



Orbital Debris Mitigation: Regulatory Challenges and Market Opportunities

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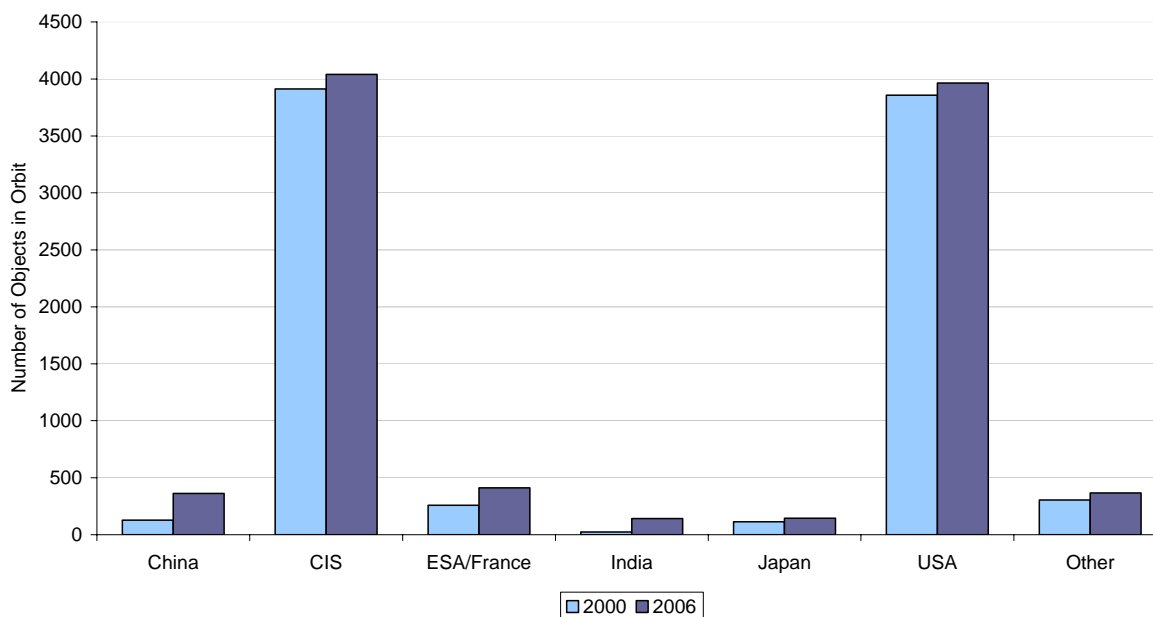
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A GROWING ORBITAL DEBRIS PROBLEM

Orbital debris, also called “space junk”, is defined as any man-made object in orbit around the Earth that no longer serves a useful purpose. On-orbit litter from a half-century of space exploration includes exploded boosters, burned out rocket motors, radioactive coolant, paint flakes, an astronaut's camera, a toothbrush, and most recently, an old Russian spacesuit tossed overboard from the International Space Station. Today, approximately 9,000 objects larger than 10 cm are being tracked in Earth orbit.¹ Because of their high orbital velocities, collisions with even small pieces of debris can involve considerable energy, and therefore pose a significant danger to spacecraft and astronauts.²

Data released by NASA in January 2006 indicates that orbital debris continues to be a growing problem for government and commercial satellite operators and manufacturers (see Figure 1). Since 2000, the number of on-orbit objects larger than a bowling ball has increased by nearly 10 percent, with the United States and Russia each contributing approximately 40 percent of the total debris. Orbital debris will continue to grow as long as there are launches of satellites and other spacecraft. Companies, however, can take significant steps towards minimizing the amount of debris that remains in space.

Figure 1: Growth in Number of Objects in Orbit, by Country/Organization, from 2000 to 2006³



To encourage (or mandate) such actions by industry, U.S. government agencies such as the Department of Defense (DoD), National Aeronautics and Space Administration (NASA), Federal Communications Commission (FCC), National Oceanic and Atmospheric Administration (NOAA), and the Federal Aviation Administration (FAA), as well as international organizations,

¹ The North American Aerospace Defense Command (NORAD) is responsible for tracking space objects.

² NASA Orbital Debris Program Office (<http://www.orbitaldebris.jsc.nasa.gov/>)

³ The Orbital Debris Quarterly News, NASA Johnson Space Center, January 2000 and January 2006 Issues. Total number of objects in orbit includes operationally active spacecraft.

are paying increasing attention to this issue, and are enacting policies and regulations to reduce the hazard posed by orbital debris to manned and unmanned spacecraft.

This white paper provides a top-level overview of the orbital debris threat and government orbital debris mitigation policy and regulatory responses to this situation. The paper also highlights the implications of these trends and associated opportunities for commercial spacecraft manufacturers and operators.

GOVERNMENTS RESPOND TO GROWING DEBRIS THREAT

United States and foreign governments have responded to the growing threat of orbital debris by tightening the regulatory regime governing orbital debris mitigation. Formal processes for reviewing new space missions' effects on orbital debris generation have been put in place at many agencies, and the number of exemptions and waivers granted is being reduced. Futron recently conducted a comprehensive survey of the leading U.S. agencies responsible for developing and enforcing guidelines and regulations aimed at reducing orbital debris (see Table 1). International organizations with regulatory or coordinating authority in this area were also reviewed.

Table 1: U.S. Government Agencies with Orbital Debris Mitigation Authority

Agency	Orbital Debris Mitigation Authority
NASA	U.S. civil government space missions
DoD	U.S. military spacecraft and launch vehicles
FCC	Non-governmental satellites
NOAA	Non-governmental remote sensing satellites
FAA	Commercial space launch and reentry vehicles

The following section reviews U.S. and international orbital debris mitigation standard practices, and describes the current status of orbital debris policies and regulations at key agencies.

U.S. ORBITAL DEBRIS MITIGATION STANDARD PRACTICES

In 2000, the Office of the Under Secretary of Defense issued joint DoD/NASA objectives and guidelines governing the design and operation of spacecraft and launch vehicle upper stages to mitigate the growth of orbital debris. These guidelines, known as the U.S. Government Orbital Debris Mitigation Standard Practices, apply to all agencies in the U.S. government with authority over space activities: launch, reentry, and spacecraft operation. The Standard Practices provide guidelines for achieving four key objectives:

- Control of debris released during normal operations
- Minimizing debris generated by accidental explosions
- Selection of safe flight profile and operational configuration
- Post-mission disposal of space structures

Because these practices are guidelines and not binding regulations, there is no level of responsibility and accountability that is legally enforceable. National security and other government programs are generally granted orbital debris waivers today, demonstrating that the current regulatory regime is relatively lenient in these cases.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA has been at the forefront of orbital debris mitigation efforts in the U.S. government. With authority over all U.S. civil government space missions, the agency has developed a policy and specific procedural requirements for orbital debris mitigation. The NASA guidelines were used, with DoD consultation and input, as the basis for the U.S. Government Orbital Debris Mitigation Standard Practices finalized in 2000, and form the basis for most other U.S. government orbital debris regulations, such as those of the FCC.

Today there is a stringent safety review process within NASA that every mission must pass through in order to ensure that there is no unnecessary orbital debris creation. This process allows for exceptions to the guidelines on a case-by-case basis, so NASA programs are not always fully compliant with all orbital debris mitigation guidelines. If an individual mission does not meet NASA requirements, it is subject to review at the Associate Administrator level to determine if changes are needed or if launching may proceed. Though this review could be considered an unofficial waiver process, this risk acceptance procedure rigorously applies NASA's policy and far-reaching requirements for mitigating orbital debris.

DEPARTMENT OF DEFENSE

The DoD has authority over all military space missions. The *Department of Defense Directive Space Policy*, issued in 1999, states that the DoD will seek to minimize the impact of space debris on its military operations. To comply with this directive, the DoD looks towards the U.S. Government Orbital Debris Mitigation Standard Practices, as outlined above, as the primary guidelines for orbital debris mitigation. Because there are no other directives for space debris mitigation in place specifically within the DoD, this environment may be viewed as the least defined and most lenient among U.S. government agencies. Accordingly, there is currently very little waiver activity within the department with respect to orbital debris mitigation requirements. Waiver processes are not typically used as a means to prevent launches, and are instead mainly employed as a way to document instances of non-compliance, so that such violations will be prevented when future missions are flown.

FEDERAL COMMUNICATIONS COMMISSION

The FCC is the primary U.S. agency responsible for authorizing non-governmental satellite activities. FCC regulations for orbital debris began in 2000 with application requirements for mitigation among specific satellite types, such as 2 GHz MSS satellites. In October 2005, the FCC announced that any applicant with a pending request for authority would be required to file an orbital debris mitigation plan within 30 days. In addition, all new license requests would require the same orbital debris mitigation plan. The mitigation plan must address spacecraft hardware design, minimizing accidental explosions, safe flight profiles, post-mission disposal, and must include a casualty risk assessment if satellite disposal involves atmospheric reentry.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NOAA has licensing and regulatory authority over remote sensing spacecraft. In 2000, NOAA issued regulations that revised the agency's minimum requirements for licensing, monitoring,

and compliance of private Earth remote sensing space systems under Title II of the Land Remote Sensing Policy Act of 1992. Among other revisions, it added an additional licensing requirement for spacecraft disposal to ensure that applicants would comply with U.S. government orbital debris mitigation practices. Applicants must submit a plan for post-mission disposal of any remote sensing satellites. If the satellite disposal involves atmospheric reentry, the applicant must provide an estimate of the total debris casualty area of the system components and structure likely to survive reentry.

FEDERAL AVIATION ADMINISTRATION

The FAA's Office of Commercial Space Transportation has licensing control over U.S. commercial space launch and reentry activities. Commercial applicants for FAA licenses must demonstrate various orbital debris mitigation characteristics for vehicle stages and components, such as having no unplanned contact with payloads after separation, and eliminating stored energy that could cause physical fragmentation. As a matter of practice, the FAA requires evidence of implementation of industry standard methods of passivation, for rendering spent upper stages remaining in orbit inert or otherwise ensuring that they will not explode or break up as a result of residual propellants, gases, or ordnance devices.

INTERNATIONAL REGULATORY ENVIRONMENT

In recent years, orbital debris mitigation has also become an important focus in the international space community. Several countries, including Japan, France, and Russia, have issued their own orbital debris mitigation guidelines. Intergovernmental organizations are also tackling orbital debris generation issues. For example, the European Space Agency (ESA) has developed guidelines and has taken one of the most proactive roles in limiting new debris creation in orbit. In 2002, after a multi-year effort, the Inter-Agency Space Debris Coordination Committee (IADC), comprised of the space agencies of 10 countries as well as ESA, adopted a consensus set of guidelines designed to mitigate the growth of orbital debris. These guidelines are an important baseline used by most countries that are launching objects into space. The United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) has also played a critical role in coordinating mitigation efforts among countries. As a result of these programs, orbital debris mitigation activities are increasingly becoming a coordinated international effort lead by IADC, rather than a country-level effort.

FUTURE POLICY AND REGULATORY SCENARIO

United States government agencies generally anticipate that current orbital debris mitigation guidelines and regulations will face more rigorous enforcement in the next five years. Within the DoD, some observers expect that there will likely be greater efforts to encourage compliance with existing guidelines, but not in the form of strictly enforced rules. Like the DoD guidelines, the current NASA standards for mitigation are not expected to change significantly in the near future, but they are expected to be enforced more comprehensively. NASA plans to release new Procedural Requirements for orbital debris mitigation in 2006, which will emphasize taking direct action to minimize debris risk and more seriously applying NASA requirements to every mission. NASA is working to coordinate its increased mitigation efforts at both the national and international level with other U.S. government agencies and intergovernmental groups. At present there is no pending legislation that would establish any new orbital debris regulations

affecting DoD or NASA missions, policies, or procedures. As described above, the FCC recently revised its regulatory requirements for debris mitigation and expects to maintain this new level of oversight and enforcement at least for the near term. NOAA and FAA expect to continue their current level of oversight and enforcement of orbital debris mitigation at least for the near term.

CHALLENGES AND OPPORTUNITIES FOR INDUSTRY

The trend towards increased government enforcement in the orbital debris mitigation area is motivating satellite system operators and spacecraft manufacturers to consider long-term approaches to regulatory compliance. Operators need to closely monitor orbital debris regulatory and policy developments around the globe because changing requirements will directly affect how operators approach satellite procurements. Spacecraft RFP documents should include clear post-life disposal requirements that manufacturers can respond to, and satellite system planning efforts need to take into account the evolving international orbital debris mitigation policy regime.

There are also market opportunities for spacecraft manufacturers. Manufacturers can create competitive advantages by pursuing a proactive long-range strategy and identifying technical solutions that optimize spacecraft system performance at total lowest development and operating cost. Subsystem and technology developers may discover an emerging market for new spacecraft components that solve the end-of-mission orbit-lowering problem at reduced cost and risk in comparison to current technical solutions involving the addition of extra fuel for use in propulsive deorbit maneuvers.

Compliance with national and international guidelines and regulations results in higher system development and operations costs and can present increased technical complexity and failure risk. Orbital debris concerns will have a growing impact on mission requirements and design and spacecraft performance, particularly for satellites operating in LEO orbits.

Evolving spacecraft technologies and mission requirements, together with stricter enforcement of orbital debris mitigation regulations, present significant challenges and opportunities for forward-looking satellite and launch vehicle operators and manufacturers. As many aspects of life become more reliant on technologies in space, it is important to assess and address the threat to on-orbit assets from orbital debris and enhance the measures that are taken to reduce this threat.

WHAT FUTRON CAN DO FOR YOU

Orbital debris mitigation policies, regulations and guidelines are playing an increasingly important role at the domestic and international level in placing new constraints on the design and operation of government and private sector space missions. Corporations and government agencies which plan for the long term and that wish to identify potential market opportunities can benefit from Futron's extensive knowledge of this evolving regulatory, policy, and technology area.

Futron's Space and Telecommunications Division is the industry leader in researching, analyzing, and forecasting space markets and programs. We possess an exceptionally strong knowledge base in the area of orbital debris mitigation policies and industry initiatives around the globe. Recent clients served here include a major US government agency and a leading aerospace technology development corporation. Our world-class team of policy and market analysts, economists, and engineers bring unparalleled skills and expertise in the following areas:

- **Policy and Regulatory Analysis.** Futron assists clients in understanding the current and emerging space policy and regulatory environment in the United States, Europe, and Asia. Our reputation for objective analysis and insight enables us to gain access to senior officials at NASA, the DoD, FAA, FCC, the ESA, JAXA, United Nations, and other key space agencies around the globe.
- **Market Research and Forecasting.** Futron is well known as a worldwide leader in space industry market research and forecasting. Surveys of government agencies and satellite operators and manufacturers, together with daily updates to our proprietary launch and satellite databases, have allowed us to develop a detailed profile of the emerging international orbital debris mitigation sector. Our industry clients have successfully employed our expertise and market intelligence to identify and lock in competitive advantages in the satellite procurement and subsystems marketplace.
- **Technology Assessment and Risk Analysis.** Futron is highly skilled in the performance of launch vehicle and spacecraft technology assessments and reliability and risk analysis. We help clients objectively evaluate the capability and readiness of space systems to enter and succeed in the global marketplace.
- **FCC Filings Service.** Futron provides a subscription-based service that disseminates information on every FCC satellite application filed since 1990. Our FCCFilings.com database contains extensive data regarding satellite operator plans to comply with FCC orbital debris mitigation regulations.

Futron Corporation was founded in 1986 and is headquartered in Bethesda, Maryland, with a branch office in Houston, Texas. Please visit our website at www.futron.com for further information about our capabilities.

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