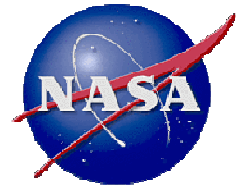


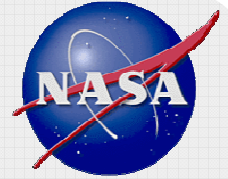
National Aeronautics and Space Administration



USA Space Debris Environment, Operations, and Policy Updates

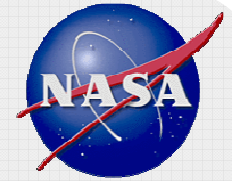
**Presentation to the 49th Session of the
Scientific and Technical Subcommittee
Committee on the Peaceful Uses of Outer Space
United Nations**

6-17 February 2012



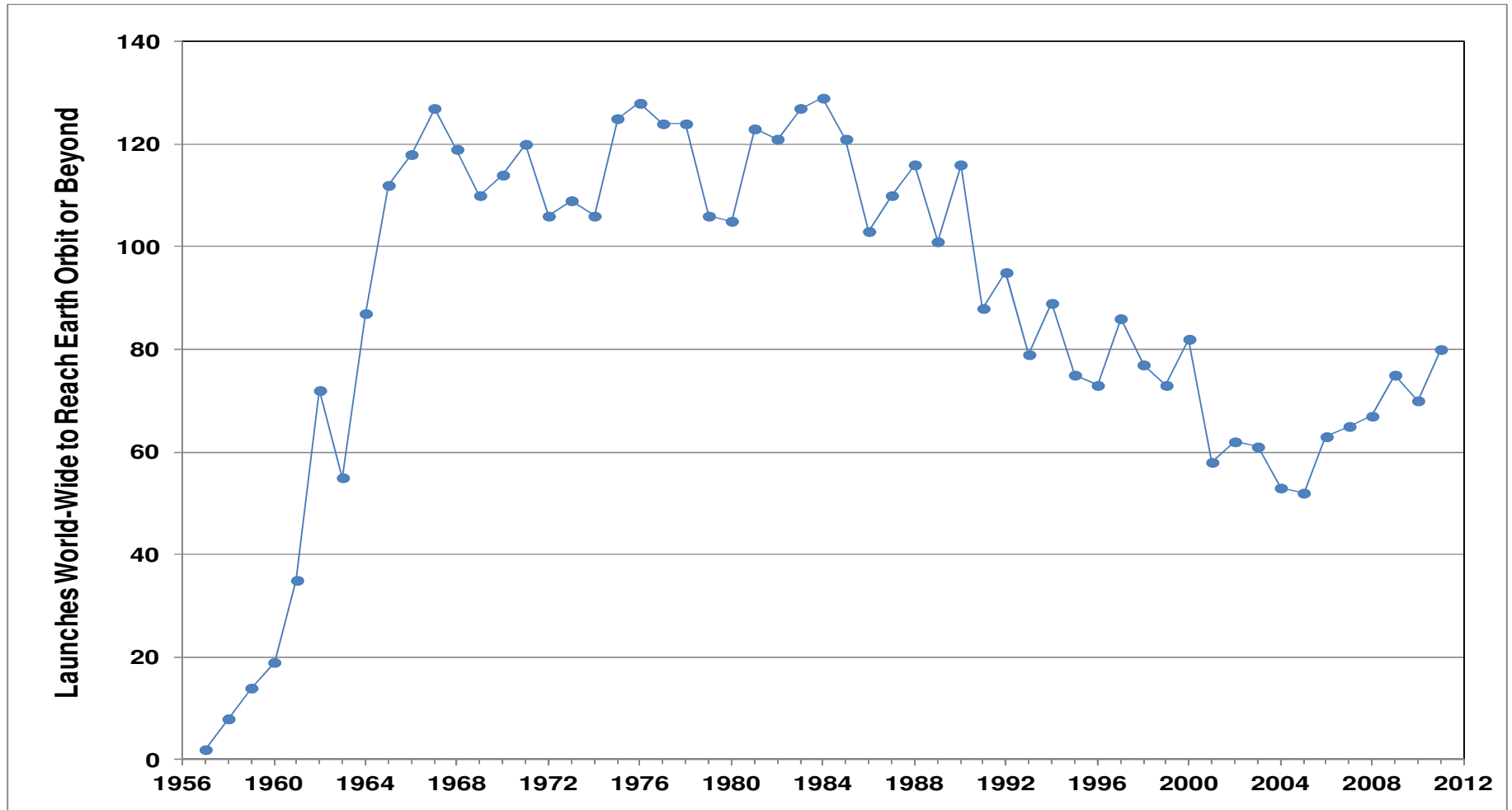
Presentation Outline

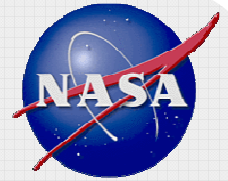
- **Earth Satellite Population**
- **Collision Avoidance Maneuvers in 2011**
- **Disposal of USA GEO Spacecraft in 2011**
- **Satellite Reentries in 2011**
- **Revision of NASA Orbital Debris Mitigation Requirements**



Global Space Missions by Year

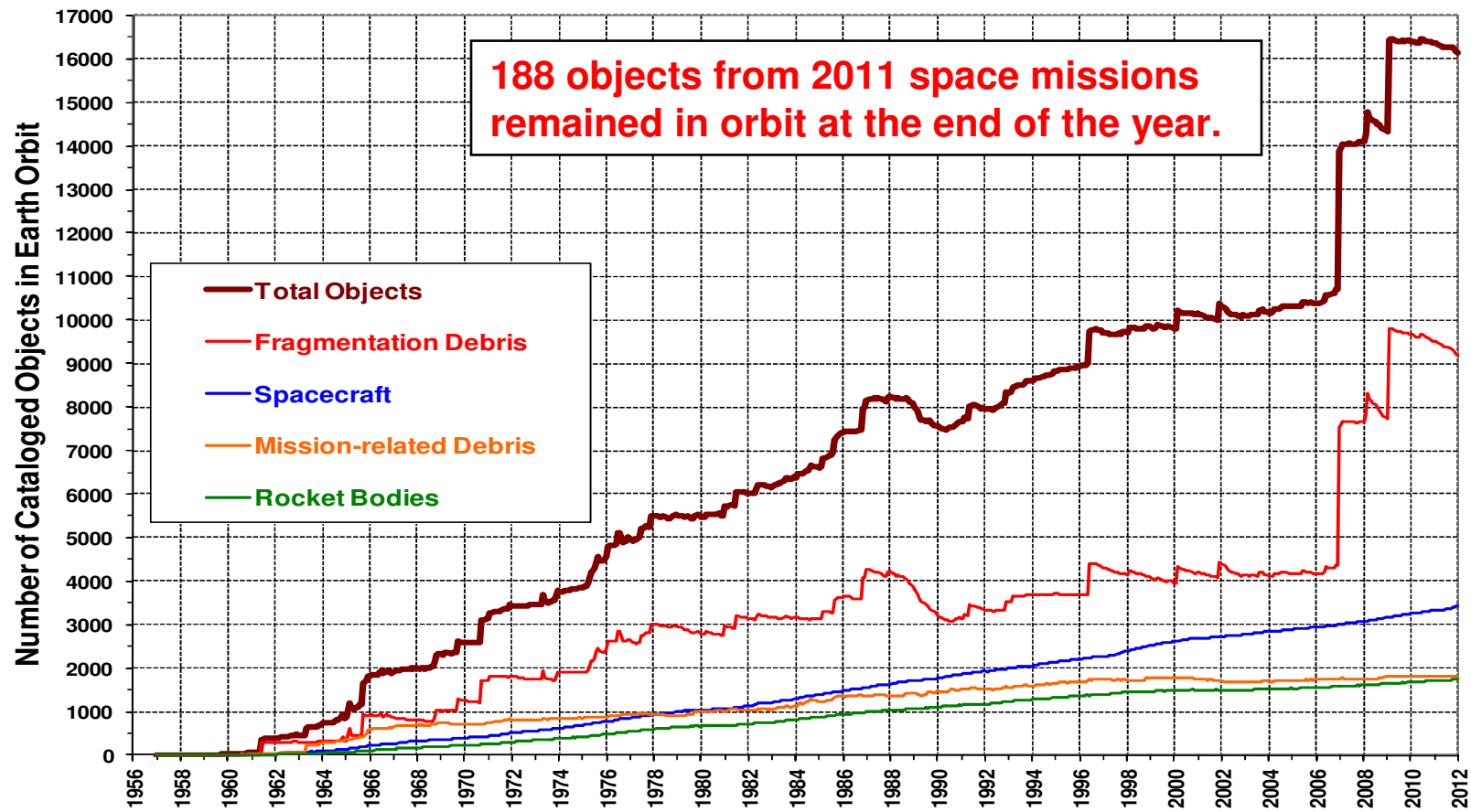
- A total of 80 space launches reached Earth orbit or beyond during 2011, the most since the year 2000.

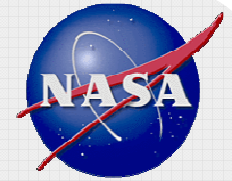




Evolution of the Cataloged Satellite Population

- The number of cataloged objects in Earth orbit, as assessed by the USA Space Surveillance System, continued a modest decline in 2011 due to increased solar activity, which increases atmospheric density and drag.



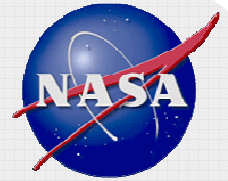


Status of Fengyun 1C, Cosmos 2251, and Iridium 33 Debris

- Only a few satellite fragmentations were detected during 2011, producing just two long-lived cataloged debris.
- The intentional destruction of the Fengyun 1C spacecraft in 2007 and the accidental collision of the Cosmos 2251 and the Iridium 33 spacecraft in 2009 remain the worst known debris generation events in Earth orbit.

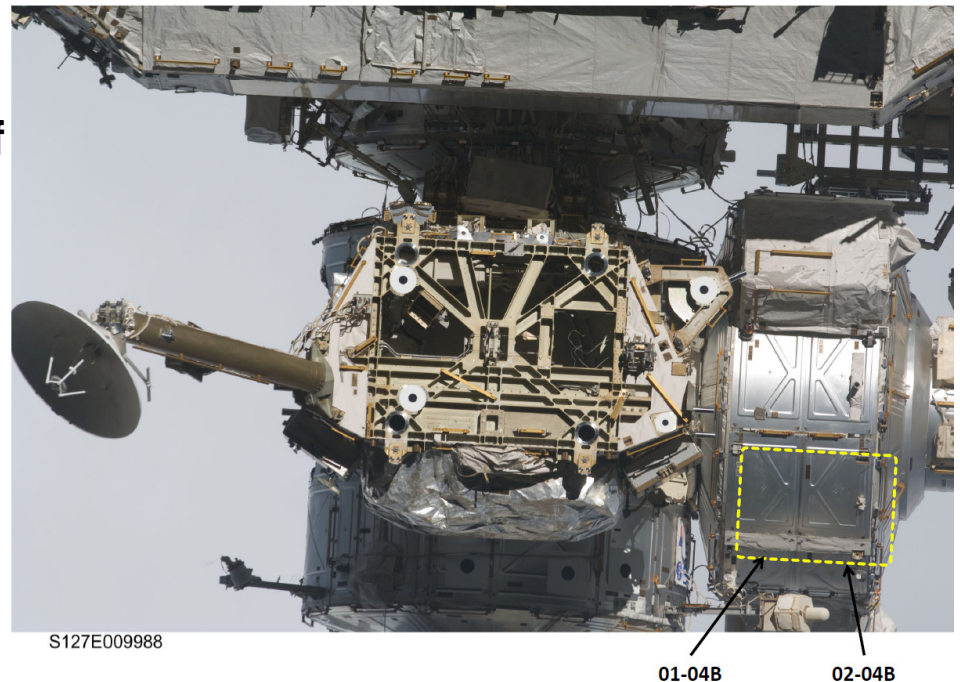
	<u>Cataloged Debris</u>	<u>Cataloged Debris in Orbit 1 Jan 2012</u>
Fengyun 1C	3218	3012 (94%)
Cosmos 2251	1541	1375 (89%)
Iridium 33	567	493 (87%)

- All together, the two events account for 36% of the total number of cataloged objects currently residing in or traversing low Earth orbit.

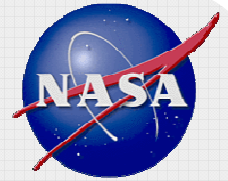


Small Particle Impacts on ISS

- **Two debris shields from the USA airlock on ISS were returned to Earth in 2010 after an exposure of nearly nine years.**
- **A detailed analysis at the NASA Johnson Space Center in 2011 found 58 craters with a diameter of 0.3 mm or more. The largest crater had a diameter of 1.8 mm and nearly penetrated the shield.**

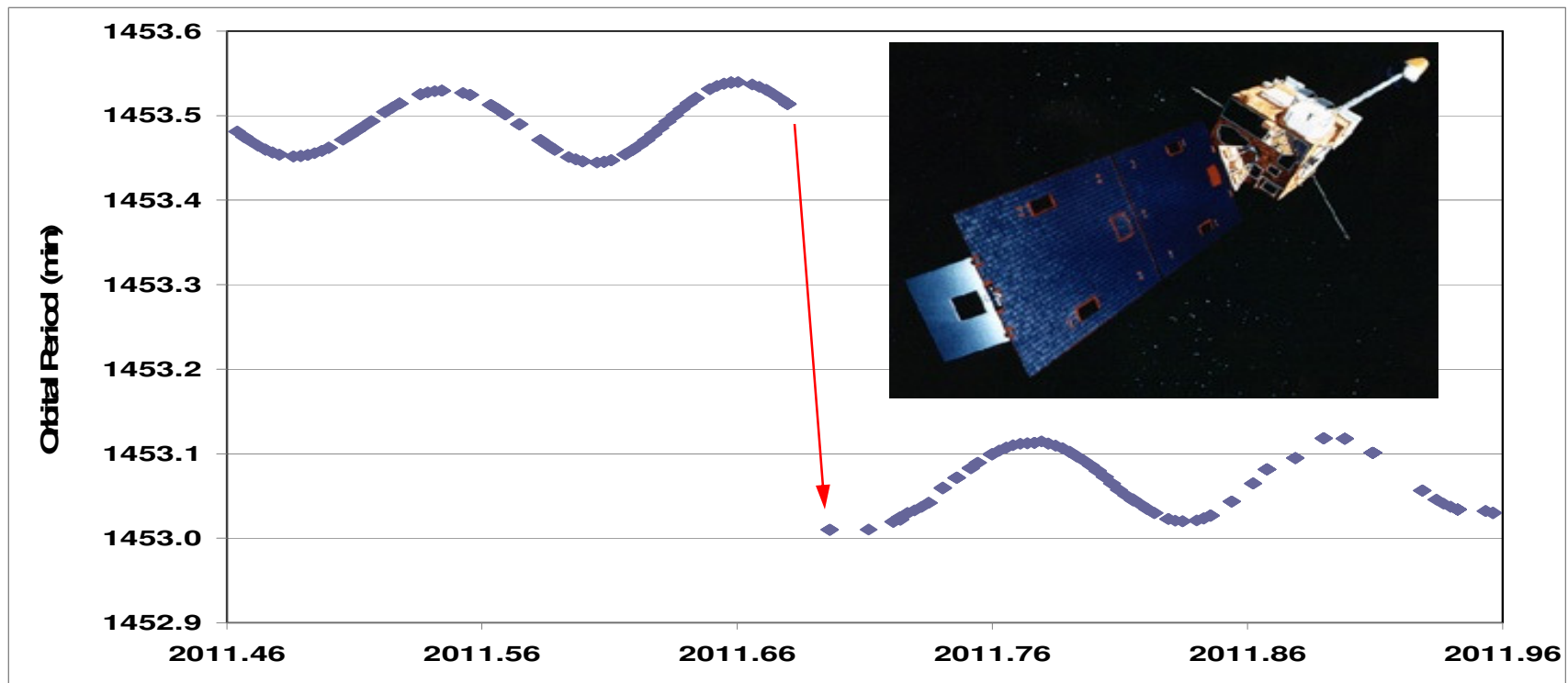


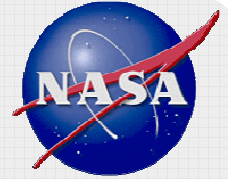
- **Six of the larger craters, including the largest one, contained residue of silica, Teflon, or both.**
- **Some of the panel craters might be evidence of secondary debris from initial impacts on ISS solar arrays.**



GOES 10 Anomaly

- Nearly two years after the GOES 10 spacecraft had been decommissioned and placed in a compliant disposal orbit above GEO, on 5 September 2011 the orbit of the vehicle was abruptly perturbed: perigee decreased by 20 km.
- The cause is still unknown, but a collision with a small object is a possibility.

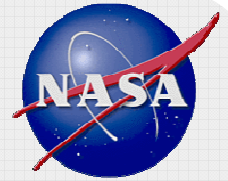




Satellite Collision Avoidance

- Since 2007 NASA has required frequent satellite conjunction assessments for all of its maneuverable spacecraft in LEO or GEO to avoid accidental collisions with resident space objects.
- During 2011 NASA robotic satellites conducted 9 collision avoidance maneuvers.

Spacecraft	Maneuver Date	Object Avoided
Aqua	2 January	Cosmos 2251 Debris
Aqua	8 February	Iridium 33 Debris
Calipso	18 February	OV2-1
Aqua	1 March	Agna D Debris
Cloudsat	18 June	Aqua
TDRS 7	18 October	Ekran 4
Cloudsat	6 November	Terra
Landsat 7	29 November	Cosmos 374 Debris
Cloudsat	14 December	Fengyun-1C Debris



ISS Collision Avoidance Maneuvers

- **The International Space Station has conducted 15 collision avoidance maneuvers since 1999.**

- Conjunction assessments are evaluated three times each day.

- **During 2011, two collision avoidance maneuvers were executed:**

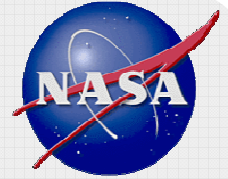
- 2 April to evade fragmentation debris from Cosmos 2251,
- 29 September to evade debris from a Tsyklon rocket body.



International Space Station

- **Two collision avoidance maneuvers have already been required during 2012.**

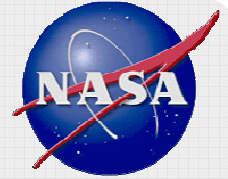
- 13 January to evade fragmentation debris from Iridium 33,
- 28 January to evade fragmentation debris from Fengyun-1C.



Disposal of USA Geosynchronous Satellites

- **Six USA civil GEO spacecraft completed operations in 2011.**
- **All were moved to disposal orbits compliant with United Nations recommendations to protect the GEO region.**

Spacecraft	International Designator	Minimum Height above GEO	Maximum Height above GEO
TDRS 4	1989-021b	460 km	560 km
INTELSAT 2	1994-040A	265 km	355 km
INTELSAT 705	1995-013A	290 km	445 km
INTELSAT 3R	1996-002A	295 km	380 km
ECHOSTAR 4	1998-028A	340 km	410 km
GOES 11	2000-022A	340 km	355 km



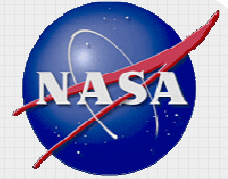
Disposal of TDRS 4

- **NASA's fourth Tracking and Data Relay Satellite (TDRS) completed more than 22 years of valuable communications service in 2011.**



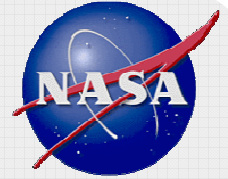
TDRS 4 spacecraft

- **On 28 November the spacecraft conducted two maneuvers to reach an initial disposal orbit of approximately 300 km by 500 km above GEO, in accordance with USA and UN guidelines.**
- **After reaching the disposal orbit, TDRS 4 conducted a series of smaller engine burns for over a week to deplete all residual propellants.**
- **All TDRS 4 passivation actions were completed by 9 December, leaving the spacecraft in an orbit of 460 km by 560 km above GEO.**



Satellite Reentries in 2011

- **Nearly 500 satellite reentries occurred during 2011.**
 - 474 uncontrolled reentries
 - 25 controlled reentries (17 spacecraft and 8 rocket bodies)
- **The uncontrolled reentries accounted for a total mass of > 100 metric tons from 63 payloads and rocket bodies.**
- **No accounts of personal injury or significant property damage were reported.**
- **The rate of uncontrolled reentries is increasing due to the approach of solar maximum in 2013; however, the vast majority of these reentries have and will continue to represent small debris which do not pose hazards to people and property on Earth.**

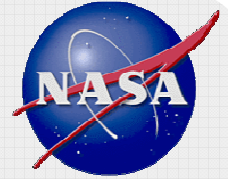


USA Orbview-3 Controlled Reentry

- **The Orbview-3 commercial remote sensing spacecraft completed its mission of more than seven years in late 2010 in an orbit of 435 km.**
- **Although Orbview-3 would have naturally fallen back to Earth well within the recommended 25-year period, the owners elected to execute a controlled reentry to immediately eliminate any potential risk of collision to other resident space objects.**
- **Four maneuvers first lowered the orbit of Orbview-3 below that of the International Space Station. Then, four additional maneuvers sent the spacecraft to a carefully orchestrated reentry over the Pacific Ocean on 13 March 2011.**



Orbview-3



Revision to NASA Orbital Debris Mitigation Requirements

- **During 2011 minor revisions were made to the NASA requirements document on orbital debris mitigation.**
- **No significant changes to the official requirements for orbital debris mitigation were made. One redundant requirement (Requirement 6.4-5) was deleted.**
- **NASA Technical Standard (NS) 8719.14A was approved on 8 December 2011.**

NS 8719.14A remains consistent with the Space Debris Mitigation Guidelines of UN COPUOS STSC.