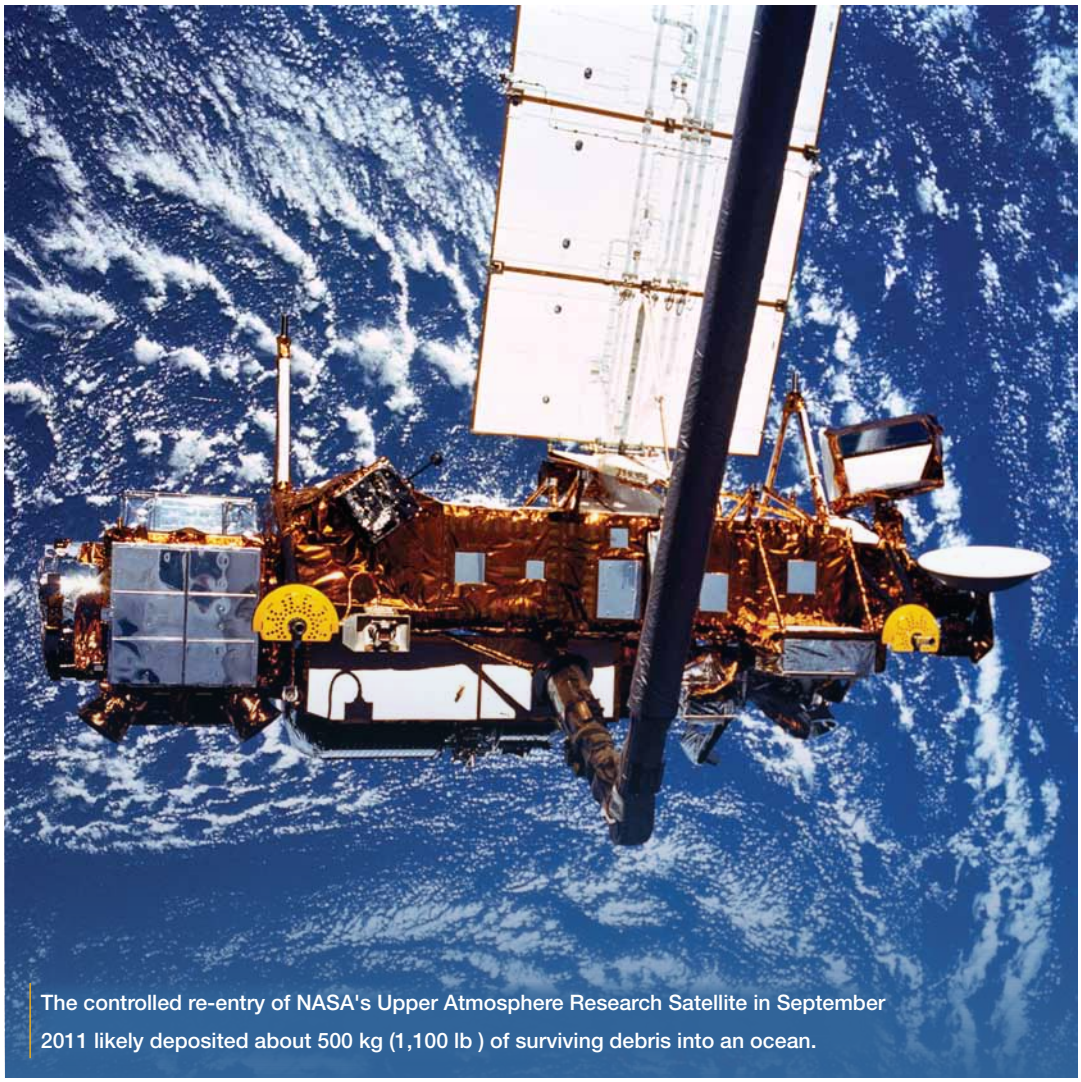
Extraterrestrial Debris



The controlled re-entry of NASA's Upper Atmosphere Research Satellite in September 2011 likely deposited about 500 kg (1,100 lb) of surviving debris into an ocean.

A notice to airmen that spacecraft fragments could fall through European airspace prompted a quick risk assessment.

BY WAYNE ROSENKRANS

The remote possibility that an uncontrolled re-entry of orbital debris, also called space debris, could endanger civil airspace falls far outside normal experience. *Space debris* is defined at the international level as "all man-made objects, including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional."[1]

Before initiating controlled spacecraft re-entries, U.S. programs must demonstrate that the probability of human casualty from the "surviving" debris — that is, debris not rendered harmless by atmospheric *demise* (objects being consumed by burning) — will not be greater than 1 chance in 10,000, says the U.S. National Aeronautics and Space Administration (NASA).[2]

In January, a de-orbiting spacecraft inspired the Russian Federal Space Agency (ROSCOSMOS) and Eurocontrol to direct the world's attention to orbital debris re-entry issues such as reasonable preparedness, mitigations and limiting human casualty risk. The issues somewhat paralleled those surrounding the April 2010 eruption of the Eyjafjallajökull volcano in Iceland.

Equivalent gaps in decision-making methods regarding orbital debris re-entry events — beyond

Images: U.S. National Aeronautics and Space Administration

alerting the aviation community — have not been identified, based on a brief *ASW* review of space agency summaries of known risks and mitigations.

A number of documents outline the high-level issues and specify mitigation procedures required by national authorities. For example, according to the Inter-Agency Space Debris Coordination Committee (IADC), a forum for space agencies from 11 nations and Europe, "If a spacecraft or orbital stage is to be disposed of by re-entry into the atmosphere, debris that survives to reach the surface of the Earth should not pose an undue risk to people or property. This may be accomplished by limiting the amount of surviving debris or confining the debris to uninhabited regions, such as broad ocean areas. … The operator of the system should inform the relevant air traffic and maritime traffic authorities of the re-entry time and trajectory and the associated ground area."[3]

NASA notes that "using materials that tend to demise [limiting the number and size of orbital debris fragments that survive] upon re-entry remains one of the more important strategies in reducing the debris risk to persons on the Earth."[4]

European Alert of 2012

Eurocontrol placed its Network Management Directorate on standby status, then alert status, "for the possible uncontrolled re-entry of the Russian satellite, Phobos Grunt, into Europe's busy airspace," according to its summary of the January event. Eurocontrol said, "[ROSCOSMOS] announced that it was expected to fall somewhere on Earth between Saturday and Monday, 14–16 January 2012. But they could not predict when — neither date nor time — or where this re-entry would happen, as it was affected by many changing factors, such as solar [space] weather and the spacecraft's orientation.

"On Sunday, the middle of the re-entry window, the [Eurocontrol] Network Management Operations Centre received a copy of an international NOTAM [notice to airmen] from the Russian authorities, requesting European states to close their airspace for a two-hour period."

On that day, Eurocontrol facilitated a coordination process and conducted a teleconference for European air navigation service providers (ANSPs) and aircraft operators.

"A number of ANSPs issued a NOTAM warning operators of the potential hazard but given the uncertainty as to the area of possible re-entry, no further action [such as closing airspace or grounding aircraft] was proposed," Eurocontrol said. "The satellite landed in the Pacific Ocean, some distance away from the Chilean coast."

Controlled vs. Uncontrolled

European Space Agency (ESA) scientists in 2009 explained how, other than by failure to propel a spacecraft into an intended orbit or beyond the Earth's gravity, even intact spacecraft ultimately experience an uncontrolled re-entry. "Satellites launched into low Earth orbit are continuously exposed to aerodynamic forces from the tenuous upper reaches of the Earth's atmosphere," ESA said. "Depending on the altitude, after a few weeks, years or even centuries, this resistance will have decelerated the satellite sufficiently so that it re-enters into the atmosphere. At higher altitudes — i.e., above 800 km [500 mi] — air drag becomes less effective, and objects will generally remain in orbit for many decades."

NASA and its counterparts draw sharp distinctions between the relative risks to people from controlled versus uncontrolled re-entries of spacecraft, including implications of the survival of debris long enough to reach aircraft altitudes. NASA said, "An uncontrolled re-entry is defined as the atmospheric re-entry of a space structure in which the surviving debris impact cannot be guaranteed to avoid landmasses. … Usually, large objects that have impacted the ground are from uncontrolled entries or orbital decay, so the impact point cannot be calculated exactly."

To read an enhanced version of this story, go to <flightsafety.org/aerosafety-world-magazine/march-2012/space-junk>.

Notes

1. IADC. "IADC Space Debris Mitigation Guidelines." IADC-02-01, Revision 1. September 2007.
2. NASA. "Process for Limiting Orbital Debris." *NASA Technical Standard NASA-STD-8719.14A*. Dec. 8, 2011.
3. IADC.
4. NASA. *NASA Handbook for Limiting Orbital Debris.* NASA Handbook 8719.14, July 30, 2008.