SPACE DEBRIS: ITS CAUSES AND MANAGEMENT

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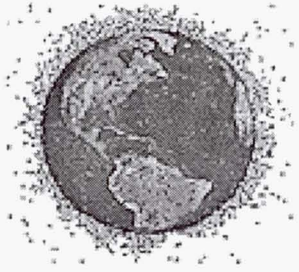
Johnson Space Center



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SATELLITE POPULATION

Johnson Space Center, Houston, Texas

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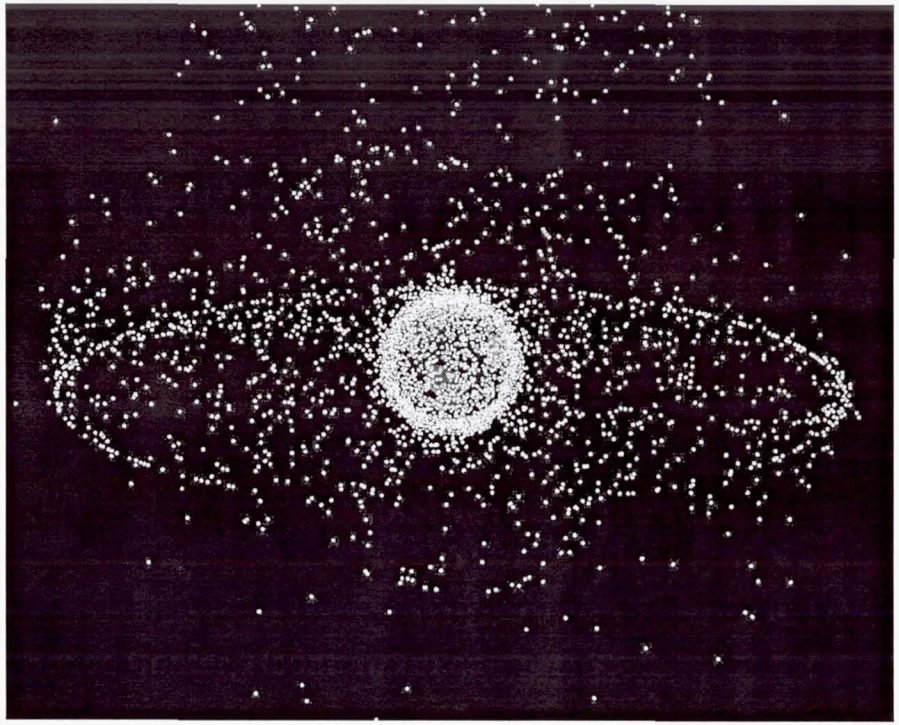

~10,000 tracked objects in 2002 (>10 cm diameter)

Comprised of spacecraft, launch vehicle upper stages, mission-related debris, and fragmentation debris

GROWTH OF THE CATALOGED SATELLITE POPULATION

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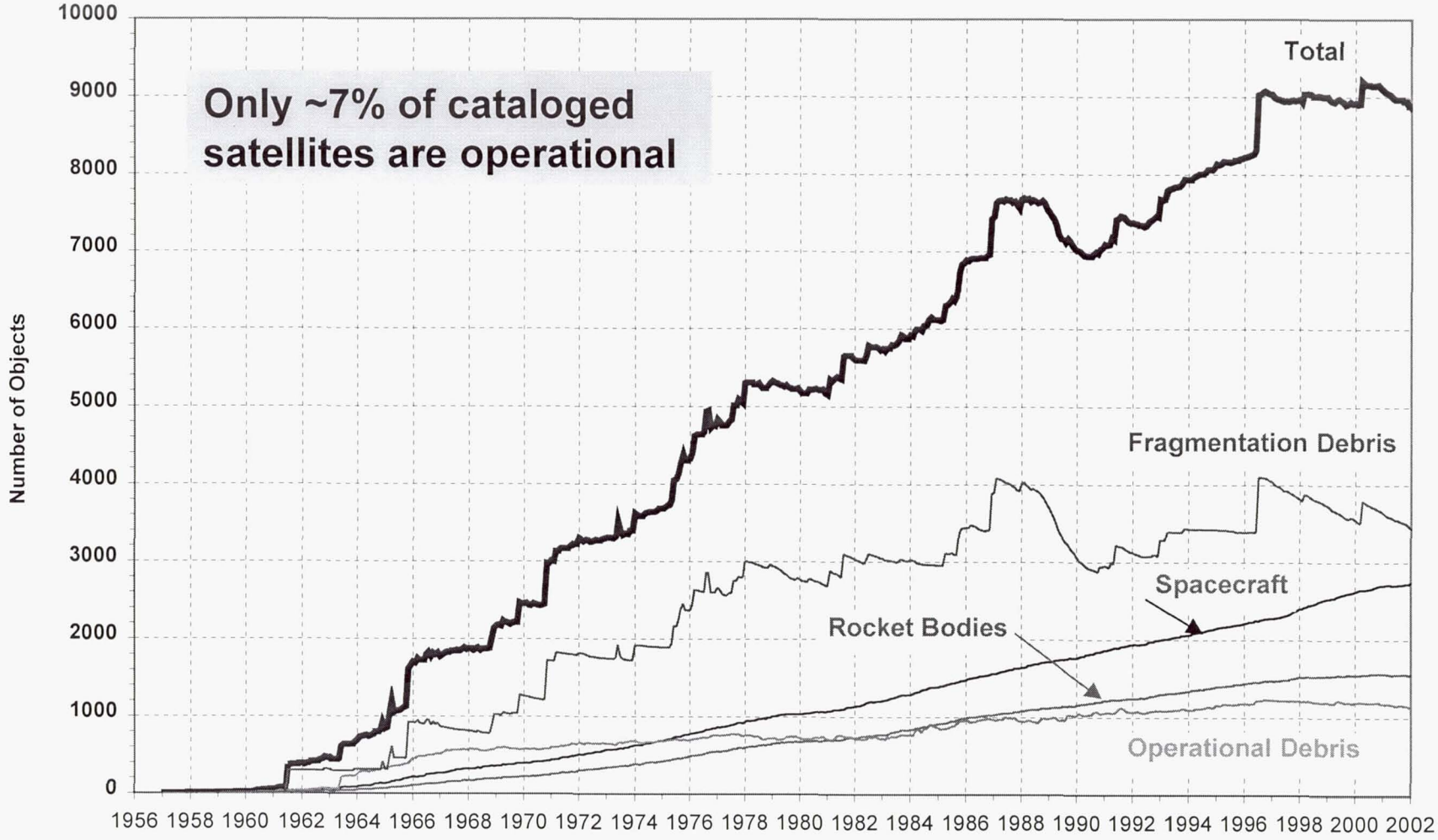

ORBITAL DEBRIS DETECTION TECHNIQUES AND SENSITIVITIES

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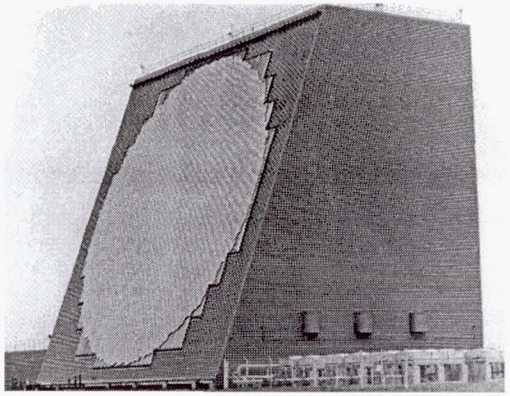
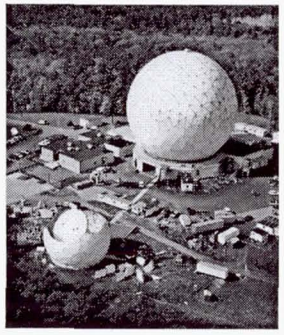




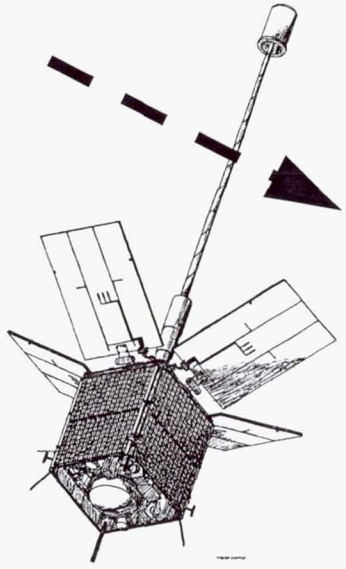
COLLISIONS WITH DEBRIS

- All spacecraft are routinely struck by small particles (<1 mm diameter), both meteoroids and orbital debris, which are much more numerous than cataloged objects
  - With rare exceptions these impacts do not affect the mission
  - On average 1-2 Space Shuttle windows are replaced after each mission due to small particle impacts

- The Space Shuttle and some robotic satellites are known to have been struck by particles of 1 mm or larger

- The only accidental collision of two large (cataloged) objects occurred in July 1996 when the French CERISE spacecraft was struck by a fragment from an Ariane upper stage which had exploded 10 years earlier

- Collisions between cataloged objects should remain rare for the next two decades



PROJECTED GROWTH OF THE LARGE SATELLITE POPULATION

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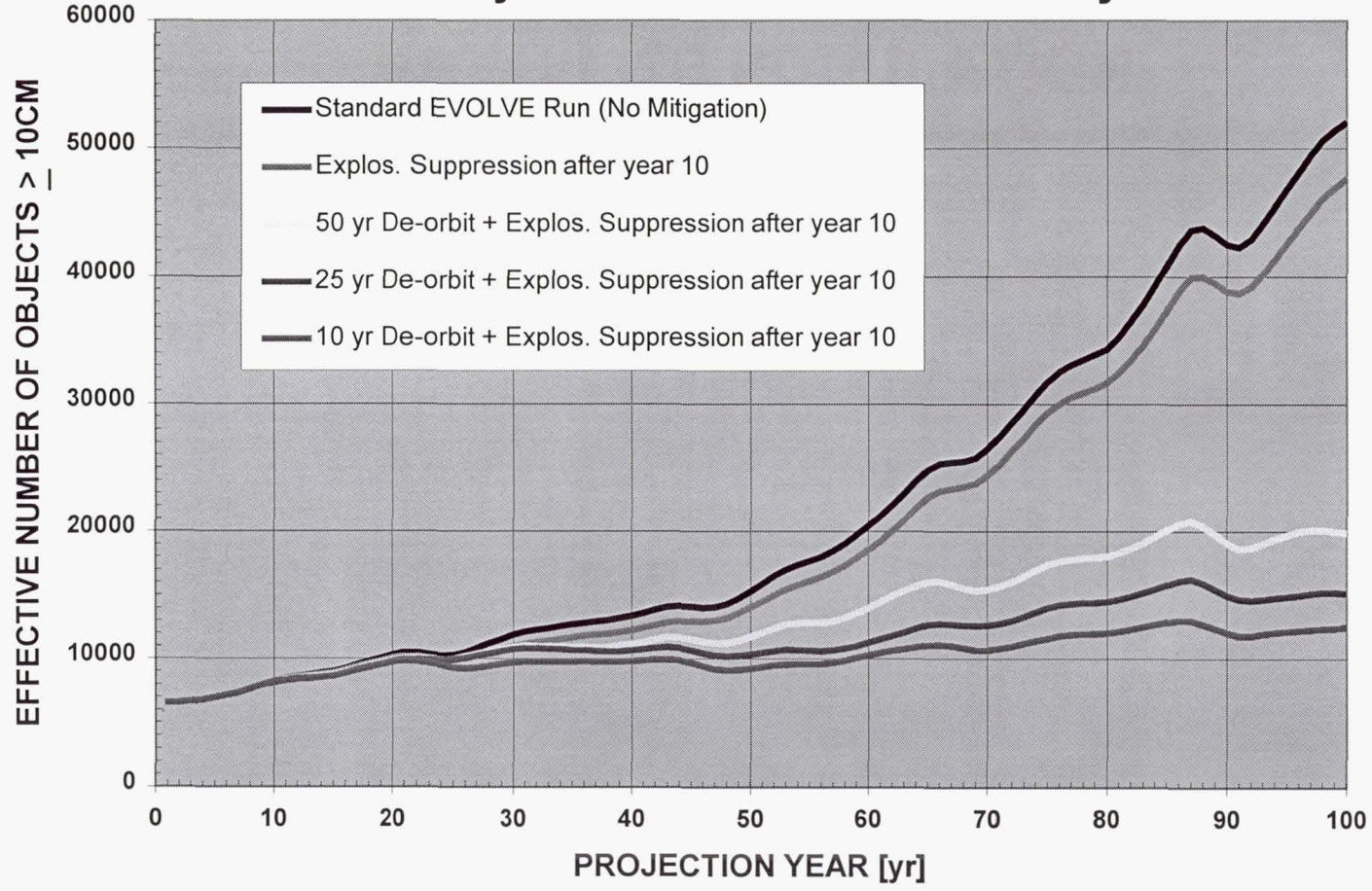
Without further implementation of orbital debris mitigation measures, the large (>10 cm) Earth satellite population might begin to grow rapidly by the end of the 21st century



U.S. SPACE POLICY AND ORBITAL DEBRIS

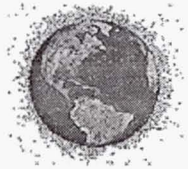
- **Orbital debris has been included in all national space policies since 1988**

- **Current National Space Policy (PDD-NSC-49/NSTC-8, 19 Sep 1996) expanded orbital debris description:**

"The United States will seek to minimize the creation of space debris. NASA, the intelligence Community, and the DoD, in cooperation with the private sector, will develop design guidelines for future government procurements of spacecraft, launch vehicles, and services. The design and operation of space tests, experiments and systems, will minimize or reduce the accumulation of space debris consistent with mission requirements and cost effectiveness.

"It is in the interest of the U.S. Government to ensure that space debris minimization practices are applied by other spacefaring nations and international fora to adopt policies and practices aimed at debris minimization and will cooperate internationally in the exchange of information on debris research and the identification of debris mitigation options."

U.S. GOVERNMENT ORBITAL DEBRIS MITIGATION STANDARD PRACTICES



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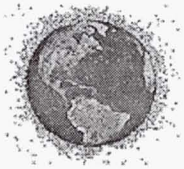
- In response to 1995 Interagency report, NASA and DoD developed draft orbital debris mitigation standard practices based upon NASA Safety Standard 1740.14

- Standard Practices cover four major areas:
  - Control of debris released during normal operations
  - Minimization of debris generated by accidental explosions
  - Selection of safe flight profile and operational configuration
  - Postmission disposal of space structure

- Standard Practices were briefed to Industry at U.S. Government workshop in Jan 1998 and finalized in Dec 2000

- Standard Practices are being used as foundation for development of international guidelines

INTER-AGENCY SPACE DEBRIS COORDINATION COMMITTEE (IADC)



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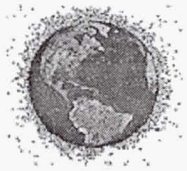
- **Established in 1993:**
  - To exchange information on space debris research activities between member space agencies;
  - To facilitate opportunities for cooperation in space debris research;
  - To review progress of ongoing cooperative activities; and
  - To identify debris mitigation options
- **11 members include space agencies from 10 countries (China, France, Germany, India, Italy, Japan, Russia, Ukraine, United Kingdom, and the United States) and the European Space Agency**
- **Currently developing consensus international orbital debris mitigation guidelines, to be presented to the United Nations in 2003**

ORBITAL DEBRIS AT THE UNITED NATIONS



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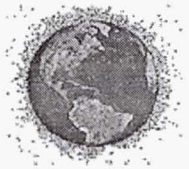
- Since 1994 the subject of orbital debris has been on the agenda of the Scientific and Technical Subcommittee (STSC) of the United Nations' Committee on the Peaceful Uses of Outer Space (COPUOS)

- A multi-year work plan culminated in the 1999 "Technical Report on Space Debris" (A/AC.105/720), summarizing the world state-of-knowledge concerning measurements and modeling of the environment as well as identified orbital debris mitigation measures

- New multi-year plan adopted in 2001 with a goal of reaching a consensus on orbital debris mitigation guidelines during 2003-2004 and beginning annual member reports in 2005

SUMMARY



- Orbital debris is internationally recognized as an environmental issue which needs to be addressed today to preserve near-Earth space for future generations

- All major space agencies are committed to mitigating the growth of the debris environment

- Many commercial space system operators have responded positively to orbital debris mitigation principles and recommendations

- Orbital debris mitigation measures are most cost-effective if included in the design development phase

Further information at www.orbitaldebris.jsc.nasa.gov