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TECHNICAL COMMISSION

Agenda Item 24: Aviation Safety and Air Navigation Priority Initiatives

**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 re-entry risk posed by space debris to aircraft and coordination of notification and procedures for such events.	
<i>Strategic Goals:</i>	This information paper relates to Strategic Goal <i>Every Flight is Safe and Secure</i> .
<i>Financial implications:</i>	None
<i>References:</i>	Doc 10209, <i>Fourteenth Air Navigation Conference (AN-Conf/14)</i> – Report of the Committee on Agenda Item 3 (AN-Conf/14-WP/213) 39th Legal Sub-Committee Meeting • Annex 11 — <i>Air Traffic Services</i>

1. INTRODUCTION

1.1 During Agenda Item 3.1 discussed at the Fourteenth 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 re-entry was raised at the 39th Legal Meeting of ICAO in 2024 the Secretariat noted the collaboration between ICAO and the United Nations Office for Outer Space Affairs (UNOOSA) and that the exchange of information was ongoing.

2. DISCUSSION

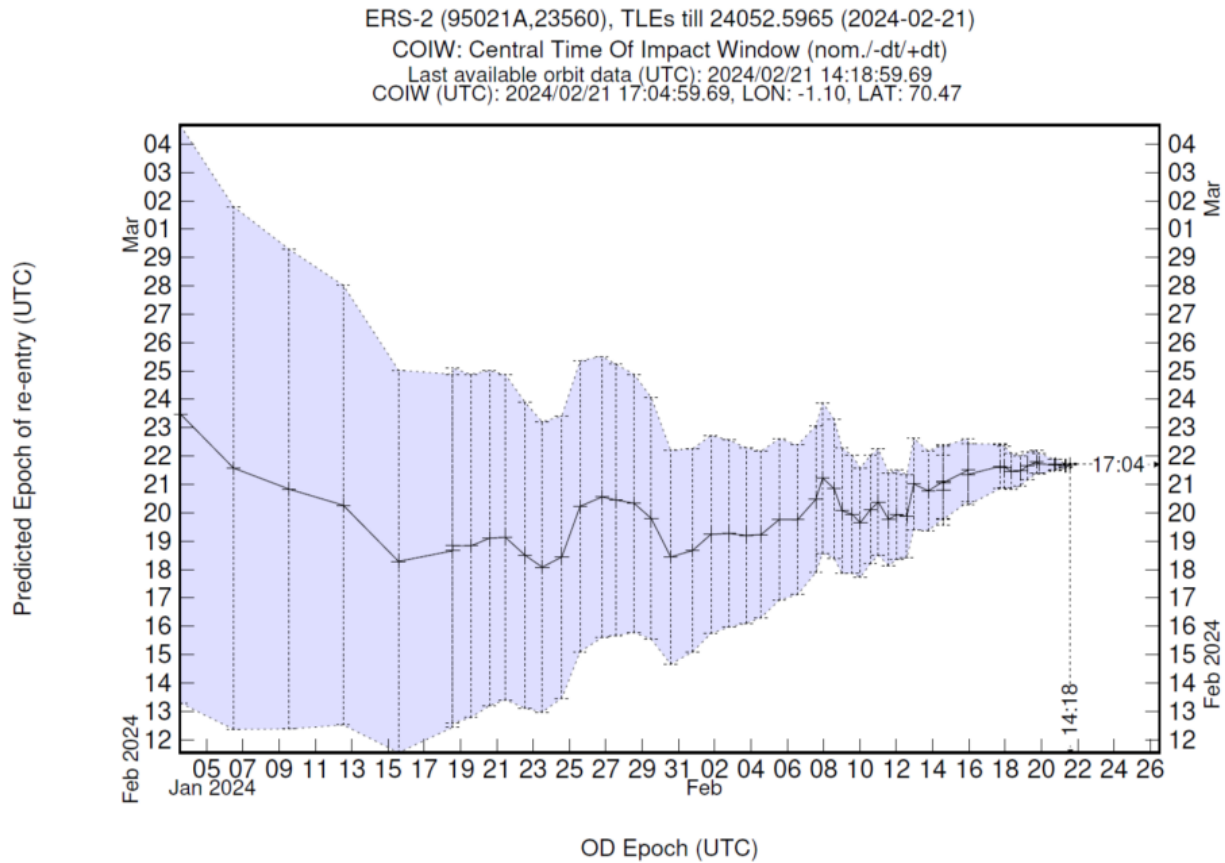
2.1 The growing number of satellites in low Earth orbit may pose an increased risk to airspace due to the risks posed by the re-entry of debris from deorbiting satellites and the upper stages of space vehicles that are needed to launch such satellites into orbit.

2.2 The international space community is calling for a greater focus on responsible practices concerning the re-entry of spacecraft and launch vehicle orbital stages – e.g., large objects, satellites or used upper stages—, which cause the greatest risk to aircraft and people on the ground. Many of these efforts have been championed by UNOOSA and the UN Committee on the Peaceful uses of Outer Space (UNCOPUOS). A key example of this work is UNCOPUOS’ Space Debris Mitigation Guidelines, which were adopted by all State members of UNCOPUOS by consensus in 2007. These guidelines were premised upon the work of the Inter-Agency Space Debris Coordination Committee, a widely-respected intergovernmental forum of thirteen civil space agencies responsible for the worldwide coordination of activities related to the issues of man-made and natural debris in space. In particular, the UNCOPUOS Space Debris Mitigation Guidelines specifically note that spacecraft and launch vehicle stages that have terminated their operational phases in orbits that pass through Low Earth Orbit should be removed from orbit in a “controlled fashion,” with “due consideration... given to ensuring that debris that survives to reach the surface of the Earth does not pose an undue risk to people or property.” Another example is the 2019 UNCOPUOS developed guidelines for the Long-Term Sustainability of Outer Space Activities, which urge States to “[t]ake measures to address risks associated with the uncontrolled re-entry of space objects.” As the international space community works to reduce risks from uncontrolled re-entries of large objects for the future, there should be discussions in consultation with 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 one of the largest causes of uncertainty in current re-entry 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 re-entry make any guidelines related to warning for such events impractical. In general, an estimated re-entry time can be off by [up to] ten percent of the orbital time remaining. This means that 10 hours before re-entry, the predicted re-entry time can be off by up to one hour and have a likely re-entry area that is 27,000 km long and 200km wide. Therefore, advanced actionable public warnings are not possible. For example, a NOTAM issued at 10 hours before a predicted re-entry would need to prohibit access to a quarter of the Earth’s navigable airspace and is therefore unpractical at this time.

2.5 As a case in point, the re-entry of the second European Remote Sensing Satellite (ERS-2) showcased how difficult it is to develop accurate and actionable predictions even when a re-entry 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 re-entry approached but as shown below, at 3 days prior to re-entry, the re-entry time window was +/-18.8 hours. At 24 hours prior to the estimated re-entry 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.



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 re-entries that pose a risk to aircraft if and when a State has practical, actionable, and reliable information.

3. CONCLUSION

3.1 Due to the current uncertainty of predictions related to the re-entry of space debris and the difficulty 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 and would encourage ICAO and UNCOPUOS to coordinate further on this topic.

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

3.3 The Assembly is invited to note the information contained in this paper

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