RECENT SPACE DEBRIS
MITIGATION ACTIVITIES IN FRANCE

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BACKGROUND

- Active participation of CNES to the preparation of regulations:
  - UN-COPUOS STSC and IADC Mitigation Guidelines
  - European Code of Conduct developed by ASI, BNSC, CNES, DLR, ESA
  - ECSS and ISO: development of standards

- Code of Conduct signed by President of CNES in November 2004

- Consequences
  - Information of operators and industry to promote the guidelines:
    - Example: GEO end of life workshop
  - Application to CNES projects
    - Example: Telecom 2A end of life
GEO END OF LIFE WORKSHOP

- Particularity of the GEO orbit, unique resource
- Need to protect and to keep available orbital positions
- Mitigation measures are necessary
- Rules are being prepared at different levels
- End of life operations already performed by some operators
  - dialog between operators and agencies necessary
  - workshop organized by CNES
OBJECTIVES OF THE WORKSHOP

■ Objective 1: To inform operators on regulatory issues under preparation:
  - to convince,
  - to support, encourage their implementation
  - to be prepared to future mandatory requirements

■ Objective 2: to get feedback from operators having performed end of life operations
  - to highlight implementation difficulties
  - to update the rules when necessary
Workshop took place on January 25, 2006 at CNES’s Headquarters in Paris

50 participants represented:

- Administrations: UK MoD, French Research Ministry
- European space agencies: BNSC (Qinetiq, RAL), CNES, DLR and ESA
- Satellite operators: Eumetsat, Eutelsat, France Telecom, Inmarsat, New Skies, SES-Americom, SES-Astra
- Industry: Alcatel Alenia Space, Arianespace, EADS Astrium, SSTL
CONTENT OF THE WORKSHOP

Objective 1: information of operators and industry

■ general overview of the situation in GEO: population, risks, reorbiting practices

■ regulatory issues discussed at different levels:
  ▪ United Nations Activities on Space Debris
  ▪ Orbital Debris Issues within the Framework of ITU
  ▪ IADC Mitigation Guidelines and Supporting Document
  ▪ European Code of Conduct
  ▪ ECSS and ISO Standardization for Space Debris Mitigation
CONTENT OF THE WORKSHOP

Objective 2: feed-back from operators having performed end of life operations
  • Description of operations already performed
  • Encountered difficulties
  • Lessons learned
  ■ End-of-Life Disposal of GEO Spacecraft under ESA Control
  ■ Perception of the International Recommendations by EUTELSAT
  ■ Astra 1A De-Orbiting
  ■ System Strategy for Telecom 2 Satellites End of Life
  ■ Orbit Management for Telecom 2 End of Life Operations
  ■ Optimum Eurostar 2000 Management for Reorbitation and Tank Passivation
MAIN RESULTS

■ Lessons learned
  • Main identified difficulties: propellant estimation, eccentricity management, tanks depletion

■ Proposal for new actions by agencies:
  • the goal is to clarify the recommendations and to facilitate their implementation

■ Recommendations: operators wish:
  • The support from agencies for development of new technologies, tools, and data bases
  • To develop the communication between agencies and operators
TELECOM 2A END OF LIFE OPERATIONS

- Launched December 16, 1991

- Operated by CNES on behalf of DGA and France Telecom

- End of life operations in October 2005
  - Phase 1: re-orbiting, altitude raising
    - Series of 13 manoeuvres in Earth pointing mode
    - Perigee obtained: 323 km above GEO
  - Phase 2: passivation
    - Tanks passivation
    - Electric passivation, satellite switch-off
Objective is to empty propellant tanks to avoid any further risk of explosion

Principle: to fire the thrusters to consume propellant

Constraints/difficulties:

- When a tank is empty, the thrust is perturbated
  - Risk to lose attitude control and TM/TC link
  - Inability to switch-off the satellite, no electrical passivation

- Thrust direction shall be controlled to avoid altitude decrease
PASSIVATION STRATEGY

■ First thrusts performed in Earth pointing mode:
  ◆ Thrust direction along velocity: altitude increase

■ Change to robust mode (Sun pointing) when detection of gas bubbles
  ◆ Larger sensors field of view
  ◆ Rotation around Sun direction

■ Thrusters activation at given time in order to:
  ◆ Empty the tanks
  ◆ Increase perigee altitude
  ◆ Keep the link with the satellite

■ Satellite switch-off
Tanks pressure evolution during passivation
TELECOM 2A END OF LIFE OPERATIONS

- Successful operations
  - Positive effect of passivation on altitude (+15 km)
  - Orbit determination using ESA and CNES optical facilities
  - Compliant with IADC and Code of Conduct: 265 km for Telecom 2A
  - Corresponding propellant mass about 11 kg
Future evolution of the orbit

Perigee and apogee altitude (km above GEO)

Minimum perigee altitude: 340 km
SUMMARY

■ The European Code of Conduct on space debris, compliant with the IADC Mitigation Guidelines has been adopted by CNES

■ As satellite operator, CNES applies the corresponding guidelines
  - Successful re-orbiting operations of Telecom 2B and 2A
  - Passivation difficulties were highlighted

■ As space agency CNES promotes the application of the guidelines
  - Workshop in Paris with industry and operators
  - Lessons learned
  - New actions identified