CENTRE NATIONAL D'ÉTUDES SPATIALES

RECENT SPACE DEBRIS MITIGATION ACTIVITIES IN FRANCE

Fernand ALBY
Centre National d'Etudes Spatiales (Toulouse)

fernand.alby@cnes.fr

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 feed-back from operators having performed end of life operations
  - to highlight implementation difficulties
  - to update the rules when necessary

GEO END OF LIFE WORKSHOP

- 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

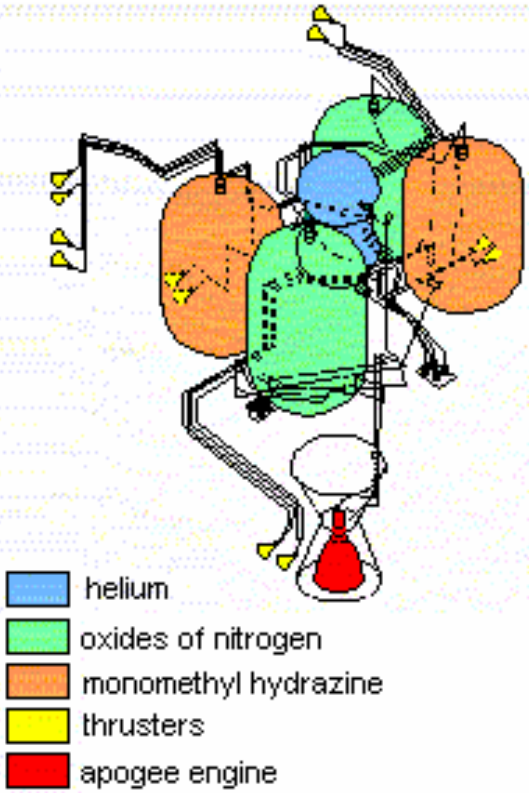
- Lessons learned
  - Main identified difficulties: propellant estimation, eccentricity management, tanks depletion
- Proposal for new actions by agencies:
  - the goal is to clarify the recommendations and to facilitate their implementation
- Recommendations: operators wish:
  - The support from agencies 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

TANKS PASSIVATION

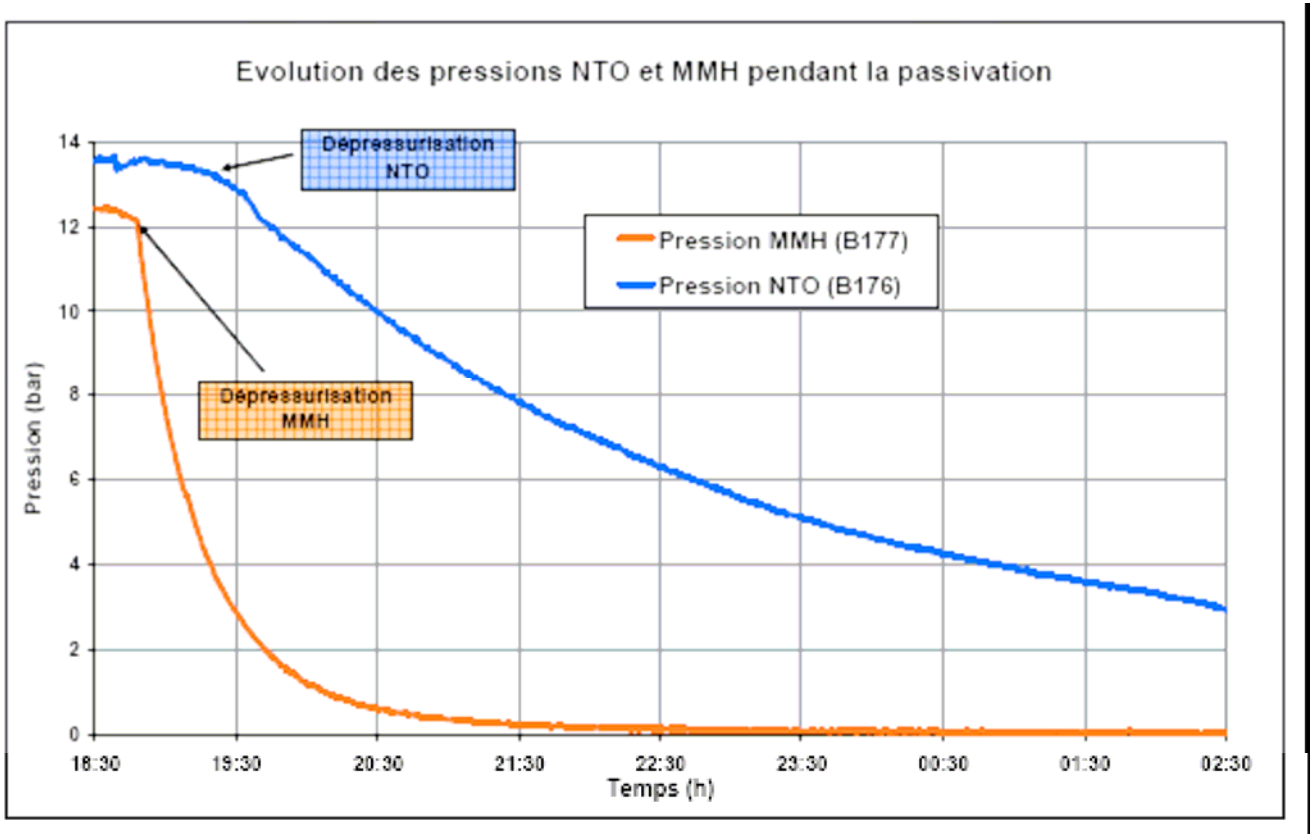
- Objective is to empty propellant tanks to avoid any further risk of explosion
- Principle: to fire the thrusters to consume propellant
- Constraints/difficulties:
  - When a tank is empty, the thrust is perturbated
    - Risk to lose attitude control and TM/TC link
    - Inability to switch-off the satellite, no electrical passivation
  - Thrust direction shall be controlled to avoid altitude decrease



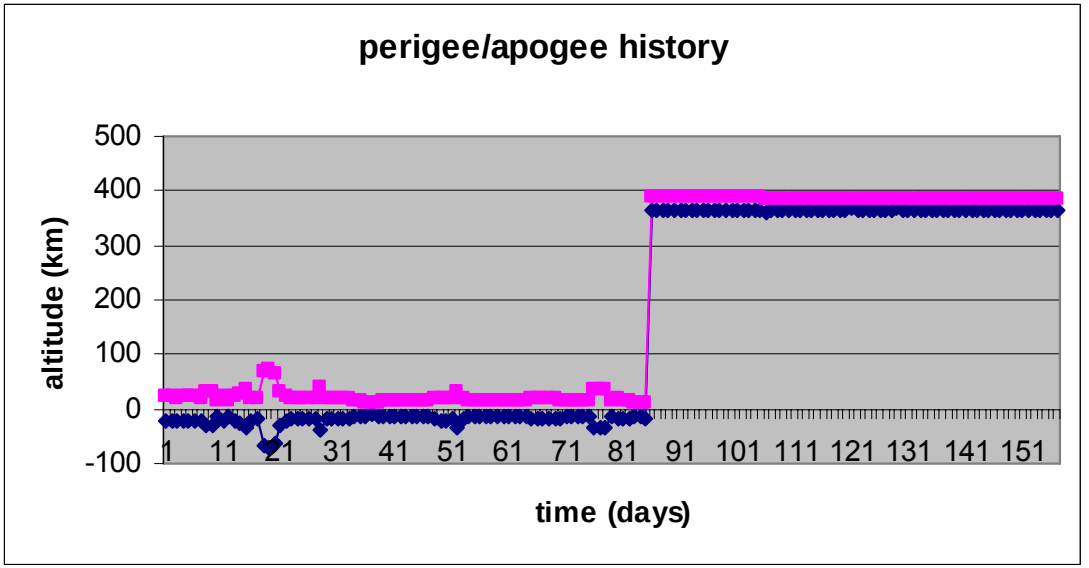
PASSIVATION STRATEGY

- 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



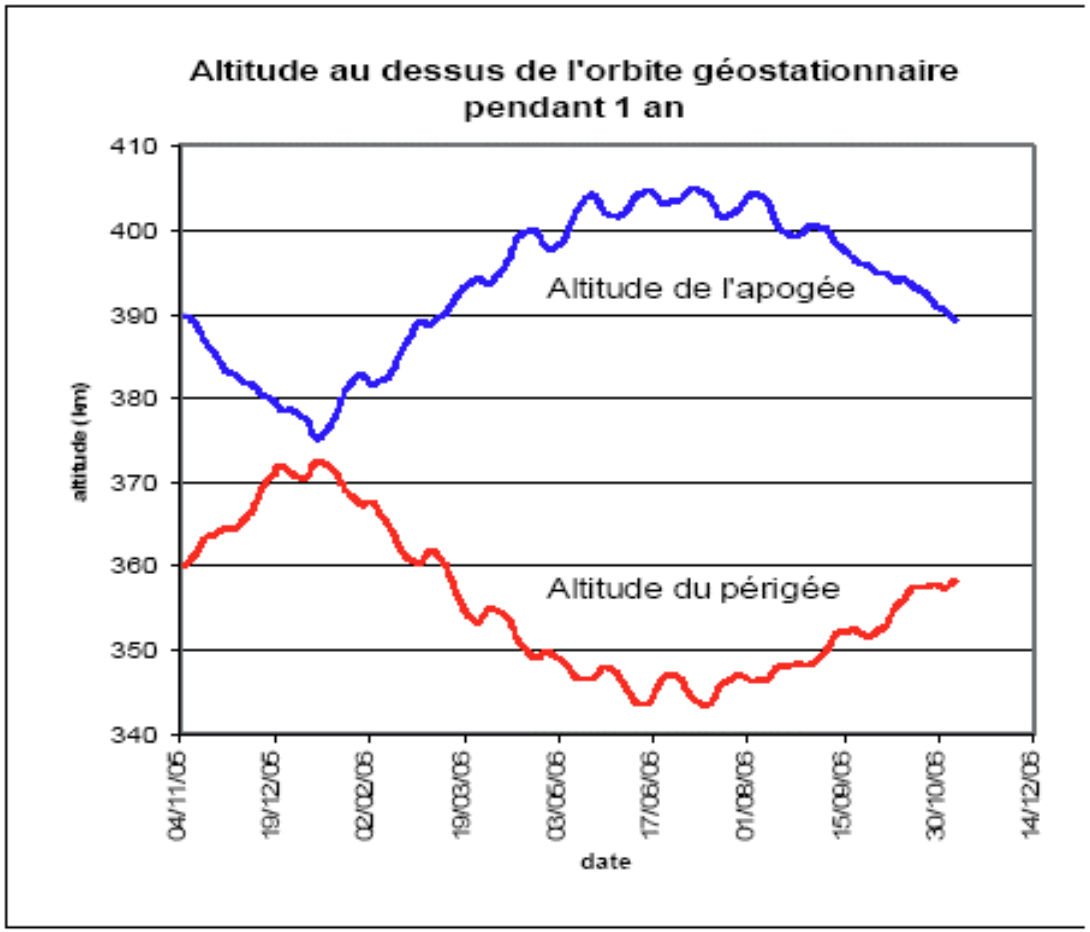
TELECOM 2A END OF LIFE OPERATIONS



- **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