International Science and Technology Center

ISTC: Activity on Space Debris Problem

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Space Safety Projects

Space Debris & Meteoroids Safety – 5

Topics:

- *Space Debris Impact on Spacecraft*
- *Pressure Vessels under Impact of Space Debris*
- *Shield Protection for Spacecraft*
- *Meteorite and Space Debris Protection of Spacecrafts*
- *Astrosols in Near-Earth Space*

FGUP «GosNIIAS»
State Research Institute of Aviation Systems
State Scientific Centre of Russian Federation

Space Debris Mitigation Workshop

26-27 April, 2010
Moscow

Focus:

long size man-made debris as launchers elements, spacecrafts, payloads and other components

Participants:

47 experts from 31 space related organizations (Brazil, the European Union, Japan, the Russian Federation and the United States)

Space Debris Mitigation Workshop

Recommendation to the ISTC:

- to increase awareness of the space debris problem in view of future pursuit of safe space exploration. To publish the proceedings of the workshop;

- to **convene a group of experts** to consider the opportunity of conducting some actions within the ISTC framework, taking due account of the activities of IADC, IAA and IAF/ COSPAR on the problem.

International Group of Experts

International Group of Experts (IGOE)

Objective: *to elaborate a vision on effective ways to remove debris that is already in the near-Earth space;*

Focus*: on the problem of long size debris removal (as launchers elements, spacecrafts, payloads and other components) that requires new technologies and international cooperation;*

Expected Results*: to increase understanding of the problem and solutions via international cooperation.*

International Group of Experts (IGOE)

IGOE Activities:

- IGOE analyzes projects/documents/publications/ideas/projects/initiatives concerning the problem;
- IGOE identifies specific areas that require immediate international discussion and cooperation.

Result:

IGOE will issue recommendations on the problem solving, which will be distributed among space agencies and other interested parties.

ISTC role:

- facilitator between Russian/CIS R&D (organizations, universities, research groups, individuals) and other R&D institutes (EU, Japan, Canada USA, Norway, Korea);
- hosts IGOE meetings.

International Group of Experts

Meetings of IGOE

- ***First meeting (July 6, 2011, St. Petersburg, Russia).***

Participants: *CNES (C. Bonnal), NASA (J-C. Liou), JAXA (T. Shimada - observer), Politecnico di Milano (Luigi DeLuca), Omsk State Technical University (V. Trushlyakov), ISTC (T. Ryzhova).*

Meeting Results:

- *IGOE creation. Recommendation on expansion of the* **IGOE** *members.*
- *Object for flight experiment on removal ("Demonstrator") was chosen (Upper stage of SLV "Kosmos-3M").*
- *Limitation of the future project duration by 5 years was agreed.*
- *The next IGOE meeting was appointed (end of November 2011).*
- *Goal of the 2nd IGOE meeting was agreed.*

International Group of Experts
Meetings of IGOE

- ***Second* IGOE *meeting (December 1-2, 2011, Moscow, Russia).***

Participants: *CNES (C. Bonnal), JAXA (S. Kibe), Politecnico di Milano (Luigi DeLuca), Omsk State Technical University (V. Trushlyakov), ISTC (A. Van Der Meer, T. Ryzhova), invited Russian experts from MAI, Lavochkin Association / Astronomical Institute of RAS.*

International Group of Experts

Meetings of IGOE

Second IGOE *meeting*

Goal: *overview of the latest activities in Space Debris Mitigation & Removal in Europe, Japan and Russia. Discussion of proposals on an international project (Active Removal System).*

The Meeting's recommendations to ISTC:

to further facilitate activity of the International Group of Experts, aimed to develop recommendations on the long size man made space debris mitigation/removal, including proposal on international project for flight experiment ("Demonstrator").

International Group of Experts

Meetings of IGOE

- ***May* 22-25, *2012,* Montreal, Canada.**

Project Proposal ("Demonstrator"), updated on the basis of comments/ recommendations made by the IGOE (December 1, 2011), was presented to Inter- Agency Space Debris Coordination Committee (IADC).

Recommendations:

- ***further development and coordination of the "Demonstrator" project;***
- ***to report to the IADC, WG-4 (Mitigation);***
- ***to harmonize the "Demonstrator" project with adopted international and national programs;***
- ***to update "Demonstrator" taking into account concrete technical recommendations made in Montreal and present at the 2nd European Workshop on Active Space Debris Removal problem.***

Russian Proposal for International Cooperation

Development of Autonomous Systems for Space Launch Vehicle Separated Parts (SP) Controlled De-orbiting.

Mitigation – development of autonomous descending onboard systems (ADOS), installed on SP.

Removal – development of additional transport-docking module (ATDM).

Project Proposal (Demonstrator)

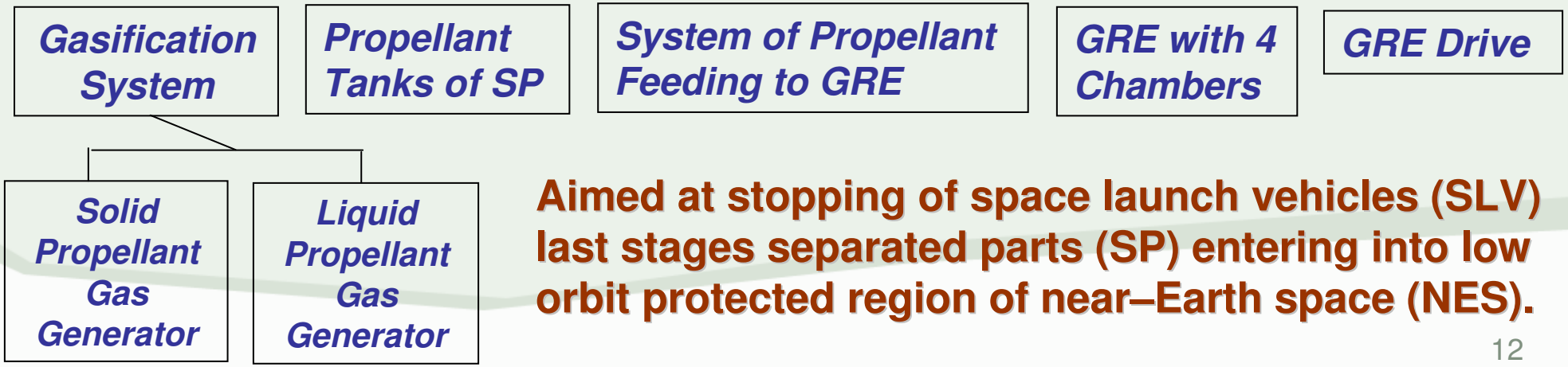
ADOS (Mitigation)

Removing of space launch vehicles (SLV) last stages separated parts (SP) from work orbits after mission ending by means of autonomous onboard descent system (ADOS)

- **Preliminary List of technologies to be developed / upgraded**

heat carrier (HC); thermodynamic CRP residuals gasification by HC feeding into SP fuel tanks; gas mixture feeding from each tank to four-chamber gas rocket engine (GRE) for chemical interaction and implementation of ΔV for de-orbiting; control of motion of center of mass around SP center of mass in time of ΔV implementation by means of controlled drive turning.

- **ADOS Composition and Principal Schemes**



Aimed at stopping of space launch vehicles (SLV) last stages separated parts (SP) entering into low orbit protected region of near–Earth space (NES).

Project Proposal (Demonstrator)

RTDM (Remediation)

De-orbiting of last stages of SP from low orbit protected region of NES by means of reusable transport-docking module, that is a part of rocket-space complex composed of SLV like «Soyuz-2»,US «Frigate» and RTDM.

RTDM composition

- Tether system (TS)
- Space micro tug (SMT)
- Docking and capturing system (DCS)

SLV "**Cosmos-3M**" second stage SP was chosen as one of the objects for ***"Demonstrator"*** project (298 objects are situated in NES with different inclination - 06.06.12).

Preliminary analysis:

- **characteristics of chosen objects for de-orbiting in one launch (Demonstrator),**
- **maximum permissible deviation for parameters of orbit for "Frigate",**
- **scheme of near guidance, docking, tightening**
- **technical problem of**
  - **undocking of SMT from US. Beginning of near guidance phase (self-guidance);**
  - **input of docking pin into nozzle of SP main engine chamber;**
  - **scheme of pin fixation in SP main engine chamber;**
  - **tightening of bunch (SMT+SP) with US;**
  - **creation of mechanical system US+SMT+SP;**

Project Proposal (Demonstrator)

Participant of innovational found “Skolkovo” - LLC «Space ecology»

Feasibility Stage Grant

- *to gather/build a consortium of the “Demonstrator” (international project), including industrial partners;*
- *to coordinate guidelines for the development of ADOS/ RTDM with the Project participants; Development of common technical specifications for systems and components;*
- *to harmonize the “Demonstrator” project with adopted international / national programs / projects;*

Project “Demonstrator”

The Project Team invites potential partners to join the Project consortium

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International Science and Technology Center

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Thank you for your attention

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