RUSSIAN FEDERATION ACTIVITY ON SPACE DEBRIS MITIGATION

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The main directions of the space debris mitigation activity

- **Space debris sources and level definition;**
- **Space debris mitigation;**
- **Detection, prediction and prevention dangerous events in space (dangerous approaching of spacecrafts and their falling no the Earth);**
- **Legal maintenance of space debris mitigation works of space debris;**
- **Participation in international works on space debris mitigation and safety of space flights in conditions.**

Observation and control of near-earth space

- **The regular control of a condition of space debris with use of Russian space surveillance network and INTERNATIONAL SCIENTIFIC OPTICAL NETWORK (ISON) is carried out.**

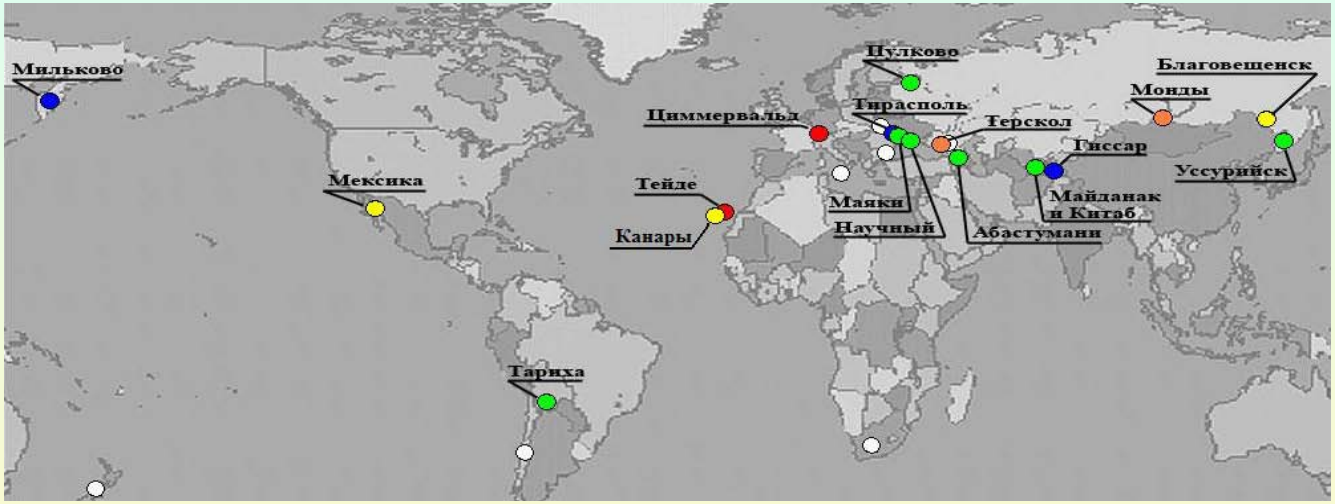
- **ISON carries out the global control of all GSO on a longitude, and also the high-precision prediction of GSO and HEO orbits of space objects.**

- **Russian space surveillance network and ISON are used for conducting databases on space objects and for prediction of dangerous events in near-earth space (including SC launches, decay and break-down of space objects).**

INTERNATIONAL SCIENTIFIC OPTICAL NETWORK (ISON)







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Assessment of Space debris population evolution

There were events in near-earth space for last 2 years (2007-2009) that have led to essential change of space debris population:

Fegun-1C fragmentation (01.2007, 900km);

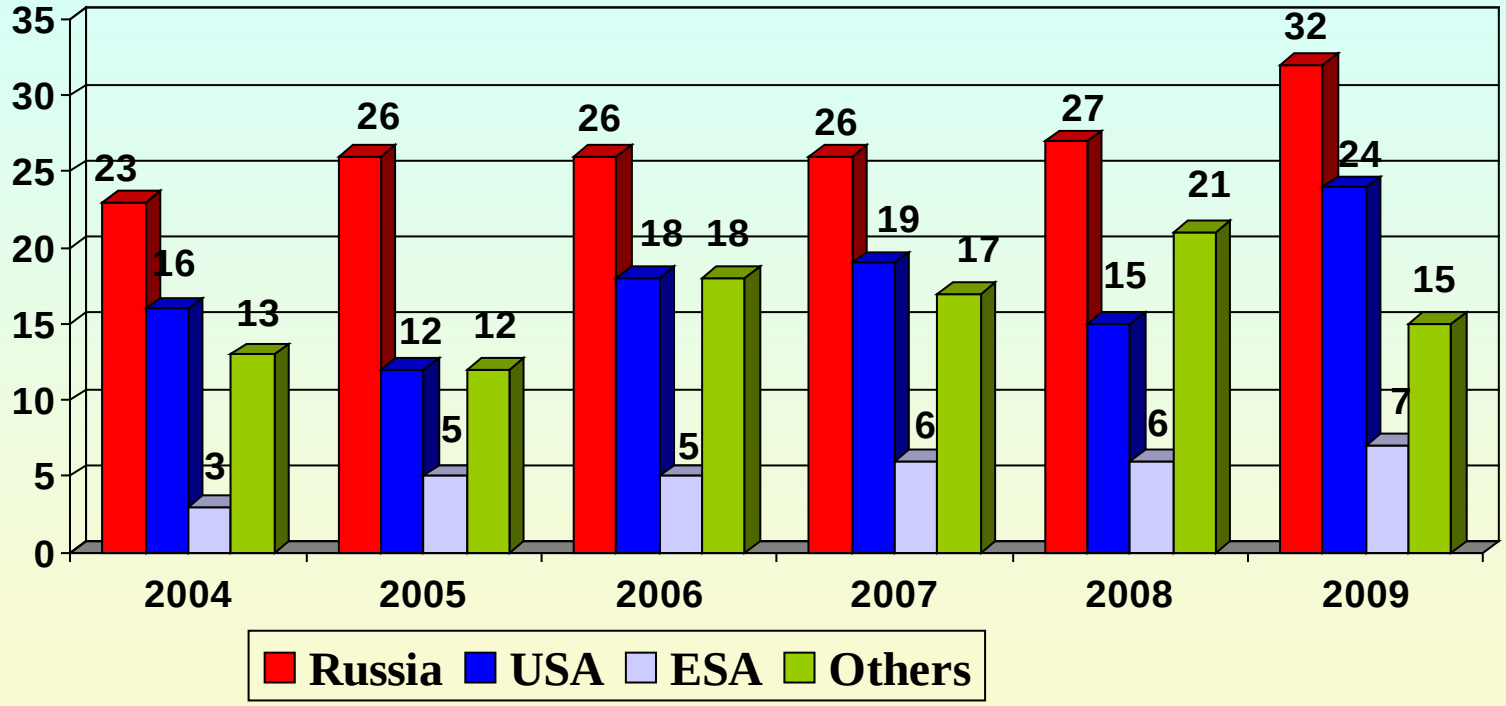
- **Collision operational SC Iridium 33 and SC Cosmos 2251 in february 2009;**

As a result more than 3 thousand of new space debris objects (more than 10-20см) were formed. Rate of a contamination of space approximately in 4 times exceeds average rate of a contamination of space for all previous years.

There is most intensively increase of space debris population in range of 600-900km.

Updating of the Russian space debris model GOST R 25645.167-2005 «Space Environment (Natural and Artificial). Model of Spatial and Time Distribution for Space Debris in LEO» was carried out in 2009.

DYNAMICS OF LAUNCHES IN RUSSIA AND IN OTHER STATES AND ORGANIZATIONS



COMPLIANCE OF ROSCOSMOS ACTIVITY IN SPACE DEBRIS MITIGATION WITH THE UN SPACE DEBRIS MITIGATION GUIDELINES (1/3)

№/№	The UN Principle of Space Debris Mitigation	The measures undertaken in the space vehicles design and operation
1	Limit debris released during normal operations	• "Briz-M", "DM" orbital stages , 3-rd stage (block "I") of "Soyuz-2" Launcher don't release space debris during normal operations. • Spacecrafts "Express-MD1", "Resurs-DK1", "Resurs-P", "Spektr", "Electro-L", "Meteor-M", "Kanopus-B" don't release space debris during normal operations.
2	Minimize during operational phases	• Strengthening of constructive materials of space vehicles and using of shields around fuel tanks, high pressure vessels not to admit accidental break-ups and to protect against impact of meteors and space debris fragments ("Monitor-E", "Resurs-DK1", "Resurs-P", "Spektr", "Electro-L", "Bion-M", "Briz-M"). • At spacecraft of "Ekspress" and "Raduga" type to prevent explosions of the detonating gas that is being produced by the silver-cadmium batteries, the said batteries were changed to the nickel-hydrogen ones. • In case of orbital stages of "DM" type the minimizing of the potential for break-ups is provided due to presence of relief dampers on fuel tanks and gas cylinders.

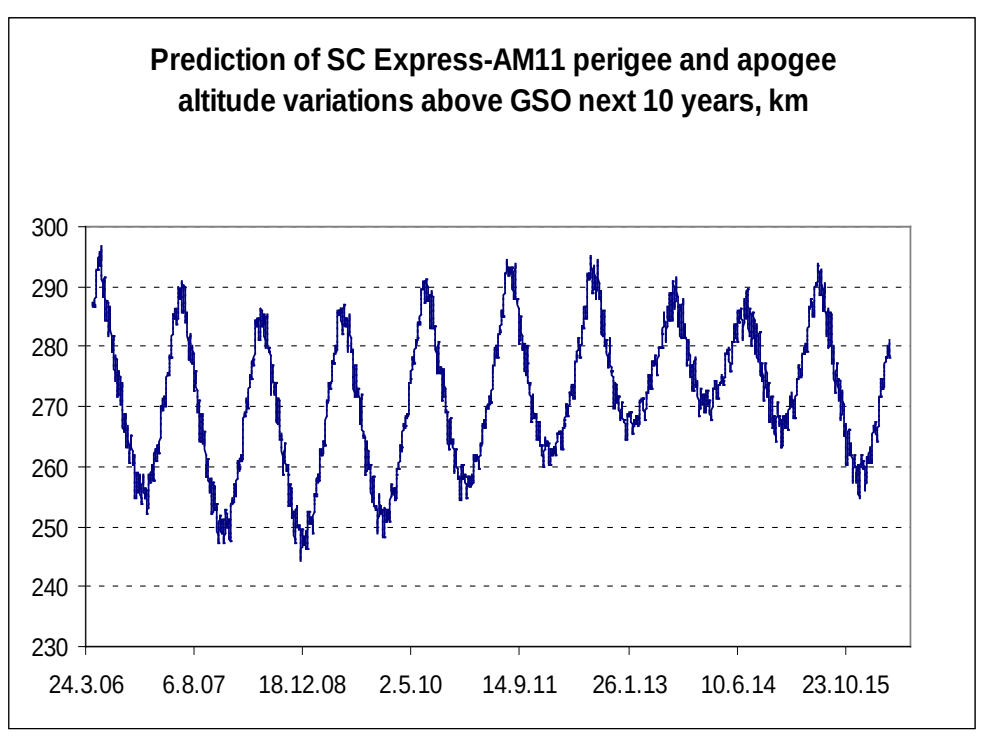
COMPLIANCE OF ROSCOSMOS ACTIVITY IN SPACE DEBRIS MITIGATION WITH THE UN SPACE DEBRIS MITIGATION GUIDELINES (2/3)

№/№	The UN Principle of Space Debris Mitigation	The measures undertaken in the space vehicles design and operation
3	Limit the probability of accidental collision in orbit	• Guaranteed withdrawal of orbital stages from the launched spacecraft is being undertaken thus decreasing the probability of dangerous collisions. • In case of the ISS the estimation of probability of collisions with large debris fragments is being carried out on a regular basis. Maneuvers of the ISS for leaving from dangerous fragments are envisioned thus decreasing the probability of collisions.
4	Avoid intentional destruction and other harmful activities	• Intentional destructions are not applied at all launchers, apogee motors and spacecraft developed by Roscosmos.
5	Minimize potential for post-mission break-ups resulting from stored energy	• The pressure release from fuel tanks is made in case of orbital stages after their withdrawal from the launched spacecraft • In case of orbital stages of “DM”, “Fregat” and “Briz” type the following procedures are implemented: the removal of the remainders of fuel of the sustainer, a burning out of the remainders of fuel from SOZ engine after separation of spacecraft, a discharge of onboard storage batteries. • In case of spacecraft of “Express” and “Gonets” types the following procedures are implemented: termination of rotation of handwheels, gyros and other mechanical devices, removal of the remainders of fuel under large pressure, a discharge of chemical sources of a current.

COMPLIANCE OF ROSCOSMOS ACTIVITY IN SPACE DEBRIS MITIGATION WITH THE UN SPACE DEBRIS MITIGATION GUIDELINES (3/3)

№/№	The UN Principle of Space Debris Mitigation	The measures undertaken in the space vehicles design and operation
6	Limit the long-term presence of spacecraft and launch vehicle orbital stages in the low Earth orbit (LEO) region after the end of their mission	• At the end of mission at presence of a fuel reserve the orbital stage "Frigat" is disposed with the subsequent splashing down. • In case of orbital stages of “DM” type after separation of spacecraft it is flooded by the last momentum pulse of the sustainer. • In case of spacecraft "Monitor" type its disposal is envisioned from to lower orbit, providing braking of space vehicle and combustion in an atmosphere. • In a design of spacecraft “Sterkh” the capability of reduction in time of its presence in an orbit by change of a configuration of solar arrays is incorporated.
7	Limit the long-term interference of spacecraft and launch vehicle orbital stages with the	• The newly designed geostationary spacecraft disposal to a burial zone (the IADC formula and eccentricity less than 0.003) is envisioned after the end of their mission

SC Express AM-11 de-orbiting (№ 2004-015A)



- After breakdown (29.03.06) SC Express AM-11 was de-orbiting (30.03.06-7.04.06) from GSO. There were 10 correction of orbit .
- First correction was performed by maneuvering engine. The rest 9 was performed by Reference System engine because of failure of maneuvering engine.
- Orbit parameters of Express AM-11 after de-orbiting:
  - apogee - ГСО + 324 km
  - perigee - ГСО + 266 km
  - inclination - 0,00026

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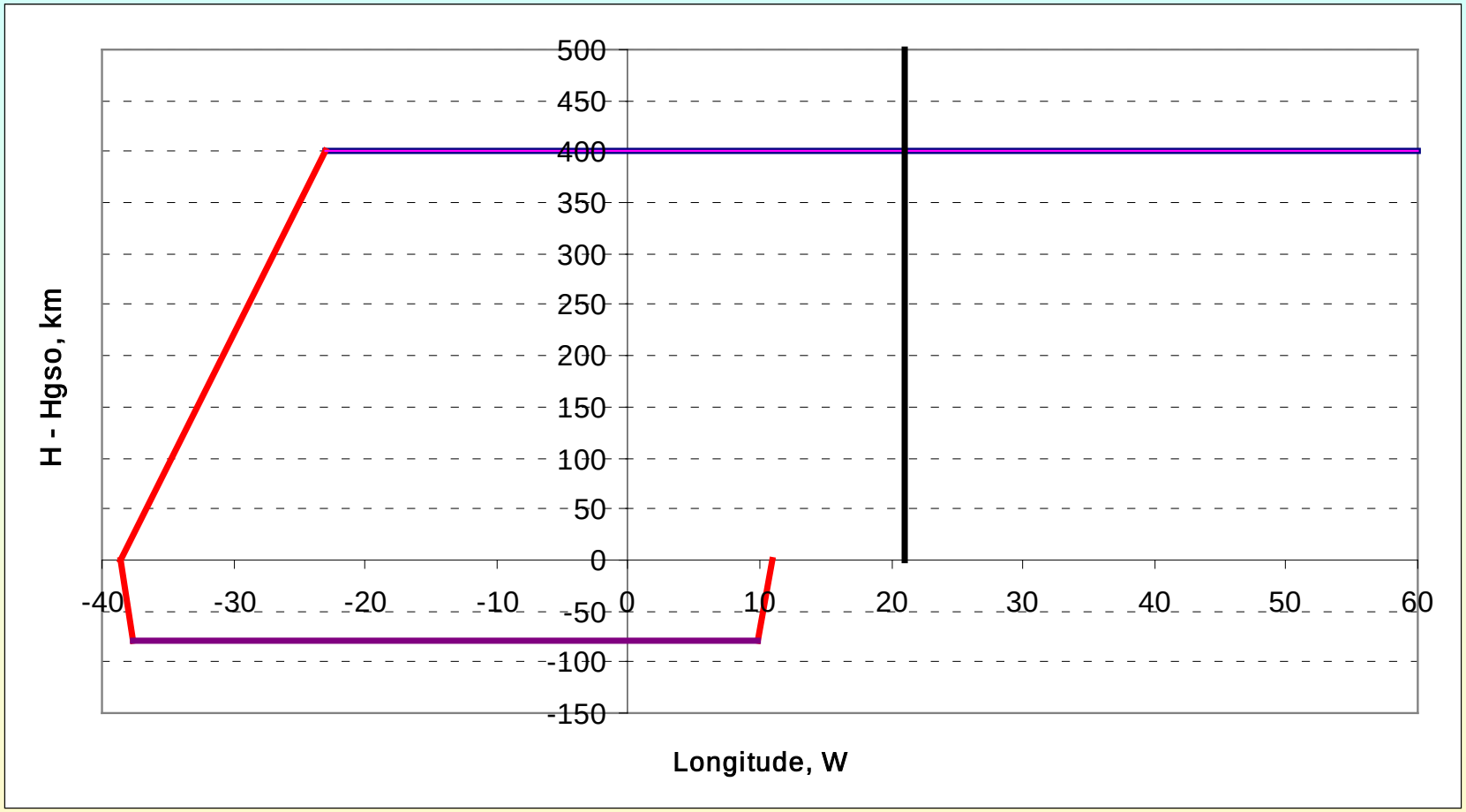
Express-A3 (00031A) actual de-orbiting scheme



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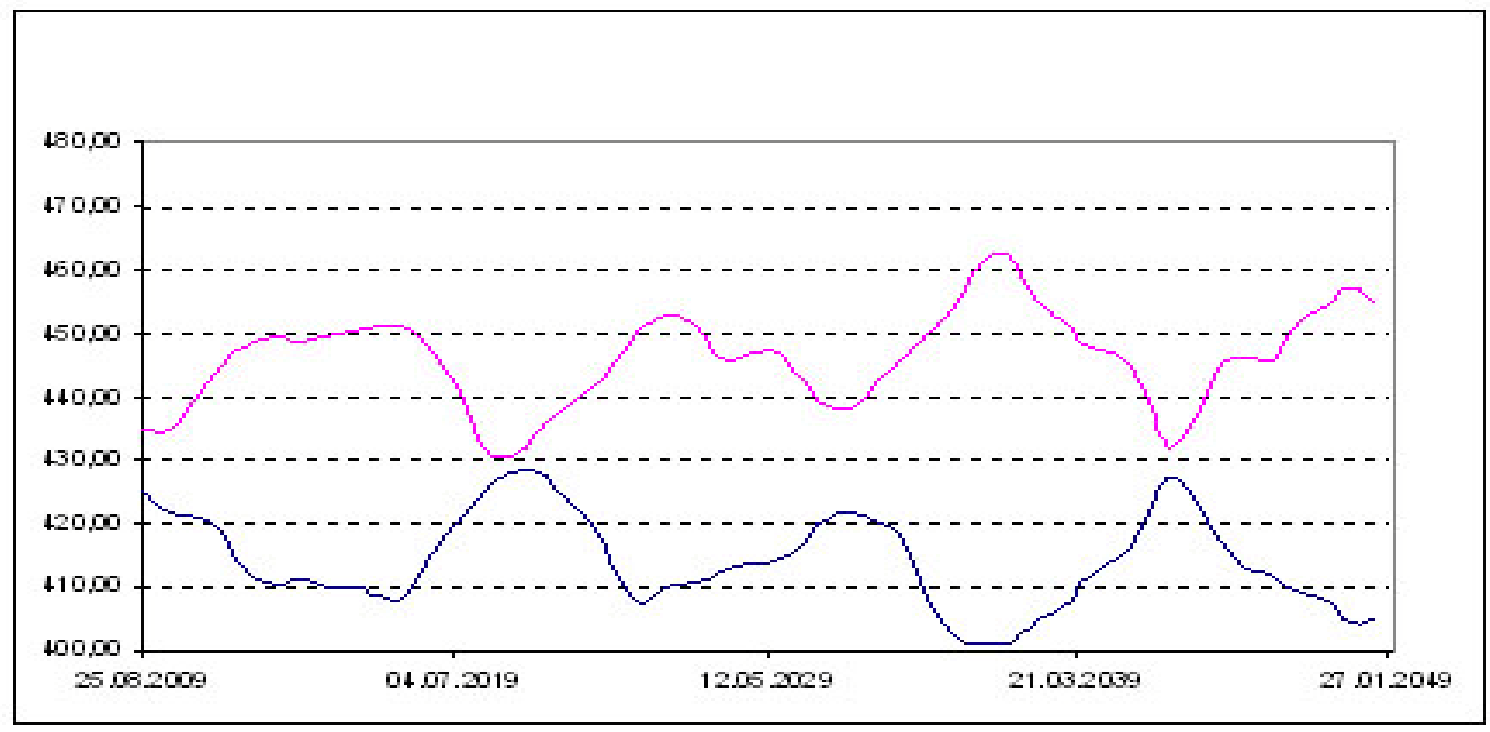
SC Express-A3 perigee and apogee altitude variations above GSO, after de-orbiting in disposal area



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Normative maintenance of works on space debris mitigation

- **National standard of the Russian Federation GOST R 52925-2008 «Space technology items. General Requirements on Space Systems for the Mitigation of Human-Produced near-Earth Space Pollution» was approved in 2008 and entered into force since 1st January of 2009. Requirements of this standard harmonized with requirements of «UN SPACE DEBRIS MITIGATION GUIDELINES».**

- **Space debris model GOST R 25645.167-2005 «Space Environment (Natural and Artificial). Model of Spatial and Time Distribution for Space Debris in LEO»**

- **OST 134-1031-2003 «Space technology items. General Requirements on protection of space systems from mechanical impact of the natural and artificial objects»**

The Russian Federation actively takes part in works of IADC, STSC UN COPUOS and ISO on development of the international standards and other documents on space debris mitigation.

Russian experts take part in workgroups of these organizations, participate in development of international documents.

It is necessary to note, that IADC was established in Moscow in 1993.

26 IADC session, Moscow, April 2008

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Conclusion

- **The space debris is a serious threat to the long term sustainable use of outer space and also for the population and various objects on the Earth.**
- **Russia attend to the problem of space debris mitigation.**
- **The activity on debris mitigation is being carried out within the framework of Russian National Legislation, taking into account the dynamics of similar measures and practices of other space-faring nations.**

Thanks for your attention!