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# INTER-AGENCY SPACE DEBRIS COORDINATION COMMITTEE (IADC)

# ACTIVITIES AND TECHNICAL CHALLENGES

Presented to:

36th Session of the
SCIENTIFIC AND TECHNICAL SUBCOMMITTEE
COMMITTEE ON PEACEFUL USES OF OUTER SPACE
UNITED NATIONS

# INTER-AGENCY SPACE DEBRIS COORDINATION COMMITTEE

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- **Multilateral structure adopted in 1993 after bilateral meetings among participants since 1987.**

- **Purposes:**

  - **To exchange information on space debris research activities between member space agencies,**

  - **To facilitate opportuntities for cooperation in space debris research,**

  - **To review progress of ongoing cooperative activies, and**

  - **To identify debris mitigation options**

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# IADC MEMBERSHIP

- **The IADC membership was expanded to 10 in 1998 and now includes:**
  - **Agenzia Spaziale Italiana (ASI)**
  - **British National Space Centre (BNSC)**
  - **Centre National d'Etudes Spatiales (CNES)**
  - **China National Space Administration (CNSA)**
  - **European Space Agency (ESA)**
  - **German Aerospace Center (DLR)**
  - **Indian Space Research Organization (ISRO)**
  - **Japan**
  - **National Aeronautics and Space Administration (NASA)**
  - **Russian Space Agency (RSA)**

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# 1998 IADC Meeting

- **CNES hosted the 16th meeting of the IADC in Toulouse, France, during 3-6 November 1998**

- **More than 90 orbital debris specialists from 10 countries participated.**

- **Actions included:**
  - **Review of Sections 3 and 4 of the UN COPUOS STSC report on orbital debris**
  - **Review of Risk Object Reentry exercise conducted 14 Oct - 1 Nov 1998**
  - **Revision of IADC Terms of Reference**
  - **Discussion of plans for the deorbiting of the Mir space station**
  - **Discussion of plans for safeguarding spacecraft during the 1998 Leonids meteor storm**
  - **Establishment of a new task to investigate LEO post-mission disposal options**

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# IADC ACTION ITEMS

- **The IADC guides its principal activities through Action Items assigned to one or more of the four Working Groups or to the Steering Group.**
  - **Working Group 1: Measurements**
  - **Working Group 2: Environment and Data Bases**
  - **Working Group 3: Protection**
  - **Working Group 4: Mitigation**
- **Action Items are normally highly focused and designed to satisfy a need of the space debris community in a timely manner.**
- **Working Group and Steering Group members work together during the year to accomplish the technical tasks and present their results at formal meetings held once or twice annually.**

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# EXAMPLES OF IADC ACTION ITEMS

- **Common database (Working Group 2)**
  - **Electronic database of orbital and vehicle characteristics of resident space objects and of laboratory analyses of returned spacecraft surfaces**
  - **Operational in 1998**
- **Risk object re-entry coordination (Steering Group)**
  - **Communications network and reentry data base established in 1998 to facilitate the timely exchange of information on the predicted re-entry location of space objects which might pose a special hazard to people or property**
  - **Network successfully tested**

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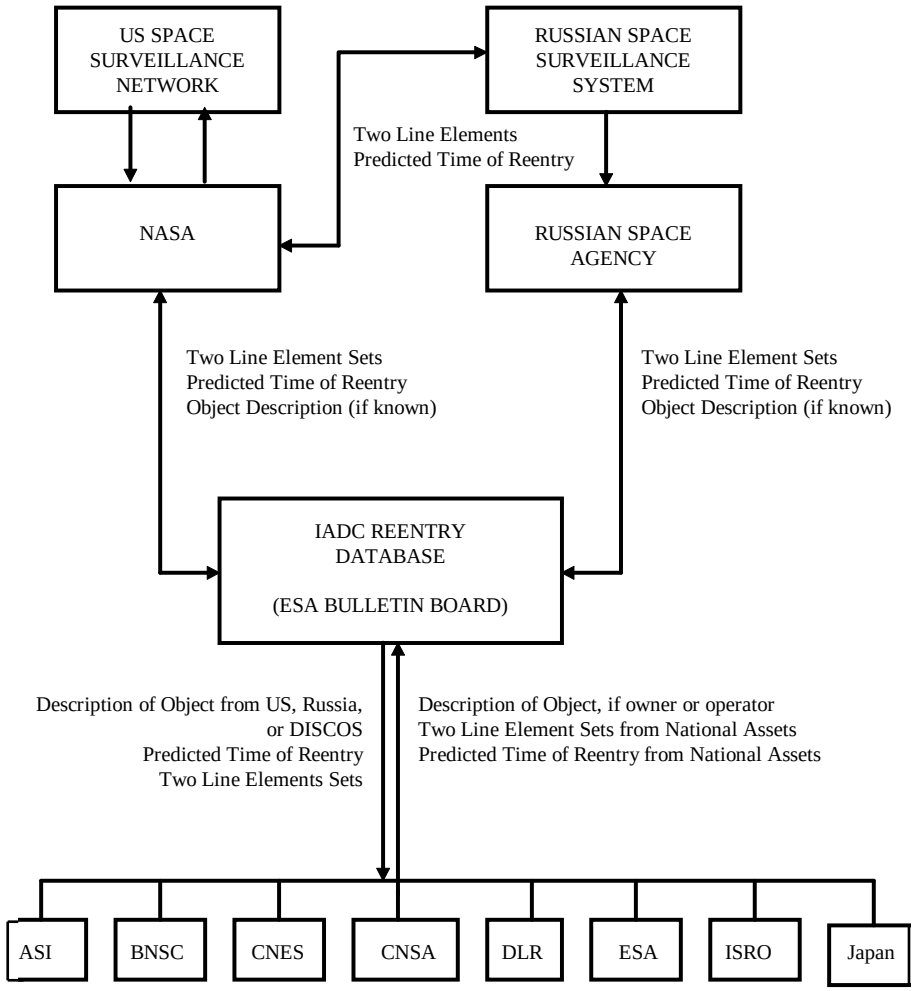
# COORDINATION FOR THE RE-ENTRY OF RISK OBJECTS



# EXAMPLES OF IADC ACTION ITEMS (continued)

- **Spacecraft protection manual (Working Group 3)**
  - Meteoroid and space debris risk assessment methodology
  - Spacecraft component and subsystem risk assessment data
  - Spacecraft system level failure and damage modes
  - Options for reducing meteoroid and space debris risks
- **Recommendation on GEO disposal orbit (Working Group 4)**
  - Technically-based guideline to determine the minimum reboost altitude for GEO spacecraft at end-of-mission
  - Guideline adopted by IADC in December 1997
  - IADC members forwarded guideline to their respective ITU representatives

# GUIDELINE FOR GEO SPACECRAFT DISPOSAL

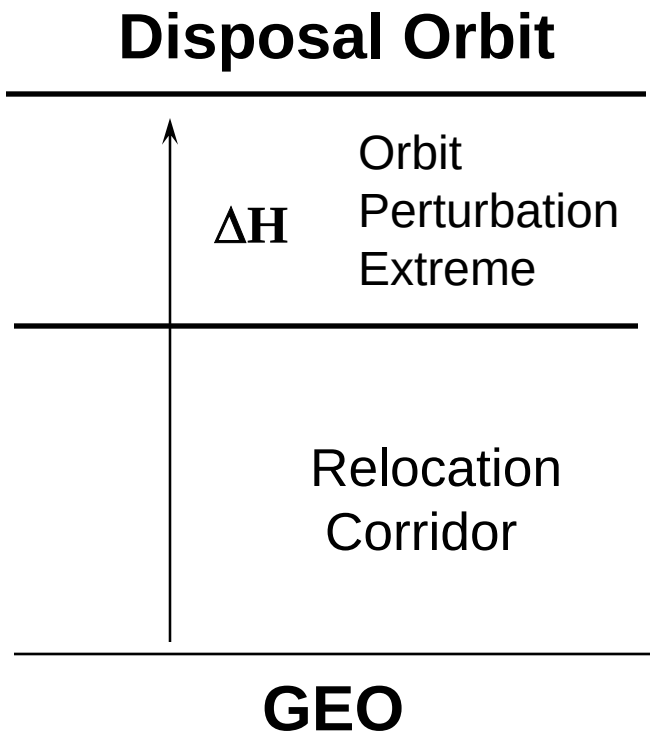
- **Objective: Prevent decommissioned spacecraft from interfering with GEO regime, including relocation corridor**

- **Minimum boost altitude:**

  **$\Delta H$ min $\geq$ 235 + 1000 x Cr x A/m**

  **where $\Delta H$ is in kilometers**
  **A/m is in $m^2/kg$**
  **Cr is the beginning of life reflectivity coefficient**

- **The disposal orbit is typically from 250 to 400 km above GEO**



# EXAMPLES OF IADC ACTION ITEMS (continued)

- **Catalog of debris mitigation practices (Working Group 4)**
  - **Will cover both spacecraft and launch vehicles**
  - **Questionnaires will be sent to launch vehicle manufactures**
- **Coordinated LEO and GEO observation campaigns (Working Group 1)**
  - **Intensive 24-hour monitoring of LEO by radar facilities conducted in November 1996**
  - **Special, periodic surveillance of GEO with optical sensors to detect debris began in October 1997**

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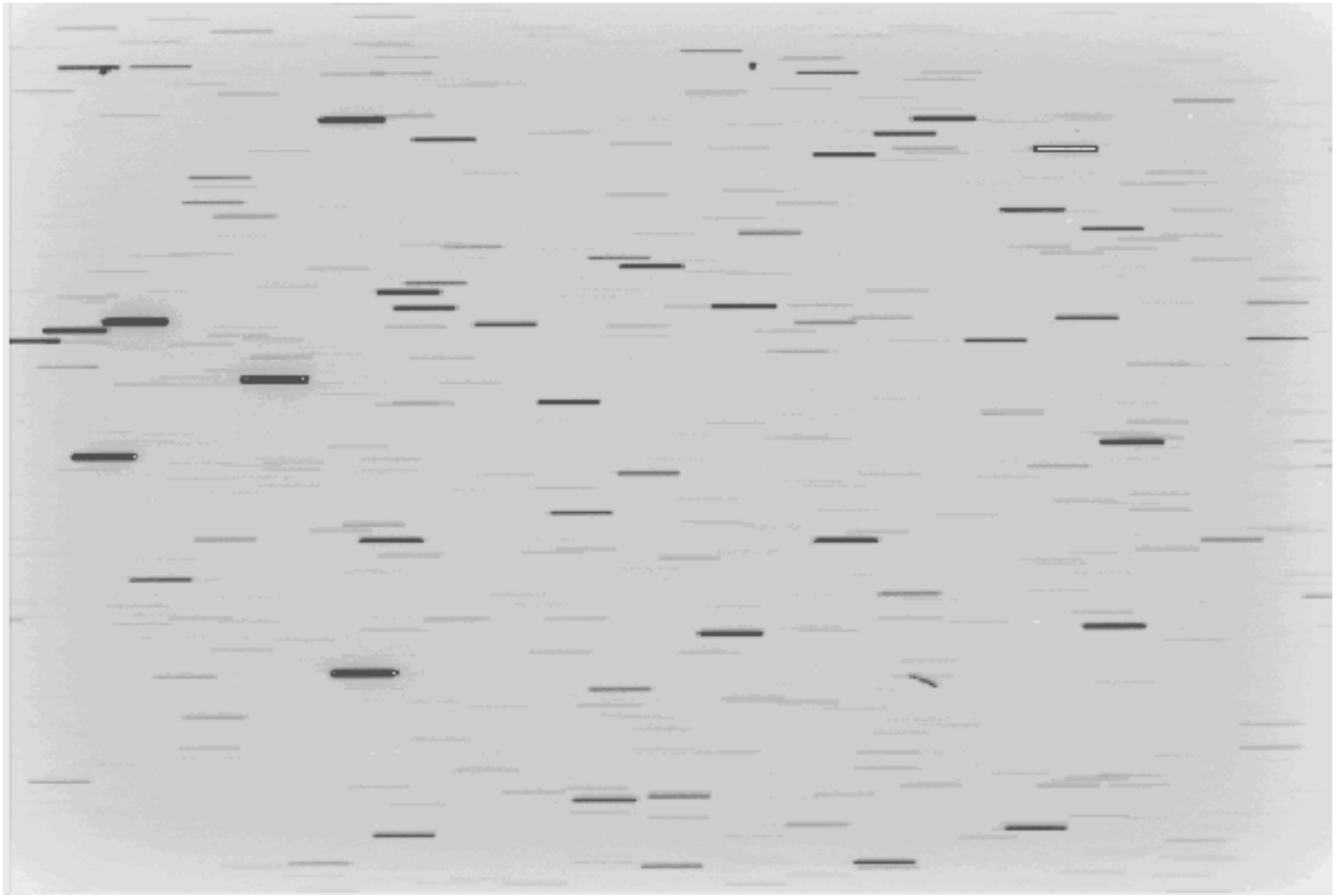
# PHOTOGRAPH FROM GEO DEBRIS SEARCH



# EXAMPLES OF IADC ACTION ITEMS (concluded)

- **List of debris sources**
  - **Characterization of man-made debris from satellite breakups, solid rocket motor firings, engine erosion, pyrotechnic devices, fluid leaks, atomic oxygen, impact ejecta, thermal cycling, and small particle collisions**
- **List of planned *in-situ* debris measurements**
  - **Description of programs to collect data on debris with spacecraft experiments**
- **Review of COPUOS draft report on space debris**
  - **Reviewed and provided recommendations on Sections 1-4**
  - **Prepared technical illustrations for report**

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# CURRENT SPACE DEBRIS TECHNICAL CHALLENGES

- **Significant advances in space debris measurements and modeling have been achieved during the past decade.**

- **Several topics require further research and development to improve the confidence level of models for the current and projected environment and to determine the effectiveness of proposed mitigation measures.**

  - **Definition of the 1-100 mm debris population in LEO**
  - **Higher fidelity fragmentation models**
  - **Identification and importance of non-fragmentation debris sources**
  - **Comparison of long-term evolution models and the effectiveness of mitigation measures**

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# TECHNICAL CHALLENGE 1

- **Debris particles > 1 mm can inflict mission-limiting damage to most spacecraft.**
- **New LEO commercial satellite constellations will be deployed in LEO at altitudes up to 2000 km.**
- **With statistical radar observations of LEO (Haystack, Haystack Auxiliary, Goldstone, FGAN), a clearer picture of the debris population of > 10 mm particles below 1000 km is emerging.**
- **Some observation data on debris as small as 2-3 mm is available, but only at very low altitudes.**
- **More comprehensive data on small debris in LEO are needed to reach a consensus on risks to spacecraft.**

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# TECHNICAL CHALLENGE 2

- **Since fragmentation debris are the principal component of debris > 1 cm, a better characterization of the debris created in breakup processes is necessary.**
  - **Number, velocity, and ballistic coefficient distributions**
  - **Shape and density characteristics**
- **Continued research in explosion and collision phenomenologies is needed via ground-testing and analysis of on-orbit satellite breakups.**
- **Studies have begun and will be evaluated in IADC Working Group 2 (Environment and Data Bases).**

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# TECHNICAL CHALLENGE 3

- **Non-fragmentation debris represent significant portions of the debris population in some size and altitude regimes, especially from**
  - **solid rocket motor effluents**
  - **sodium potassium droplets**
- **Higher fidelity source and decay models are necessary to improve debris environment projections.**
- **Continuing search for currently unidentified sources of debris is also prudent.**

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# TECHNICAL CHALLENGE 4

- **Developing a common understanding of the potential rates of growth of debris is vital to determining when the adoption of different mitigation measures may be appropriate.**
- **Differences in the projections of the long-term environment should be examined, but variations in model formulations will not permit complete agreement.**
- **IADC Working Group 2 is now performing this type of comparison for LEO constellation models.**
- **Subsequent cost-benefit analyses could also aid in the selection of mitigation measures for implementation.**

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# SUMMARY

- **The IADC is dedicated to promoting the advancement of knowledge in all areas related to space debris.**
- **The 10 members of the IADC represent the world's leading spacecraft and launch vehicle developers and operators.**
- **Although the state and growth rate of the space debris environment is becoming better known, several technical challenges must be addressed to provide higher confidence in current and future spacecraft risk assessments.**
- **The IADC remains available to assist the Scientific and Technical Subcommittee and to provide annual updates on space debris research.**