ACTIVITY OF THE RUSSIAN SPACE AGENCY TO SOLVE THE SPACE DEBRIS PROBLEM

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The Russian Space Agency (RSA) considers the problem of assuring space flight safety under conditions of near-earth space debris including uncontrolled reentry, protection and mitigation to be rather actual.

To solve the problem Russian Space Agency considers the following tasks to be of the first priority.

1. Organization of ecological monitoring near - eath space environment including space debris (SD) tracking, SD models development, prediction of NESE and danger of SD for future space flights.

2. Setting up of a common information system (a hardware and software complex) for predirtion and information covering of space object dangerous approach events and uncontrolled reentry.

3. Development of methods and means of spacecraft (S/C) and orbital station protection.

4. Development and introduction of measures to mitigate space debris population.

Detailed information about the results of Russian specialists will be reported later. The present report contains the Russian Space Agency point of view to abovestated problems.

At persent to track SD fragments, measuring over 0.2-0.3m at LEO the RSA organizations use data, supplied by radars of Russian Space Serveillance System, while to track SD fragments measuring more than 0.5-Im in the GEO region they use data from onground optical systems of the Russian Academy of Sciences.

To-day these data do not suffice for assuring space mission safety. To obtain information on SD fragments less than 10 cm in size RSA specialists conduct developments of onboard tracking techniques operating in the optical and IR bands, as well as of sensors of direct impacts for registering SD fragments of midium and small 'category. Prototypes of these devices have been built. Feasibility of mounting them onboard the International Space Station (ISS) for assuring the station flight safety is under study.

The Russian Space Agency pays great attention to development and specification SD model with untrackable fragments. Professor A.Nazarenko of the RSA Program Research Center has developed a statistical model, which is taken as a base model by Russian specialists. Available differences of the model from the NASA ORDEM-96 model are at present of the natural character and will be eliminated during joint investigations.

From our point of view it is necessary develop an international standard relying on these models.

The problem of assessing and mitigating GEO region SD population is considered by RSA as a separate and urgent objective. By 1996 the Russian Catalog comprised about 600 GEO objects measuring over 1 m. Orbital characteristics of 50 objects are being refined.RSA supposes to track GEO objects less than 1 m in size using a space vehicle having its orbital parameters close to those of GEO. At present RSA organizations investigate various versions of building such observation system.

Results of the investigations made by Russian scientists have shown that after 2017 drifting orbits of spacecraft launched after 1963 will beging to return to the GEO region, thus increasing the risk of spacecraft collisions with space debris fragments. At present the GEO debris population should be recognized as approaching the dangerous degree and in association with this it should be necessary to start practical implementation of efforts to refine assessments of GEO population and to prevent further pollution of GEO region the latter being the international property. For this purpose it should be obligatory within the framework of international cooperation to:

- organize joint GEO object tracking and develop a common catalog;

- develop a methodological mechanism for identification of GEO objects applying observation data, long-term prediction of their motion and motion collision risk;

- develop coordinated recommendations on GEO region protection.

Another acute problem drawing the world public opinion lately and which have been reflected in works being conducted by RSA is the problem of radioactive space debris generated by fragmentations of onboard nuclear power installations. Calculations made by Russian specialists demonstrate, that at present total activity of the generated nuclides constitutes about IkCu

and is determined mainly by Cesium-137 and Strontium-90 nuclides (half-lives of about 27 and 28 years accordingly) and this activity does not present significant threat to

spacecraft and orbital station operations.

Qualitative information on the radioactive space debris was discussed at hearings of the Russian State Duma and submitted to the UN Committee on the Peaceful Uses of Outer Space. To-day being governed by the safety assurance principles, adopted by UN General Assembly RSA continues its activity for assuring nuclear power installations reliability and assessing radioactive debris environment.

One of the basic areas of the RSA activity, is setting up of a common information system (interagency in future) providing for gathering, storing, processing and operational distribution of data in support of information covering of events associated with uncontrolled reentry and dangerous approaches of manned spacecraft and orbital stations with each other and with space debris fragments. At present they developed principles of building such a system, a pattern of cooperation of organizations, and the positive experience in information covering of uncontrolled reentry of some space vehicles have been acquired.

RSA is interested in conducting works jointly with foreign partners to set up a common information system and database for assuring flight safety.

Protection of space vehicles against high-velocity space debris fragment effects is assured by RSA organizations in the following main directions:

a) Protection using an additional screening.

Central Research Institute of Maching Building has developed and experimentally tested multi-layer screens, integrating corrugated aluminum layers and lattices.

Preliminary tests demonstrated their efficiency in shielding spacecraft against space debris fragment effects. In particular, these screens enable to get an angle of divergence of secondary fragments of space debris greater than that of flat screens; they are not expensive and easy to produce.

b) Protection due to nonconformal screens deployed in orbit.

Such screens may be deployed at considerable distances from S/C, they may be movable, thus making it possible to significantly increase protection from the most probable directions of SD fragment actions. Efficiency of an orbital station protection by such screens and feasibility of their phased deployment in space have been evaluated.

c) Protection using an avoiding maneuver.

This method efficiency significantly depends on accuracy of SD orbits definition, margin of the characteristic speed and other factors. Currently effective methods and means for realizing protection maneuver are being developed. The main problem is to lower the probability of false alarms.

d) Protection by means of quick detection of a puncture of the S/C wall by a space debris fragment and restorataion of its tightness. Results of the investigations conducted by Russian specialists demonstrate, that with comparably low weight expenditures (10-20 kg) it is possible to develop a system for operative puncture spot detection using a mechanical-action transducer system. The time allocated for tightness restoration may run to several hours, which is fully adequate for performing the required scale of works. The steps considered above are planned to be implemented for protecting the ISS Russian modules. Capabilities of the onboard puncture diagnostics system have been evaluated. It is shown, that to diagnose a puncture at the area of 100 m^2 with the accuracy of several centimeters would require about 30 sensors.

The first-priority measures, undertaken by RSA in field of mitgation are aimed at excluding spent spacecraft and spent stages explosions, being at present the basic sources of generating particularly dangerous small fragments.

At present when updating existing and developing new space technology the leading enterprises of RSA undertake measures enabling to mitigate space debris population. In particular such measures include:

- finishing of the transfer module DM of the Proton launcher in order to exclude separation of units of the propulsion system firing-support engine from the module in flight and prevention of their explosions in space;
- improvement of the spacecraft power supply systems in order to enhance their operational reliability during powered and unpowered flight;
- rigging of the Soyuz-2 launcher upper stage being under modification now with a passive deceleration system in order to prevent accumulation of spent units in operational orbits;
- removal of spent spacecraft from GEO using fuel remainders (it concerns operational spacecraft of the Stationer-D, Ekran-M and Gorizont types) and using a special fuel reserve assuring a guaranteed altitude elevation of 200 km;
- development of a projects for freeing GEO of large space debris fragments.

At present it becomes obligatory to develop recommendations and in perspective normative documents directed at preventing further growth of space debris population to include the GEO region within the framework of international cooperation.

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