Removing orbital debris with less risk

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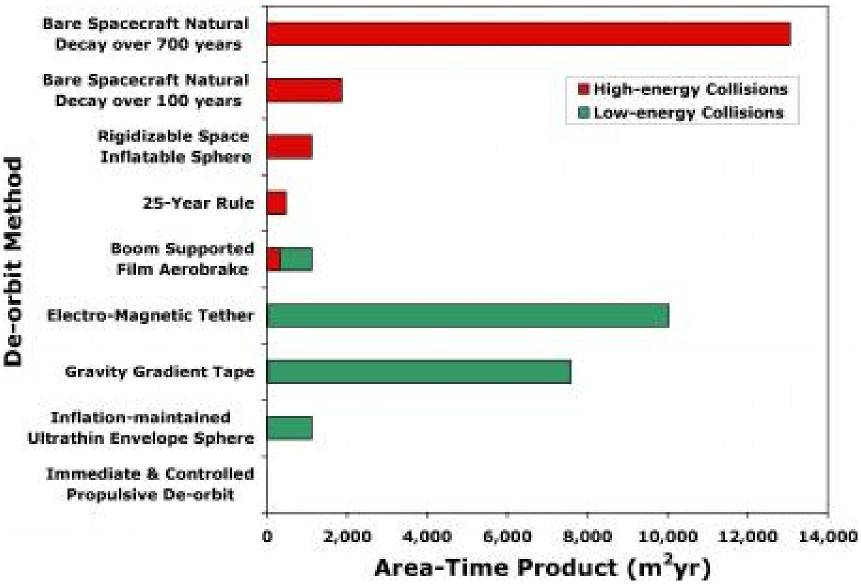

This graph displays the area-time product summary comparison of the several deorbit devices evaluated for their risk. High-energy collisions can create significant amounts of new and dangerous orbit debris and low-energy collisions, while not generating significant new debris, can disable operating satellites. Area-time product, measured in square meters per year, is the product of collision cross-section area multiplied by the time for the object to reentry the atmosphere. Credit: Global Aerospace Corporation

Global Aerospace Corporation (GAC) announced today that the American Institute of Aeronautics and Astronautics (AIAA) is publishing an article entitled "Removing Orbital Debris With Less Risk" in the March/April edition of the *Journal of Spacecraft and Rockets* (*JSR*) authored by Kerry Nock and Dr. Kim Aaron, of GAC, and Dr.

Darren McKnight, of Integrity Applications Incorporated, Chantilly, VA. This article compares in-orbit debris removal options regarding their potential risk of creating new orbital debris or disabling working satellites during deorbit operation.

Space debris is a growing problem in many orbits despite international debris mitigation guidelines and policies. While this space environmental issue has been discussed and studied for years, many critical parameters continue to increase. For example, the number of significant satellite breakup events has averaged about four per year. Removing large amounts of material already in orbit has been a major issue for debris mitigation strategies because a large object, like a satellite or spent rocket stage, is not only more likely to be involved in an accidental collision due to its large collision cross-section but the large mass has the potential to be the source for thousands and thousands of smaller, but still dangerous, debris if involved in a collision.

Deorbit devices have been proposed for dealing with the growing problems posed by orbital debris. The authors describe these devices that can use large structures that interact with the Earth's atmosphere, magnetic field or its solar environment to deorbit large objects more rapidly than natural decay. Some devices may be better than others relative to the likelihood of collisions during their operation. Current mitigation guidelines attempt to address this risk by calculating an object's atmospheric drag area times its orbit decay time to compare the probability of a large object experiencing a debris-generating impact. However, the authors point out that this approach is valid only for collisions with very small debris objects. Since the peak in the distribution of the area of orbital debris occurs for objects with a size close to 2 m, some of which are operating satellites, it is important to incorporate an augmented collision cross-section area that takes into account the size of both colliding objects. This new approach leads to a more valid comparison among alternative deorbit approaches.

Two other factors that affect the potential risk of a particular deorbit device are the nature of hypervelocity impacts and the level of solar activity. The authors describe the physics of hypervelocity impacts in space that can affect the assessment of risk. In addition, they describe how solar activity level affects the decay process and alters the result of the calculation of collision cross-section area times decay time, which is a measure of the risk of the deorbit device. The authors also characterize two types of collision risk, that is, the risk of creating new debris-generating objects in hypervelocity impacts by high-energy collisions and the risk of disabling operational satellites by low-energy collisions.

The implication of this new approach to determining risk indicates that ultra-thin, inflation-maintained drag enhancement devices pose the least risk of creating new debris or disabling operating satellites, while electromagnetic tethers are shown to have a very large risk for disabling operating satellites. All deorbit devices studied appear to have less risk than leaving an object in orbit even for only 25 years, which may suggest a possible need to reconsider current orbital debris mitigation guidelines that allow objects to remain in orbit that long.

"As the orbital debris hazard increases, it will be critical that the community can use techniques that have high operational effectiveness and low risk. Inflatables have been the best balance for that approach in my mind and I hope that this paper exposes more of the aerospace industry to the benefits of using inflatables to accelerate the reentry of non-operational spacecraft," said Dr. McKnight.

Finally, atmospheric drag deorbit devices are found to be much more efficient during periods of high solar activity and therefore pose a lower overall risk. Permitting a satellite to use a smaller drag device over 25 years, which will average about two solar cycles, means it will incur about three times the risk compared with a larger device selectively operated near solar max (including the time taken waiting for solar max).

As a result, the authors recommended that drag augmentation devices be sized and timed to complete their deorbit function only during solar max in order to further reduce the risk of creating new debris.

More information: arc.aiaa.org/doi/abs/10.2514/1.A32286

Provided by Global Aerospace Corporation

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