EXHIBIT J - RUSSIAN ORBITAL DEBRIS REGULATIONS

National Standard of the Russian Federation

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Space Technology Items

General requirements for mitigation of near-Earth space debris population

valid as of 01/01/2009

1. Range of application

This standard defines the general requirements for mitigation of near-Earth space debris population.
The requirements specified herein shall be applicable to new or upgraded space systems intended for research, socioeconomic (including space technology items for deep space exploration), commercial and special (defense) purposes.
The requirements specified herein shall be applicable at any life stage of space technology items starting from an RFP, designing, manufacturing to commissioning, operation and disposal.

2. Regulatory references

In this standard, references to the following standards are used:
State Standard 25645.103-84 Physical Conditions of Space. Terms and Definitions.
State Standard R 25645.167-2005 Space Environment (Natural and Artificial). Model of Spatial and Temporal Distribution of the Density of Anthropogenic Substance Flows in Space.

Note: When applying this standard, please check the validity of reference standards and classifiers in the public information system on the official web-site of the Federal Technological Regulatory and Metrology Agency or in the index of national standards published annually on January 1 or in information indices published monthly. In the event that any reference standard is modified or replaced, please use the modified or replacing reference standard.

3. Terms and Definitions

In this standard, the following terms have the following definitions:

3.1. "Near-Earth Space" has the meaning specified in State Standard 25645.103.

3.2. "Space System" means hardware including orbital systems and injection systems for space use.

3.3. "Orbital System" means a space system intended for operation in orbit.

3.4. "Injection System" means a space system intended for the delivery of orbital systems from the surface of the Earth to assigned outer space regions with assigned motion parameters.

3.5. "Extraterrestrial Object" has the meaning specified in State Standard R 25645.167.

3.6. "Active Service of an Extraterrestrial Object" means the operation of an extraterrestrial object in orbit for its intended purpose.

3.7. "Space Debris" means all artificial extraterrestrial objects located in near-Earth orbit (including their fragments or parts) that have completed their active service.

3.8. "Anthropogenic Pollution" means the process of formation of new objects increasing the space debris population in near-Earth space.

3.9. "Operational Element" means space debris formed after separation of technological elements from a spacecraft, launch vehicle or upper stage in near-Earth space as a result of regular spacecraft ascent and active-in-orbit service.

3.10. "Passivation" means the removal of all power reserves on board a spacecraft or removal of certain systems upon completion of active service.

3.11. "Operational Orbit" means the orbit, in which a spacecraft is operated for its intended purpose.

3.12. "Protected Geostationary Orbital Region" means a segment of the spherical envelope of near-Earth space defined as follows:

- minimum altitude equal to the geostationary orbit altitude minus 200 km;

- maximum altitude equal to the geostationary orbit altitude plus 200 km;
- minus 15 degr. ≤ latitude ≤ plus 15 degr;
- geostationary orbit altitude of 35,787 km.

3.13. "Protected Low Near-Earth Orbit Region" means a spherical region of near-Earth space with an altitude on max. 2,000 km.

3.14. "Extraterrestrial Object Removal (Disposal) Region" means a region of near-Earth space to which an extraterrestrial object is removed after end of active service for the purpose of mitigating the danger of its collision with other objects.

3.15. "High Elliptical Orbit" means the orbit of an extraterrestrial object with an eccentricity of over 0.4.

3.16. 'Orbital Lifetime of an Extraterrestrial Object" means the period of time from the injection of an extraterrestrial object into operational orbit to its entry into dense atmosphere.

3.17. "Dense Atmosphere" means the region of atmosphere where an extraterrestrial object can not move along a closed ballistic trajectory.

4. Abbreviations

In this standard, the following abbreviations are used:

HEO high elliptical orbit;
GSO geostationary orbit;
PS propulsion system;
SC spacecraft;
SD space debris;
EO extraterrestrial object;
LNEO low near-Earth orbit;
NES near-Earth space;
US upper stage;
LV launch vehicle.

5. General

5.1. The main sources of anthropogenic pollution of NES are as follows:

- accidental explosions of space systems;
- self-destruction of SC (SC systems) after completion of active service or as a result of emergency;
- discharge of operational elements (springs, pushers, pyrotechnical bolts, etc.) into NES;
- LV, US and SC stages after end of active service;
- SC destruction as a result of in-orbit collision with another SC or natural objects;
- discharge of unused propellant;
- erosion of materials off SC surface;
- rope systems separating after use;
- discharge, into NES, of vital activity facilities of manned SC.

5.2. Space systems shall be designed in a way to avoid any accumulation of SD in NES. If it is impossible, any accumulation of SD shall be minimized in terms of quantity, occupied space and period of existence in orbit.

The population of SD in NES can be mitigated using the following main methods:

- prevention of SD formation during regular operation of space systems;
- prevention of potential destruction of space systems, inter alia, as a result of an explosion;
- removal of space systems from operational orbits after end of active service;
- prevention of space systems' collisions in orbit;
- reduction of ballistic life for space systems after end of active life.

5.3. The requirements specified herein for space systems in terms of mitigation of anthropogenic NES pollution shall be included in new or upgraded space system RFPs as a separate section.

5.4. All space system design and operating documents shall specify a list and essence of design, organizational and technological measures to meet the RFP requirements for mitigating anthropogenic NES pollution.

5.5. When planning programs, projects or experiments involving the launch of space systems, it shall be made sure that the trajectories of such objects can be reliably determined using available observation facilities.

5.6. When planning measures to meet the requirements specified in section 6 hereof, there shall be taken into account the cost of meeting such requirements.

5.7. When examining space technology products, certification agencies shall analyze if the requirements for mitigating anthropogenic NES pollution are met.

5.8. Each case of anthropogenic NES pollution including those not related to the compliance with the provisions of section 6 hereof, shall be analyzed to identify the causes of such situations and prepare recommendations for their avoidance.

5.9. Control over compliance with the assigned space system requirements for mitigation of anthropogenic NES pollution shall be the responsibility of the owner of the space system concerned.

6. General space system requirements for mitigation of anthropogenic pollution of near-Earth space

6.1. The general space system requirements for mitigating anthropogenic pollution of near-Earth space shall be as follows:

- avoidance of formation of SD fragments of SC payload separation systems using pyrotechnical or pneumatic locks, various pushers, SC instrument safety lids and springs, and of the discharge of fragments of separation systems using pyrotechnical bolts, extended cumulative charges, pyrotechnical knives or pyrotechnical guillotines;
- avoidance of the discharge of fragments of nozzle plugs, nozzle lids or other PS elements;
- rope retraction into SC after use;
- avoidance of unprepared discharge of any solid waste into NES when using manned orbital systems;
- designing of orbital systems intended for GSO operations so as to avoid any separation of their PS during service. If such PS separation is unavoidable, it shall be performed in an orbit where the PS will at all times remain outside the protected GSP region.

6.2. General requirements for preventing space systems destruction

6.2.1. Prevention of unintended destruction of orbital systems and injection systems while in service

When designing and developing orbital systems and injection systems there shall be analyzed possible effects and potential breakdowns, which may lead to unintended destruction of such systems.

When in service, orbital systems and injection systems shall periodically be tested to identify and forecast events, which may lead to their destruction or loss of control. Space system design documents shall provide for measures that shall be taken if such events are identified, including measures to be taken to remove the SC from its orbit and passivate it, if such events are unavoidable.

6.2.2. Prevention of intentional destruction of space systems

When designing and developing orbital systems and injection systems there shall be excluded any intentional destruction of such orbital systems or injection systems (self-destruction, intentional collision, etc.) or other action that may lead to the formation of SD and substantially increase the risk of collision with an EO.

Orbital systems and nuclear-powered injection systems may be subject to standard separation procedures provided that such procedures comply with radiation safety requirements [1].

Orbital systems and injection systems may be self-destroyed directly before entering dense atmosphere to reduce the risk of fallout of large EO. In regular orbit, no self-destruction of orbital systems or injection systems (including special SC) shall be allowed.

6.2.3. Prevention of the destruction of space systems after completion of active service

The following shall be performed to prevent (make minimally probable) accidental explosions of orbital systems or injection systems after end of active service:

(a) passivation;

- removal of residual propellant from the tanks of orbital systems and injection systems, residual propellant and gases from all PS cavities by afterburning or draining to prevent accidental destruction as a result of growing pressure or chemical reactions initiated by outer space factors;
- discharge of batteries and breaking of lines of charge;
- bleeding of gases from high-pressure tanks to pressure level securing no ruptures or destructions generating SD;
- discharge (rotation termination) of flywheels, gyroscopes and similar mechanical devices;

(b) keeping temperature control pipelines pressurized;

(c) the design of space system pyrotechnical elements must exclude their actuation when hit by SD.

Note: Section 6.2.1. is not applicable to space systems designed to enter the atmosphere under control for destruction after completion of their active service.

6.3. General requirements for preventing collisions of space systems with extraterrestrial objects

6.3.1. Before a space system and an injection system are launched, there shall be assessed the risk of their collision with catalogued EO and there shall be selected appropriate time slots to minimize such risk.

6.3.2. Programs of long-term manned missions shall provide for measures to avoid collisions with catalogued EO.

6.3.3. Orbital systems shall be designed to provide maximum protection against destruction when collided with SD thus generating more SD.

6.4. Requirements for the removal of space systems after completion of their service to disposal areas or orbits with a shortened period of ballistic life

6.4.1. Orbital systems and injection systems operating in the GSO region shall, after completion of service, be removed from the GSO so that they can not collide with SD remaining in the GSO region. The elevation of the perigee of the disposal orbit over the altitude of the GSO in km is calculated as follows:

$$235 + (1{,}000 \quad Cr \times A/m),$$

where

235 km is the sum of the upper limit of the protected GSO region by altitude (200 km) and maximum deviations of the SC orbit due to lunar, solar or Earth gravity disturbances (35 km);
Cr is the solar radiation pressure coefficient (normally, 1 to 2) km kg/m;
A/m is the SC cross-section area to SC mass ratio after completion of service and passivation, sq.m/kg.

The eccentricity of the orbit of SC removal from the GSO shall not exceed 0.003.

6.4.2. All orbital systems and injection systems that completed service and are located in the LNEO region or crossing it (including SO in HEO) or that may move there at a later stage shall be removed to an orbit where any of the following conditions is met:

- no more than 25 years of passive ballistic life due to the effect of the residual atmosphere;
- to exclude the possibility of entering the LNEO, the ES is removed to the disposal area.

6.4.3. Any orbital systems featuring no orbit changeability or maneuverability after completion of service shall be removed to the LNEO region and have a passive ballistic life of max. 25 years.

6.4.4. Any orbital systems carrying radioactive, toxic or other harmful substances shall be removed from their orbit so that any contamination, with such substances, of the atmosphere or surface of the Earth is excluded.

Bibliography

[1] United Nations Principles related to the use of nuclear power sources in space.