

ACTIVITIES ON SPACE DEBRIS IN RUSSIA

V. Blagun, Yu. Levitskiyi, S. Kulik

Russian Aviation & Space Agency, 42 Shchepkin Street, Moscow 129857, Russia

ABSTRACT

The Russian Aviation & Space Agency (Rosaviakosmos) considers the problem of assuring the space mission safety under conditions of the near-earth space artificial debris population to be urgent. To tackle this problem Rosaviakosmos organizes a complex of R & D activities in the following high-priority areas.

1. SPACE DEBRIS TRACKING. INFORMATION SUPPORT SYSTEM

The Russian Space Surveillance System maintains the catalog of low perigee space objects greater than 20-30 cm in size. Russian specialists keep a catalog of space objects (SO) located in the GEO orbit region. The catalog covers over 800 objects measuring more than 0.5m, among them are active spacecraft (S/C), librating and drifting S/C as well as the objects with obsolete orbital characteristics or without any orbital data.

On-board instrumentation for recording collisions with spacecraft structure components has been developed based on strain-gauge, film and other types of collision sensors, which sense impacts of particles with mass of fractions of gram or more at velocities from one to tens of km/s.

The promising work direction carried out by Rosaviakosmos is the establishment of an information system for following events, non-controlled reentry of space objects in the upper atmosphere and reducing the risk of collisions of manned S/C and orbital stations (OS) with space debris fragments. Initial data on motion parameters of space debris fragments rely on the SO catalog information of the Russian Space Monitoring System. Information exchange with international organizations is planned in accordance with the pattern agreed upon with IADC.

2. ELABORATION OF SPACE DEBRIS MODELS

Great attention is paid to the improvement of space debris models. The statistical model of small size space debris fragments worked out by Professor A.I. Nazarenko has been adopted as a Russian standard. A deterministic analytical space debris model enabling to track the motion of separate large size space

out. The probability of dangerous approaches of orbital stations with cataloged objects is calculated.

The uncertainty of space debris information obtained using Russian and foreign models still exists with the order of magnitude errors. To eliminate it would require the continuation of dedicated activity of different states in the field of space debris tracking and simulation. The issue of the near-earth space debris population should be carefully considered within the IADC framework. These issues are in accordance with the IADC goals in its main activity areas.

3. SHIELDING AGAINST SPACE DEBRIS EFFECTS

The main efforts are concentrated at developing a screen shielding of the modules of the ISS Russian segment. By now the following basic results on strengthening the ISS service module protection have been obtained:

- Non-conformal screen shield made of basalt fabric cloths (the so-called unfolding wings) has been developed.
- Conformal screen shield for the service module conical section has been developed.
- The efficiency of the developed screen structures has been validated by calculations.
- The acquired results may be used for designing other types of spacecraft and orbital stations.

Protection by prompt detection of wall penetration by debris and restoring of wall tightness is under study. Results of studies completed by Rosaviakosmos specialists show that quick penetration holes detection system using mechanical impact sensors can be created at relatively low mass penalties (10-20 kg). Time to tightness restoring can be several hours which is sufficient to make the necessary repair.

Russian specialists have carried out a great work volume to prepare the "Reference Guide for Protection against Space Debris Fragment effects" (IADC Protection Manual).

4. SPACE DEBRIS POPULATION MITIGATION

In July 2000 the branch Standard of Rosaviakosmos "General Requirements to Limitation of Near-Earth

document signifies the opening of a new page in the practical activity of the space industry organizations to mitigate the near-earth space debris population.

The Standard requirements in the whole comply with the provisions of similar documents of NASA, NASDA and other space agencies.

The main work areas to mitigate near-earth space debris population are as follows:

1. the prevention of intended fragmentations of S/C and SLV to exclude the situations directly before upper atmosphere reentries;
2. the reduction of the number of disengaged technological elements;
3. the S/C and SLV system passivation after the active service life end and other measures.

Special focus is placed on providing safe utilization of GEO. To prevent insertion into operating orbit of orbital stages of Proton launch vehicles the spacecraft transfer is called for GEO using onboard power unit. Measures are undertaken on controlled reorbiting of the spent spacecraft from GEO to burial zone (more than 200 km above GEO).

The Russian Party will introduce the above-listed measures step by step regarding newly developed space items taking into account the cost-effectiveness of realized measures and on condition that other nations have the same approach to the problem.

5. THE THIRD OBSERVATION CAMPAIGN ON THE SPACE OBJECTS RE-ENTRY

The Russian Aviation & Space Agency took active part in the third observation campaign on the Soyuz-U third stage re-entry. The orbital data of the stage were determined as a result of joint work of Rosaviakosmos and Russian SSS specialists. Good agreement was achieved between our data and data of US SSN and German FGAN radar observations. In future all the procedures of the re-entry data exchange should be made in the complete volume

independently whether the object is really dangerous or just a test one.

6. CONCLUSION

1. The pressing work areas are space debris object tracking, space debris pollution model perfection and relying on these measures specification of requirements for mitigation measures and protection of manned S/C.

2. The Russian Federation will study and introduce mitigation measures as applied to newly developed space items on condition that all other space-fairing nations adopt corresponding international agreements and observe them.

As for space technology models developed or operated in compliance with the technical requirements in force by now the mitigation measures will be introduced proceeding from the actually existing technical capabilities.

3. The Russian Aviation & Space Agency has actively participated in the third IADC observation campaign on the Soyuz-U third stage re-entry. Good agreement was achieved between our data and data of US SSN and German FGAN radar observations.

4. The problem of mitigation measures comprises a great number of unsolved challenges including for instance space debris growth due to small satellite operation, and limitation of the S/C and SLV passive lifetime by 25 years. In the opinion of Rosaviakosmos efficient recommendations on introduction of mitigation measures may be drawn up and mutually agreed only on the basis of a thorough solution of technical problems and adoption of coordinated schedule of their implementation.

5. The Russian Space & Aviation Agency voices confidence in that close international cooperation is a pledge of successfully solving the problems of space debris.