ORBITAL DEBRIS PROGRAM OFFICE

Frequently Asked Questions

1. What is orbital debris?

Orbital debris is any human-made object in orbit about the Earth that no longer serves any useful purpose.

2. What are examples of orbital debris?

Derelict spacecraft and upper stages of launch vehicles, carriers for multiple payloads, debris intentionally released during spacecraft separation from its launch vehicle or during mission operations, debris created as a result of spacecraft or upper stage explosions or collisions, solid rocket motor effluents, and tiny flecks of paint released by thermal stress or small particle impacts.

3. How much orbital debris is currently in Earth orbit?

More than 23,000 orbital debris larger than 10 cm are known to exist. The estimated population of particles between 1 and 10 cm in diameter is approximately 500,000. The number of particles larger than 1 mm exceeds 100 million. As of January 1, 2020, the amount of material orbiting the Earth exceeded 8,000 metric tons.

4. How is the number of orbital debris determined?

Large orbital debris (> 10 cm) is tracked routinely by the U.S. Space Surveillance Network. Objects as small as 3 mm can be detected by ground-based radars, providing a basis for a statistical estimate of their numbers. Assessments of the population of orbital debris smaller than 1 mm can be made by examining impact features on the surfaces of returned spacecraft, although this has been limited to spacecraft operating in altitudes below 600 km.

5. What is the principal source of large orbital debris?

Satellite explosions and collisions. Prior to 2007, the principal source of debris was from explosions of launch vehicle upper stages and spacecraft. The intentional destruction of the Fengyun-1C weather satellite by China in 2007 and the accidental collision of the American communications satellite, Iridium-33, and the retired Russian spacecraft, Cosmos-2251, in 2009 greatly increased the number of large debris in orbit and now represent one-third of all cataloged orbital debris.

6. Is orbital debris uniformly distributed about the Earth?

Most orbital debris resides within 2,000 km of the Earth's surface. Within this volume, the amount of debris varies significantly with altitude. The greatest concentration of debris is found near 750-1000 km.

7. How fast is orbital debris traveling?

In low Earth orbit (below 2,000 km), orbital debris circles the Earth at speeds of about 7 to 8 km/s. However, the average impact speed of orbital debris with another space object is approximately 10 km/s, and can be up to about 15 km/s, which is more than 10 times the speed of a bullet. Consequently, collisions with even a small piece of debris will involve considerable energy.

8. Does the International Space Station have to dodge orbital debris?

The U.S. Space Surveillance Network regularly examines the trajectories of orbital debris to identify possible close encounters. If another object is projected to come within a few kilometers of the International Space Station (ISS), the ISS will normally maneuver away from the object if the chance of a collision exceeds 1 in 10,000. This occurs infrequently, about once a year on average.

9. How is the International Space Station protected against orbital debris?

The ISS is the most heavily shielded spacecraft ever flown. Critical components, e.g., habitable compartments and high pressure tanks, will normally be able to withstand the impact of debris as large as 1 cm in diameter. The risk of a critical ISS component being struck by debris 1-10 cm in diameter is slight and ways to reduce this risk are being investigated.

10. How did the Mir space station fare during its 15-year stay in Earth orbit?

Photographs of Mir's exterior show large numbers of impacts from small orbital debris and meteoroids. The most significant damage was to the large, fragile solar arrays that could not be protected from small particles. Orbital debris caused no loss of mission or capability on Mir.

11. Do the low altitude, commercial communication satellite networks pose special debris issues?

Systems such as Iridium, Orbcomm, and Globalstar do not represent unique debris problems. In fact, many of the systems are being deployed in ways designed to minimize orbital debris generation. Often, upper stages and spacecraft are placed in lower altitude orbits after their missions have been completed to accelerate their fall back to Earth.

12. How long will orbital debris remain in Earth orbit?

The higher the altitude, the longer the orbital debris will typically remain in Earth orbit. Debris left in orbits below 600 km normally fall back to Earth within several years. At altitudes of 800 km, the time for orbital decay is often measured in centuries. Above 1,000 km, orbital debris will normally continue circling the Earth for a thousand years or more.

13. Is reentering debris a risk to people and property on Earth?

A significant amount of debris does not survive the severe heating that occurs during reentry. Components which do survive are most likely to fall into the oceans or other bodies of water or onto sparsely populated regions like the Canadian Tundra, the Australian

Outback, or Siberia in the Russian Federation. During the past 50 years an average of one cataloged piece of debris fell back to Earth each day. No serious injury or significant property damage caused by reentering debris has been confirmed.

14. What about orbital debris in the geostationary orbit near 36,000 km altitude where many telecommunications and meteorological spacecraft operate?

Our ability to detect orbital debris at such heights is limited, but studies indicate that the orbital debris population is probably less severe there than in low Earth orbit. However, since the geostationary orbit is a special natural resource, many spacecraft operators boost their old spacecraft into higher, disposal orbits at the end of their mission.

15. With so many objects in Earth orbit, what is the likely outcome of collisions between orbital debris and operational spacecraft?

Operational spacecraft are struck by very small, sub-millimeter-sized orbital debris (and micrometeoroids) routinely with little or no effect. Millimeter-sized orbital debris represents the highest penetration risk to most robotic missions operating in low Earth orbit. The probability of two large objects (> 10 cm in diameter) accidentally colliding is very low. The worst such incident occurred on 10 February 2009 when an operational U.S. Iridium satellite and a derelict Russian Cosmos satellite collided.

16. What can be done about orbital debris?

The most important action currently is to prevent the unnecessary creation of additional orbital debris. This can be done through prudent vehicle design and operations. Cleaning up the environment remains a technical and economic challenge.

17. What is the U.S. policy on orbital debris?

Since 1988 the official policy of the U.S. has been to minimize the creation of new orbital debris, i.e., orbital debris mitigation. The 2010 National Space Policy addresses the importance of preserving the space environment, including orbital debris mitigation. NASA and the Department of Defense are also directed to pursue research and development of technologies and techniques to mitigate and remove on-orbit debris, reduce hazards, and increase the understanding of the current and future debris environment.

"Orbital debris poses a risk to continued reliable use of space-based services and operations and to the safety of persons and property in space and on Earth. The United States shall seek to minimize the creation of orbital debris by government and non-government operations in space in order to preserve the space environment for future generations (2010 National Space Policy)."

The threat from orbital debris is also highlighted in the June 2018 Space Policy Directive-3 (SPD-3), the National Space Traffic Management Policy, "Orbital debris presents a growing threat to space operations. Debris mitigation guidelines, standards, and policies should be revised periodically, enforced domestically, and adopted internationally to mitigate the operational effects of orbital debris." The SPD-3 further states that "The United States should develop a new protocol of standard practices to set broader expectations of safe space operations in the 21st century. This protocol should begin with updated ODMSP, but

also incorporate sections to address operating practices for large constellations, rendezvous and proximity operations, small satellites, and other classes of space operations. These overarching practices will provide an avenue to promote efficient and effective space safety practices with U.S. industry and internationally." The United States Government Orbital Debris Mitigation Standard Practices (ODMSP) were updated in 2019, per SPD-3.

18. How do U.S. Government agencies handle orbital debris issues?

NASA and the Department of Defense have issued requirements governing the design and operation of spacecraft and upper stages to mitigate the growth of the orbital debris population. The Federal Aviation Administration, the National Oceanic and Atmospheric Administration, and the Federal Communications Commission also consider orbital debris issues in the licensing process for spacecraft and upper stages under their auspices. A set of U.S. Government Orbital Debris Mitigation Standard Practices (ODMSP) was developed in 1997 and approved in 2001. The ODMSP was updated in 2019, per SPD-3.

19. Does U.S. industry follow similar guidelines?

Manufacturers and operators of U.S. spacecraft and upper stages are aware of the hazards of orbital debris and the need to mitigate its growth. Many firms voluntarily adhere to measures designed to limit the growth of orbital debris.

20. Do other countries have guidelines on orbital debris?

Yes, Russia, China, Japan, France, and the European Space Agency have all issued orbital debris mitigation guidelines.

21. Is there an international treaty on orbital debris?

No, but the leading space agencies of the world have formed the Inter-Agency Space Debris Coordination Committee (IADC) to address orbital debris issues and to encourage operations in Earth orbit which limit the growth of orbital debris. In addition, since 1994 orbital debris has been a topic of assessment and discussion in the Scientific and Technical Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS). Both IADC and COPUOS have published orbital debris mitigation guidelines for the international community to follow.

22. Where can I read more about orbital debris?

An excellent primer on the many aspects of orbital debris is the Interagency Report on Orbital Debris (Office of Science and Technology Policy, Executive Office of the President, 1995). A more in-depth summary can be found in Orbital Debris: A Technical Assessment (National Research Council, 1995). See also the United Nations Technical Report on Space Debris.

Quelle: https://orbitaldebris.jsc.nasa.gov/faq/