SEE Bulletin

Developing Tomorrow's Space Technologies Today

NASA's Space Environments and Effects Program — *Spring/Summer 1997*

Delay of Bulletin

The SEE Program had made the decision to delay this Spring Bulletin to include an article about the release of the NRA which was originally scheduled for mid-May time frame. Due to unforeseen circumstances on getting the NRA released, the SEE Program decided to combine the Spring and Summer editions and to include information about the NRA and SEE Workshop. The Fall edition of the bulletin will be released as regularly scheduled.

Bulletin Subscribers

If you have moved, changed E-mail addresses, etc., please inform the SEE Program Coordination Office so we may update our database. You may do this by E-mailing Billy Kauffman:

billy.kauffman@msfc.nasa.gov

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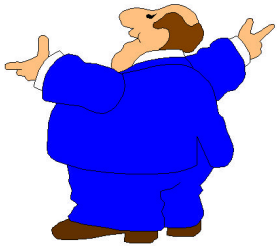
SEE Program's NASA Research Announcement is here!



The NASA Research Announcement (NRA) for SEE was released on July 3, 1997. This NRA seeks "engineering tools" that can be readily implemented to increase our knowledge and understanding of the space environment. Proposals in all technical areas of SEE are sought: Electromagnetic Effects; Ionizing Radiation; Meteoroid and Orbital Debris; Materials and Processes; Neutral External Contamination; Plasmas, Solar Activity; as well as Thermosphere and Thermal Environment. A non-exhaustive list and description of topics of particular interest to SEE is given in the NRA document. This list reflects some of the needs of our space environments customers. We realize that the study of the space environment is generating more interest in the science and engineering community than ever before. A NRA gives both the proposer and NASA maximum flexibility to develop products which will make maximum impact. The NRA document gives details that the proposer hopefully will find helpful in preparing their submission, along with details of our expectations on deliverables. To further assist proposers in directing their efforts, we have specified two areas of study which are not within the scope of this NRA: 1.) Any study on biological effects - this area is covered by other NASA programs. 2.) Flight Experiments - funding limitations force us to delay our direct involvement in sponsoring studies of this type. In the meantime, we remain advocates for this area.

The overall budget for this NRA is expected to be approximately $2.0 million, pending availability of funds from NASA Headquarters. Approximately 18 awards are expected to be made sometime in early 1998. Every effort will be made to award proposals in each of the SEE technical areas listed above. Copies of the NRA can be obtained by clicking on the "SEE NRA -8-20" link found in the left hand column of the homepage (http://see.msfc.nasa.gov), or through the NASA Acquisition Internet Service (NAIS) website: (http://procurement.nasa.gov/EPS/MSFC/Synopses/NRA-8-20/sol.html#Solicitation). Printed copies of the NRA may be obtained either by sending an E-mail request to Cindy Upton at cindy.upton@msfc.nasa.gov, or by faxing a request to Ms. Upton at (205) 544-8807. Questions concerning this NRA may also be addressed to Ms. Upton by either E-mail (preferred) or fax. The deadline for submitting proposals is October 3, 1997.

Small Business Innovative Research

Cindy Upton, Marshall Space Flight Center

The selections for the Phase 1 SBIR (Small Business Innovative Research) awards for the 1996 SBIR season were announced on January 8, 1997. NASA selected 349 research proposals for negotiation of 1996 SBIR Phase I contracts valued at $24M. There were 2,367 proposals submitted in response to the 1996 SBIR solicitation and evaluated by ten NASA field installations and NASA Headquarters. The award listing can be found on the SBIR/STTR homepage: http://nctn.hq.nasa.gov/SBIR/SBIR.html. The SEE Program Office is pleased to advocate four of these newly awarded proposals. There were a total of 17 proposals submitted in the Space Environmental Effects subtopic. The selected proposals were:

1. Electric Propulsion Laboratory, Inc., "New Technology Plasma Contactor". This study is aimed at charge control of large satellites and space structures, using higher voltage solar arrays to enable these spacecraft to operate reliably in a wide range of ambient space plasma environments. A unique plasma source design will be presented which is capable of operating over a wide range of plasma electron currents, including transient, and very high current spacecraft charging demands, while requiring a minimum gas flow and very low power.

2. ROR Enterprises, "Spacecraft Contamination Model Handbook: Applications and Comparisons". The innovation of this study is the unique comparison of and the criteria to use each of the large number of spacecraft contamination models that have been generated by NASA and private industry. Currently, the capabilities of each model vary significantly, so that it is hard for users to know exactly what they should

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On-Orbit Radio Frequency Environment

Tony Clark, Marshall Space Flight Center

Radiated electric field immunity requirements for electrical equipment and systems are developed from the electromagnetic environment in which the equipment or system is intended to operate. For spacecraft systems and payloads, an on-orbit radio frequency (RF) electromagnetic environment is created by ground, sea, and space based RF transmitters. NASA's Space Environments and Effects (SEE) Program has sponsored an activity to develop and publish an unclassified document with up-to-date on-orbit RF data pertinent to the spacecraft electromagnetic compatibility (EMC) community. The results of the activity are documented in the contractor report; "The On-Orbit Radio Frequency Environment", NASA-CR-4776. The principle investigator is a 30 year veteran of spacecraft EMC, Mr. Ralph Lawton, G.B. Tech, Inc., Houston, TX. This work extensively utilized the RF emitter databases and services of the Department of Defense Joint Spectrum Center, Annapolis, MD. The Joint Spectrum Center is in turn supported by the Illinois Institute of Technology Research Institute (IITRI).

As a precursor to the study, Mr. Lawton conducted a survey of satellite builders and users to determine the data content and form that would most benefit the aerospace EMC community. Both commercial and government users were surveyed and the results were used to both focus the data requested of the Joint Spectrum Center and shape the format of the final document. A significant driving factor in the final document format was the need to remain unclassified. Efforts were taken to maximize the information content required by the aerospace EMC community while omitting select information (ex. emitter location) to allow the document to remain unclassified.

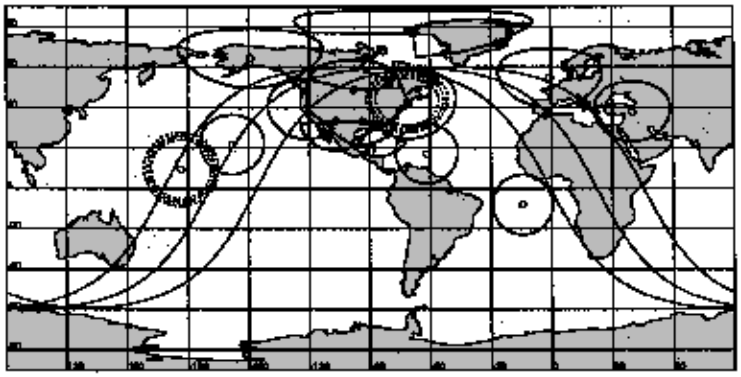

Figure 1. United States Space Surveillance Network

The original Joint Spectrum Center data set encompassed over 50,000 RF emitter entries. Data selection criteria, such as the ability to produce an electric field of at least 2 V/m at 100 nautical mile, was used to filter the number of RF emitter entries to those that most contribute to the on-orbit RF environment. No spaceborne emitters were found to meet the criteria. Some seaborne and airborne emitters were found to be likely illuminators. Most of the emitters that constitute the greatest threat to satellites are ground based radars.

NASA-CR-4776 contains a table describing the top thirty-one greatest threats, i.e. the thirty-one emitters that produce the highest on-orbit RF electric field levels and are considered likely illuminators to spacecraft. NASA-CR-4776 also contains a suite of plots, electric field strength verses frequency histograms, indexed for various satellite altitudes and inclinations.

A difficult question that is always connected to an RF environment study centers around the likelihood of RF illumination. NASA-CR-4776 addresses the on-orbit illumination issue to a degree by discussing the numerous and powerful RF emitters that are operated by several nations for the purpose of detecting and tracking satellites. A brief discussion on the United States Space Surveillance Network (US SSN), including a table of radar assets, is presented. Figure 1 shows the US SSN RF illumination areas for a 200 nmi orbit. Information taken from recent open literature on the Russian Space Surveillance Systems is provided as well.

In concluding, "The On-Orbit Radio Frequency Environment", NASA-CR-4776, will provide the aerospace community with an up-to-date reference for the electric field levels that a spacecraft can expect to experience in Earth orbit. Obviously, as old radars are taken out of service and new emitters are placed in operation, this environment changes over time. Consequently, studies such as this need to be performed periodically. Some efforts are also underway to initiate a space station flight experiment to monitor RF illumination of a spacecraft. Such an experiment would not only verify the electric field amplitudes presented in NASA-CR-4776, but would provide valuable information on the probabilities, frequency, and duration of RF illumination.

Space Environments and Effects (SEE) Program Workshop

The purpose of the SEE Workshop, held on April 29-30, 1997, was two-fold: To call together the membership of the SEE Program Technical Working Groups in order to update the April 1996 technical roadmaps and also to provide technical input to the SEE NASA Research Announcement (NRA). Each member of the six SEE Technical Working Groups — Electromagnetic Effects; Ionizing Radiation; Materials and Processes; Meteoroid and Orbital Debris; Neutral External Contamination; and Plasma, Thermosphere, and Solar Activity — were invited to the workshop to participate with their peers in proposing technical activities to be considered by the SEE Program.

To formulate the initial roadmaps, each technical working group proposed activities they felt would be pertinent to meeting the needs and goals of the

Dr. Dana Brewer (SEE Program's Headquarters Sponsor) and Mr. Steve Pearson (SEE Program Manager) discuss future activities of the SEE Program.

NASA mission centers. Each technical activity was summarized within different categories as determined by each technical working group and then prioritized. Activities for flight experiments were also addressed at the workshop but were not prioritized, as they will not be eligible for the NRA. Those prioritized activities pertinent to the NRA, along with the accompanying Task Summary Sheets, were compiled for submittal to the SEE User Steering Committee for final prioritization prior to the NRA announcement. The final step in the process will be to provide a schedule for each activity resulting in roadmaps. As a result of a recent reorganization, the SEE Program is now part of the Spacecraft Systems Crosscutting Technology Development Program. Each technical activity developed at this workshop will respond to technology requirements that are

Mr. Dale Atkinson (left) and Dr. Joel Williamsen discuss future efforts for the Meteoroid and Orbital Debris Technical Working Group

applicable to, preferably more than one, NASA Customer Mission areas (i.e., crosscutting). These mission areas are Space and Planetary, Human Exploration and Development of Space (HEDS), Earth Science, Commercial Remote Sensing, and Information and Communication. The five crosscutting technologies are Spacecraft Systems, Instrument Systems, Information Systems, Telerobotics and Autonomy, and Communications. The SEE program is part of Spacecraft Systems. The SEE technical tasks proposed by the workshop and the accompanying charts (roadmaps) will be used to aid not only in NASA planning activities, but also to provide an input as to what kind of technical tasks to procure through the upcoming NRA process. It is anticipated that the NRA contracts will be funded and awarded beginning in FY98.

To view an Executive Summary of the workshop, please visit the SEE Program Website at: http://see.msfc.nasa.gov.

Ms. Cindy Upton (left), Ms. Sopo Yung (center) and Ms. Elaine Hamner review NRA instructions.

Small Business Innovative Research

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use. A handbook will be generated that compares the models in great detail and clearly defines the application for each.

3. Boundary Technologies, Inc., "Electrically Conductive Anodized Aluminum Thermal Control Coatings". Here, the electrical conductivity of anodized aluminum thermal control coating will be enhanced by deposition of an electronically conductive metal oxide within the anodic oxide pores. The electrical charge that might otherwise accumulate on its surface in the ambient space plasma will leak off through the coating. This will prevent structural damage from sputtering of the alloy substrate at coating breaks, and minimize electrical noise.

4. Triton Systems, Inc., "Electrically Conductive Space Durable Thermal Control Coatings To Mitigate Space Environmental Effects". New materials will be developed which are expected to improve electrically conductive thermal control coatings, with properties never before seen in a single material. The Phase I effort is expected to provide an electrically conductive, optically-clear, atomic oxygen (AO) -resistant, vacuum ultraviolet (VUV) stable, light-weight and user-friendly material which will effectively mitigate the problems associated with spacecraft electrostatic surface charging in the high-energy electron environments.

SBIR awarded proposals related to SEE at other NASA centers are available for viewing on the SEE Website at: http//see.msfc.nasa.gov/see/whatsnew.html.

Coming in Fall 1997 Issue...

- ***Web Browser Search Tool for LDEF Data***
- ***Results of Contamination Workshop***
- ***Design Guidelines for Composite Materials (EMI/EMC)***

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We are sending this issue to people we believe will be interested in the SEE Program. If you are not, please pass it on to someone else and let us know. Anyone interested in receiving the SEE Bulletin, may contact Ms. Belinda Hardin at:

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Previous issues and current information can be found by visiting our homepage at:
http://see.msfc.nasa.gov/

Recent Website Additions:

- Information on NASA Small Business Innovation Research (SBIR) and Small Business Technology Transfer: http://see.msfc.nasa.gov/see/whatsnew.html
- SEE related SBIRs awarded proposals across NASA: http://see.msfc.nasa.gov/see/sbir.htm
- The addition of a SEE FTP site: ftp://see.msfc.nasa.gov
- Technical Information on two M&OD models in the SEE Website Models Directory; MADHAZ and ORDEM96: http://see.msfc.nasa.gov/see/mod/models.html
- Link to the New Orbital Debris Document Depository and Orbital Debris Quarterly News: http://see.msfc.nasa.gov/see/mod/models.html
- New SEE Program Personnel Directory: http://see.msfc.nasa.gov/see/directory.html
- Plasma and Fields and the Solar, Thermal & Thermosphere Technical Working Groups (TWGs) have combined to the Plasma and Thermosphere (Solar and Thermal Environment) TWG.
- SEE Program Workshop Executive Summary is now on our Website: http://see.msfc.nasa.gov/see/workshop.html

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