released during normal operations. Each instance of planned release of debris larger than 5 millimeters in any dimension that remains on orbit for more than 25 years should be evaluated and justified on the basis of cost effectiveness and mission requirements.

B. Minimizing Debris Generated By Accidental Explosions

Programs and projects will assess and limit the probability of accidental explosions during and after completion of mission operations.

1. *Limiting the risk to other space systems from accidental explosions during mission operations*: In developing the design of a spacecraft or upper stage, each program, via failure mode and effects analyses or equivalent analyses, should demonstrate either that there is no credible failure mode for accidental explosions, or, if such credible failure modes exist, design or operational procedures will limit the probability of the occurrence of such failure modes.

2. *Limiting the risk to other space systems from accidental explosions after completion of mission operations*: All onboard sources of stored energy of a spacecraft or upper stage should be depleted or safed when they are no longer required for mission operations or post-mission disposal. Depletion should occur as soon as such an operation does not pose an unacceptable risk to the payload. Propellant depletion burns and compressed gas releases should be designed to minimize the probability of subsequent accidental collision and to minimize the impact of a subsequent accidental explosion.

C. Selection Of Safe Flight Profile And Operational Configuration

Programs and projects will assess and limit the probability of operating space systems becoming a source of debris by collisions with man-made objects or meteoroids.

1. *Collision with large objectives during orbital lifetime*: In developing the design and mission profile for a spacecraft or upper stage, a program will estimate and limit the probability of collision with known objects during orbital lifetime.

2. *Collision with small debris during mission operations*: Spacecraft design will consider and, consistent with cost effectiveness, limit the probability that collisions with debris smaller than 1-centimeter diameter will cause loss of control to prevent post-mission disposal.

3. *Tether systems* will be uniquely analyzed for both intact and severed conditions.

D. Post-mission Disposal Of Space Structures

Programs and projects will plan for, consistent with mission requirements, cost effective disposal procedures for launch vehicle components, upper stages, spacecraft, and other payloads at the end of mission life to minimize impact on future space operations.

1. *Disposal for final mission orbits*: A spacecraft or upper stage may be disposed of by one of three methods:

a. Atmospheric reentry option: Leave the structure in an orbit which, using conservative projections for solar activity, atmospheric drag will limit the lifetime to no longer than 25 years after completion of mission. If drag enhancement devices are to be used to reduce the orbit lifetime, it should be demonstrated that such devices will significantly reduce the area-time product of the system or will not cause spacecraft or large debris to fragment if a collision occurs while the system is decaying from orbit. If a space structure is to be disposed of by reentry into the earth's atmosphere, either the total debris casualty area for components and structural fragments surviving reentry will not exceed 8 meters squared, or it will be confined to a broad ocean or essentially unpopulated area.

b. Maneuvering to a storage orbit: At end of life, the structure may be relocated to one of the following storage regimes:

1) Between Low Earth Orbit and Medium-altitude Earth Orbit (MEO): Maneuver to an orbit with perigee altitude above 2000 kilometers (km) and apogee altitude below 19,700 km (500 km below semi-synchronous altitude).

2) Between MEO and Geosynchronous Earth Orbit (GEO): Maneuver to an orbit with perigee altitude above 20,700 km and apogee altitude below 35,300 km (approximately 500 km above semi-synchronous altitude and 500 km below synchronous altitude).

3) Above GEO: Maneuver to an orbit with perigee altitude above 36,100 km (approximately 300 km above synchronous altitude).

4) Heliocentric, Earth-escape: Maneuver to remove the structure from earth orbit, into a heliocentric orbit.

Because of fuel gauging uncertainties near the end of mission, a program should use a maneuver strategy that reduces the risk of leaving the structure near an operational orbit regime.

c. Direct retrieval: Retrieve the structure and remove it from orbit as soon as practical after completion of mission.

2. *Tether systems* will be uniquely analyzed for both intact and severed conditions when performing trade-offs between alternative disposal strategies.