International Civil Aviation Organization
CAR/SAM Regional Planning and Implementation Group (GREPECAS)

INFORMATION PAPER

GREPECAS/22 — IP/13
20/09/24

**Fourth GREPECAS–RASG-PA Joint Meeting and**
**Twenty-second Meeting of the CAR/SAM Regional Planning and Implementation Group (GREPECAS/22)**
Virtual Phase (Asynchronous, 16 September to 11 October 2024)
In-Person Phase (Lima, Peru, 20 to 22 November 2024)

---

**Agenda Item 5:** **CAR/SAM Air Navigation Services (ANS) Implementation**

**5.1 Air Traffic Management (ATM), Airspace optimization, Air Traffic Flow Management (AFTM) and Search and Rescue (SAR)**

# THE DIFFICULTIES OF PREDICTABILITY AND ADVANCE COORDINATION RELATED TO RANDOM REENTRY OF SPACE DEBRIS

(Presented by The United States)


**EXECUTIVE SUMMARY**

This paper presents the United States' position regarding reentry risk posed by space debris to aircraft and coordination of notification and procedures for such events.


| | |
|---|---|
| **Action:** | Note the information presented in this IP. |
| *References:* | • 14th Air Navigation Conference – Report of the Committee on the Third Agenda Item (AN-Conf/14-WP/213)<br>• 39th Legal Sub-Committee Meeting<br>• Annex 11, *Air Traffic Services* |

## 1. Introduction

1.1. During Agenda Item 3.1 discussed at the14th Air Navigation Conference (AN-Conf/14) in September 2024, the Committee Chair noted that multiple States highlighted the importance of better understanding the issue of re-entering space debris and uncontrolled space objects. When the topic of risk to aircraft from reentry was raised at the 39th Legal Meeting of ICAO in 2024 the Secretariat noted the collaboration between ICAO and the United Nations Office of Outer Space Affairs (UNOOSA) and that the exchange of information was ongoing.

## 2. Discussion

2.1. The growing number of large satellite constellations in low earth orbit poses an increased risk to airspace due to the risks posed by the reentry of any debris from deorbiting satellites and the upper stages of space vehicles that are needed to launch such satellites into orbit. A study commissioned by the United States, Federal Aviation Administration in 2021 evaluated the impact that the growing number of large constellations currently being launched may have on reentry risks in the future. The study found that approximately 85% of the debris that would survive reentry would come from one major constellation and evaluated what the risk of downing an aircraft from that debris would be approximately 10 years from now and found that the chance of an aircraft downing event in 2035 would be .0007.

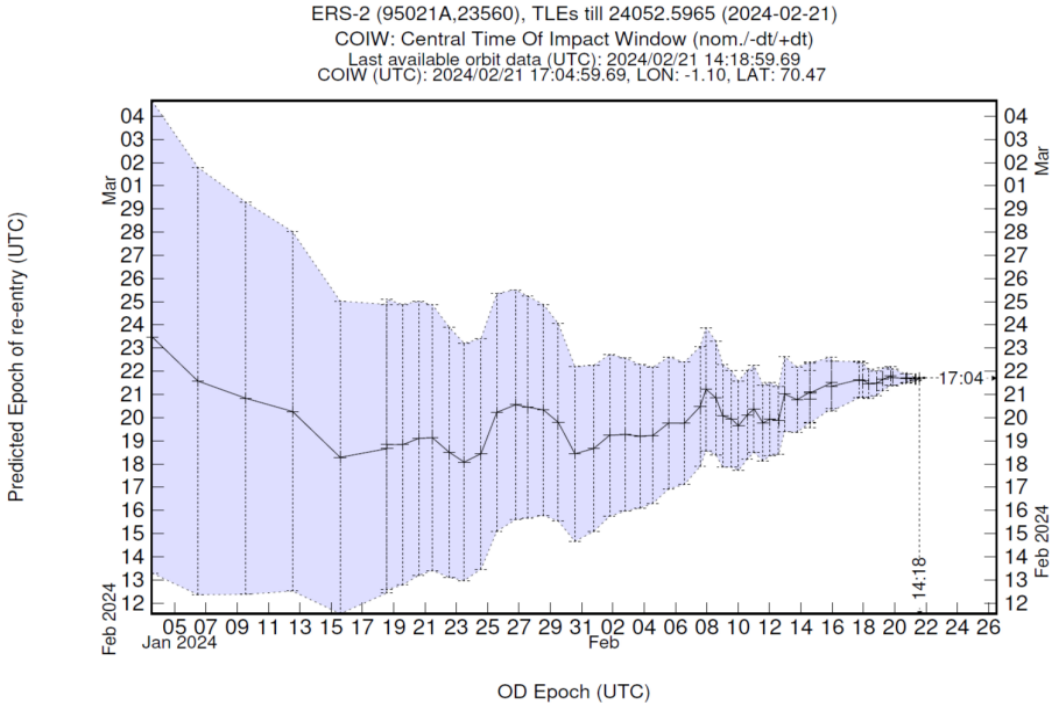
2.2. The international space community, through efforts led by UNOOSA, is moving towards requiring controlled reentry for any large objects, satellites or used upper stages, which cause the greatest risk to aircraft and people on the ground. An example of this can be seen in the UNOOSA developed guidelines for the Long-Term Sustainability of Outer Space Activities; these include measures to address risks associated with the uncontrolled reentry of space objects. These guidelines were adopted by all members of the Committee on the Peaceful Uses of Outer Space in 2019. This shift will allow for meaningful danger areas to be known and coordinated in advance. The US is working to support this shift through several avenues. As the international space community works to reduce risks from uncontrolled reentries of large objects for the future, there continue to be discussions in the international aviation community about what advanced coordination is possible in the current environment.

2.3. Predictability and advanced coordination for re-entering debris is currently limited by the uncertainty inherent in these events. The inability to accurately predict the density of the layers of earth's atmosphere, which produce the drag that causes the decay of satellites orbits, is the largest cause of uncertainty in current reentry modelling. Differences in atmospheric models and unpredictable solar activity also affect density forecasts.

2.4. The current lack in accuracy for advanced predictions related to the time and location of a reentry make any guidelines related to warning for such events impractical. In general, an estimated reentry time can be off by [up to] ten percent of the orbital time remaining. This means that 10 hours before reentry, the predicted reentry time can be off by up to one hour and have a likely reentry area that is 27,000 km long and 200km wide.[1]. Therefore, advanced actionable public warnings are not possible. For example, a NOTAM issued at 10 hours before a predicted reentry would need to prohibit access to a quarter of the earths navigable airspace and is therefore unpractical at this time.

2.5. As a case in point, the reentry of the second European Remote Sensing Satellite (ERS-2) showcased how difficult it is to develop accurate and actionable predictions even when a reentry is intentional, based on good data, and best efforts are made. The European Space Agency (ESA) intentionally de-orbited ERS-2 at the end of its operational life. The graph below produced by ESA shows the uncertainty in the date and time of the impact window. Predictions became more accurate as reentry approached but as shown below, at 3 days prior to reentry, the reentry time window was +/-18.8 hours. At 24 hours prior to the estimated reentry time, the predicted impact time still had +/- 4.61 hours of uncertainty. This uncertainty makes any sort of procedures or best practices for related NOTAM coordination and notification difficult, if not impossible.

[1] FAA Report P.L. 116-260 Risks Associated with Reentry Disposal of Satellites from Large Constellations (faa.gov)




2.6. Per Section 2.19 of ICAO Annex 11 (Air Traffic Services), Member States should already be coordinating with the appropriate air traffic services authorities if and when they have actionable knowledge related to any activity potentially hazardous to civil aircraft. These provisions also therefore apply to reentries that pose a risk to aircraft if and when a State has practical, actionable, and reliable information.

## 3. Conclusions

3.1. Due to the current uncertainty of predictions related to the random reentry of Space Debris and the difficultly such uncertain predictions cause relating to the worthwhile and practical coordination of related NOTAMS, the United States does not at this time, believe it would be worthwhile for ICAO to evaluate the development of notification protocols or procedures for the management of airspace related to such events.

3.2. States provide notification through existing procedures laid out in the relevant SARPs when they have reliable information that a reentry event poses an unacceptable risk to the airspace and an accurate idea of what airspace will be impacted.

3.3. The Conference is invited to note this information.

— END —