Optimization of Space Environments and Materials Related Resources

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Abstract

Members of NASA's space environments related discipline areas are proposing establishment of an Applied Spaceflight Environments (ASE) Office. This Office would address the existing gap between spaceflight environments knowledge and the application of this knowledge for cross cutting aerospace industry use. Currently there is no coordinated consistent approach to address space environment related materials issues therefore each program must define and develop program specific data and products. This approach can result in duplicating effort, over or under engineering, using inappropriate critical information, and accepting additional risk.

The ASE Office would provide coordination across the aerospace industry and be a valuable resource by providing funding for sustained multi-program support in three technical areas that have a demonstrated user demand for products and services. These technical areas are (1) natural environments characterization and modeling, (2) environmental effects on materials and systems, and (3) operational space environments. This presentation will focus on environmental effects on materials and systems but also show the relationship with the other two areas.

The ASE Office would coordinate materials/component/system performance data dissemination, product development, and product transition to external users. Many NASA field centers have materials/parts testing and performance data/assessments developed through laboratory testing and spaceflight experiments for NASA mission programs, commercial aerospace companies, and other federal agencies. These activities are not coordinated and data is not readily available Agency/industry wide. The ASE office would leverage all of these efforts to create one place where public information could be made available and where programs needing related services could be guided to appropriate experts or organizations within the Agency. ASE Office responsibilities would include responding to internal and external NASA user needs with product development and technical assistance; facilitating materials flight experiment opportunities; and, providing a coordinated effort to capture, archive, and distribute spaceflight environments and materials data.

National Aeronautics and Space Administration

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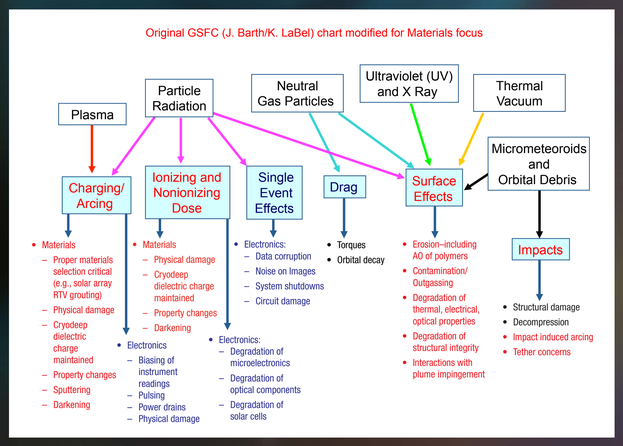
- **The Nation's dependence on space assets is increasing in all contexts—personal, commercial, military, and political.**
- **2009 NASA Office of Chief Engineer (OCE) Space Weather Report calls for a coordinated and focused effort:**
  - **Improve intraagency and interagency communication and cooperation in space weather related activities.**
  - **Develop and implement standards and guidelines for space system radiation hardness and space environment risk mitigation.**
  - **Faster turn around needed from research to operations with improved models.**
- **NASA Space Environments and Effects (SEE) community should be/continue to be a resource for the aerospace industry.**

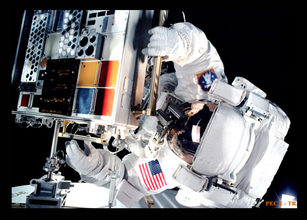
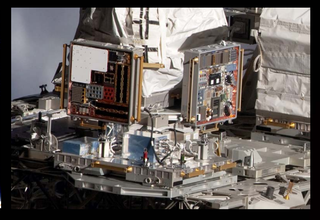
Space Environments and Related Effects



- **SEE Concerns:**
  - Human Rated Systems
  - Autonomous Systems and Satellites/Probes
  - Science Instruments
  - Passive radiation shielding vs all active systems that must perform (thermal control, ECLSS, and power) vs subsystem interactions (vents and dumps effecting thermal surface deposition.
  - Thruster plume impingement (e.g., electric prop thruster–induced env; sputtering, erosion, and charging/arcing; and satellite station keeping).

- **SEE related concerns and information/data must be considered in all program phases:**
  - Design (system architecture/requirements definition, environments definition, materials, and component selection).
  - Manufacturing processes can affect material performance (e.g., beta cloth).
  - Hardware development and qualification (component/subsystem testing and qualification), and operation of space flight systems.

Environmental Effects on Materials and Systems

Space Flight Environment Scope: All natural environments that have influence in the design, development, and operation of space flight systems including terrestrial surface and atmosphere, planetary surfaces and atmospheres, low-Earth orbit (LEO) to geosynchronous Earth orbit (GEO), and interplanetary space.

Members of NASA's space environments related discipline areas are proposing to address the existing gap between space flight environments knowledge and the application of this knowledge for crosscutting aerospace industry use.

To resolve this problem, a NASA initiated effort has been proposed to provide a consistent means to coordinate efforts across the aerospace industry and would provide a valuable resource for sustained multiprogram support in three technical areas that have a demonstrated user demand for products and services.

These technical areas are:

(1) Natural Environments Characterization and Modeling.
(2) Environmental Effects on Materials and Systems.
(3) Operational Space Environments—Space Weather.

This poster focuses on Environmental Effects on Materials and Systems.

Establishing a coordinated consistent approach to address space environment related issues for NASA, DOD, and commercial aerospace would better utilize limited funding. Currently, each program must define, fund, and develop program specific data and products. This approach can result in duplicating effort, over or under engineering, using inappropriate critical information, and accepting additional risk.

A coordinated effort is needed to address materials/component/system performance data dissemination, product development, and product transition to external users. Existing resources are housed in multiple locations within multiple organizations across the country.

NASA's SEE capabilities related to materials:

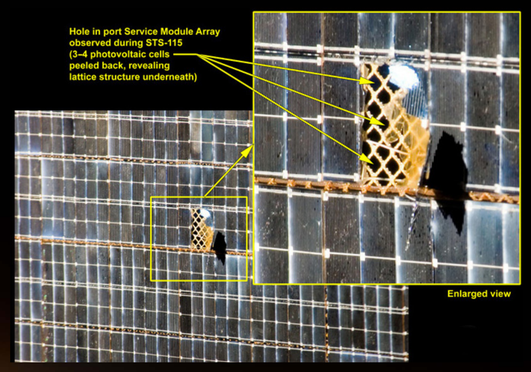
- Test facilities, capabilities, and expertise:
  - Test capabilities details same as in Ron Turner/Analytic Services Inc. submittal to NASA CEO entitled "NASA Space Environment/Space Weather Test Facilities Overview."
- Materials testing, diagnostics, and failure analysis support.
- World class instrumentation and engineering expertise for post exposure analyses.
- Experience in ground testing used to qualify new materials (e.g., composites).
- Flight experiments experience—relation to ground test capability:
  - Materials—LDEF, EOIM, OPM, POSA, and MISSE
  - Instruments—ISS: SPSR, PC, and FPMU
- Reference data:
  - SEE Website <http://see.msfc.nasa.gov>:
    - SEE Knowledgebase – outgassing data.
    - SEE models/tools.
    - SEE related materials data/resins, coatings, and tethers.
  - MAPTIS Website <http://maptis.nasa.gov>:
    - Materials and Processes Technical Information System (MAPTIS) housing.

SEE and materials data are not readily available Agency/industry wide. A focused approach would leverage all of these efforts to create one location to serve as an entry/exit point for space environment related products including:

(1) Space environments products (models and tools) and data for design phase support.
(2) Test facilities/capabilities availability and subject matter experts/expertise.
(3) Transition of research to applications.

Partner responsibilities would include responding to internal and external user needs with product development and technical assistance, facilitating materials flight experiment opportunities, and providing a coordinated effort to capture, archive, and distribute space flight environments and materials data.

Solar Array Impact

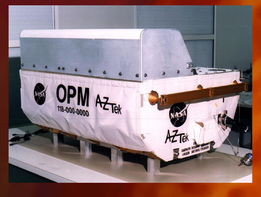


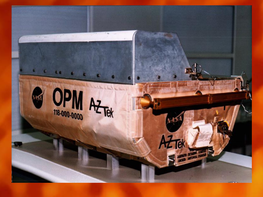
Program Considerations:

- Environment should drive adequate requirement definition—consider full lifetime.
- Use of analysis tools/models to conduct most cost effective system evaluations.
- Perform space simulation testing on most critical materials/components/systems to verify performance/new materials/new use of materials.
- Materials and component design, selection, control, and test play an important role in ensuring mission success.
- Utilize space operations' related tools to predict space environment effects and possible on-orbit mitigation strategies over mission lifetime.
- When possible, fly piggyback instruments to gather environmental data to build science databases while verifying tools.

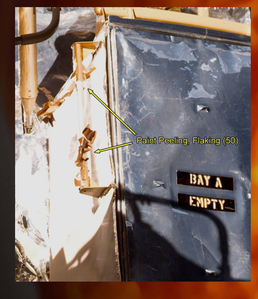
NASA field centers including GRC, GSFC, JPL, JSC, LaRC, and MSFC have varying types of resources such as materials/parts testing and performance data/assessments developed through laboratory testing, space hardware application, and space flight experiments for NASA mission programs, commercial aerospace companies, and other federal agencies.

Optical Properties Monitor (OPM) UV Darkening





Coatings Degradation Poses Multiple Risks



Flight sample showing AO, UV, and MMOD impact (black dot)

STS-7 Orbiter window impacted with paint chip