SEE Bulletin

Developing Tomorrow's Space Technologies Today

NASA's Space Environments and Effects Program — *Winter 1997 Issue*

The Mir Photo Survey is now available for viewing on the SEE website at: http://see.msfc.nasa.gov

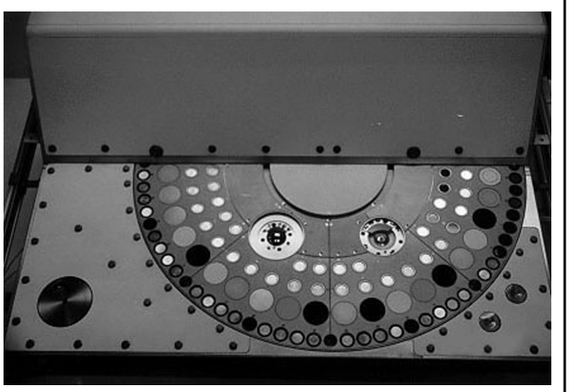
Bulletin Subscribers

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

Thanks,
Billy Kauffman
SEE Program Coordination Office

Contents

Optical Properties Monitor



The stability of materials used in the space environment continues to be a limiting technology for space missions. This technology is important to all users of space...NASA, Department of Defense (DoD), Industry and Universities. The Optical Properties Monitor (OPM) offers a comprehensive space research program for studying the effects of the space environment, natural and induced, on optical, thermal, space power and other materials.

OPM was developed under the NASA In-Space Technology Experiments Program (In-STEP) and the International Space Station (ISS) Phase I Risk Mitigation Experiment Program. Some of the major objectives of OPM are:

- to determine the effects and damage mechanisms of the MIR space environment on materials
- to provide flight testing of spacecraft and optical materials
- to provide data to validate ground test facilities and prediction models
- to develop and test a multifunctional, reusable flight instrument for the in-situ study of the behavior of materials in the space environment

continued on page 3

Major Changes Within SEE Program

by Steve Pearson, SEE Program Manager

The past year, which is the first year that the Space Environments & Effects (SEE) Program has been managed by the Marshall Space Flight Center, has been a very successful year for the SEE Program with many significant accomplishments. A SEE Web site and quarterly SEE Bulletin were initiated to keep the SEE community aware of recent accomplishments and opportunities. A SEE display was developed and will be present at the AIAA conference at Reno, NV on January 6, 1997. SEE technical roadmaps were developed to chart the technical path the SEE Program should be headed. A SEE

continued on page 2

Major Changes Within SEE Program

continued from page 1

server was set up to archive SEE flight data and to make this data readily available to the SEE community. Two SEE technology development activities were completed with their results distributed to the SEE community. Several SEE flight experiments were successfully advocated. Extensive collaboration with other government agencies has begun. The list goes on and on...

However, in our attempts to better serve NASA, and each of it's Enterprises, there are several significant changes which are being made in the SEE Program. The SEE Program, which is now sponsored by NASA's Advanced Technology and Mission Studies Division (Code SM), recently reviewed it's activities with Dr. Peter Ulrich, Director of Code SM, and identified several areas where the SEE Program could make some changes which would better serve the agency.

A major variation will be the SEE Program's expanding it's scope and technical roadmaps to better serve the Space Science Enterprise's deep space and planetary missions. In the past, at the direction of NASA Headquarters, the SEE Program has primarily focused on technology needs for near-earth missions. We will now expand the SEE Program to include SEE technology development for deep space and planetary missions, as well as continue to focus on near-earth missions sponsored by the Mission to Planet Earth and Human Exploration and Development of Space Enterprises. This expansion of scope will require closer collaboration with the Space & Planetary Customer Mission Area at the Jet Propulsion Laboratory as well as the Mars exploration work being led by the Johnson Space Center.

The technical roadmaps will also be expanded to include existing and future SEE flight experiments, and their corresponding technical flight data, as well as technology development activities currently under way as a part of the Small Business & Innovative Research (SBIR) Program.

In order to effectively meet these new technology needs and develop updated technical roadmaps, the SEE Program is looking to restructure its existing technical working groups to identify technical subgroups which will work together more closely to develop the initial roadmaps for each discipline area. These roadmaps will then be coordinated with the overall technical working groups to insure that all technical concerns have been addressed and an initial prioritization will be determined by the overall technical working group. These technical roadmaps will then be submitted to the SEE User Steering Committee for overall prioritization. A NASA Research Announcement (NRA) will then be issued seeking parties to participate in the development of these technologies. It is expected that this NRA will be forthcoming in the early summer of 1997, with the technology development activities to begin in October of 1997.

Another new thrust of the SEE Program is better collaboration in the area of SEE with other government agencies. Recent discussions with the National Oceanic Atmospheric Administration (NOAA) and the United States Air Force's Phillips Laboratories have shown great potential to recognize maximum benefits from the United States taxpayers' money.

While we are overwhelmed at the work which lies ahead, we within the SEE Program are excited about the bountiful opportunities which exist. 1997 promises to indeed be a year of many opportunities.

System Guidelines for EMC Safety Critical Circuits- Design, Selection and Margin Demonstration

by Ralph Lawton, GB Tech, Inc.

NASA has recognized the need for clear guidelines to describe methods for implementing EMC critical circuits requirements, especially for large complex projects. Large projects require specialization by engineering groups which often individually lack the expertise to define which circuits are critical to life and mission and which are susceptible to critical disruption from the effects of electromagnetic interference. The process for verifying adequate safety margins for these circuits is also frequently misinterpreted. Engineers and managers need a clear roadmap of logical steps to meet safety requirements by selecting and demonstrating margins on critical circuits, while keeping firm control on associated costs.

To address this issue, the NASA Space Environments Effects (SEE) Program sponsored the development of System Guidelines for EMC Safety Critical Circuits- Design, Selection and Margin Demonstration. The document developed defines the processes for implementing the requirements while containing the associated costs. The operational sequence and flowchart for applying appropriate skills in determining EMC critical circuits is defined as well as techniques for critical circuit margin demonstration.

This set of critical circuit guidelines provides a step-by-step process for determining EMC critical circuits, including the responsibilities of the management and safety personnel versus those of the EMC engineer. Verification of the critical circuit margins is also addressed in the areas of analysis and test. Field-to-wire and cable-to-cable coupling equations are provided as well as typical circuit susceptibility responses. Testing methods for verifying an adequate margin between the electromagnetic environment and the susceptibility of the critical circuit are also described in the guidelines. Radiated and conducted environments including transients are considered. Various acceptable test methods for each approach are given to add to the flexibility of the guidelines. The use of examples is emphasized in each stage of the critical circuit determination and margin demonstration process. In fact, entire program examples of the EMC critical circuit process are provided in the Appendix for the Skylab and Space Shuttle Solid Rocket Booster Programs. Critical circuit design guidelines are also provided which describe grounding, shielding, bonding and other design techniques to reduce the susceptibility of circuits.

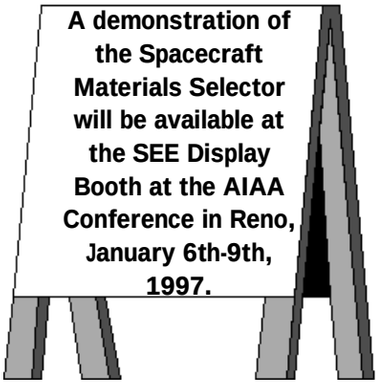
The SEE Program is working toward having an example copy of the guidelines available at the display booth at the AIAA conference in Reno on January 6th-9th, 1997. Also, the document will be available through the SEE website in the very near future.

Spacecraft Materials Selector Artificial Intelligence System

Dr. Gary Pippin, Boeing Defense & Space Group

The use of computer programs as assistants for design, trade studies, materials selection, and space environments selection is an effective means of capturing and retaining relatively "scarce" knowledge. Even as "experts" retire, move to other organizations or positions, or simply must allocate their time to many different programs, these electronic systems allow access to essential information.

The Spacecraft Materials Selector (SMS) artificial intelligence system under development consists of a backward-chaining inference engine and a set knowledge bases for space environments definition and materials properties and performance assessment. This system stores, summarizes, and aids retrieval of information about spacecraft materials performance under a wide range of conditions.



The first part of the SMS system is the Spacecraft Environments Predictor(SEP). The SEP identifies space environmental factors present around a spacecraft flying a specified mission. The knowledge base requests information about essential flight parameters, including launch date, inclination, altitude range, mission duration, and external surface orientation. The knowledge base predicts significant environmental exposures and estimates exposure levels of those environment factors, based on the level of detail provided during the mission definition.

The SEP is designed to support preliminary design and trade studies and materials selection decisions. The user may input well-known values for a specific mission, or may test a series of "what if..." ideas to determine which environment factors are present, and if detailed modeling of specific environment factors are needed. The SEP is capable of calling other programs which calculate the values of selected parameters, and then return the results to the SEP for use in the decision-making process. This expert system was initially constructed at Boeing Defense and Space group using the Boeing Expert System Tool(BEST), an inference engine developed by Boeing Information & Support Services.

Eventually, the spacecraft materials selector will be available through the Space Environments and Effects (SEE) Program website. An input form for collecting information related to the performance of materials on spacecraft exteriors will also be available. This will allow input from people with data which may not be widely available. Data will be evaluated for suitability for inclusion in the knowledge base at scheduled intervals and if appropriate, rules will be added or adjusted. The form will include areas for suggested rule(s), a reference to the source of the data, the data, and any comments of the person submitting the suggestion about of the quality of the data.

The SMS is intended to be used for preliminary design and trade studies, recommending materials for specific applications, identifying prohibited materials, assessing performance of materials over the duration of a defined mission, and to identify the environments present during the mission. The results will be quantitative if enough information is known, or may be a qualitative summary to guide the engineers selection of materials and required hardware testing. As with all expert systems, the spacecraft materials selector will develop over time. Current and upcoming flight experiments, the MIR Environmental Effects Payloads(MEEP), the Optical Properties Moniter(OPM), the Effects of Space Environment on Materials(ESEM), and other flight experiments will provide the source of new data to extend the capabilities of the SMS.

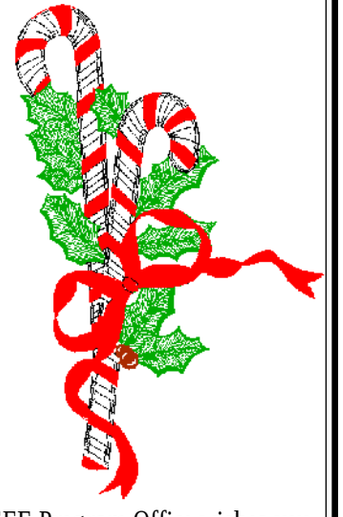
Optical Properties Monitor

continued from page 1

OPM is scheduled to be carried to orbit on STS-81 (January 1997), attached to the outside of MIR and retrieved on STS-89 (February 1998).

The OPM flight hardware system is a fully integrated package consisting of three optical measuring instruments positioned around the periphery of a circular sample carousel. Test samples are arranged on half a circular carousel in four concentric circular rows. OPM also contains three types of environmental monitors. Temperature Controlled Quartz Crystal Microbalance (TQCM) sensors monitor molecular contamination and Atomic Oxygen (AO) sensors monitor the AO fluence. Radiometers monitor the solar and earth irradiance. The two TQCM contamination monitors and the AO monitor are mounted on either side of the exposed portion of the carousel and have the same view of the space as the exposed test samples.

The Data Acquisition and Control System (DACS) is located inside the OPM enclosure and beneath the carousel. The DACS will control all aspects of experiment operations, process and collect analog and digital data, format and transfer data to the spacecraft data interface, and condition and distribute power to all systems.



The SEE Program Office wishes you a safe and happy holiday season.

Coming in Spring 1997 Issue...

- ***Development of On-Orbit Electromagnetic Environment Publication***
- ***Technology Development Activities Update***
- ***SEE Program NRA Update***

Don't Miss the SEE Display at Reno!

Latest SEE Program Happenings

Technology Development Activities

• System Guidelines for EMC Safety Critical Circuits- Design, Selection and Margin Demonstration, produced by Ralph Lawton of G.B. Tech Inc., should be available for distribution by the middle of January, 1997.

• Beta testing for the new ionizing radiation model "The Ionizing Radiation Environment and its Effects on Satellites (CREME 96)", developed by James Adams of NRL, should begin in mid to late January, 1997.

• The SEE Program's model and database servers are on-line. They are expected to be fully functional by mid February, 1997.

Space Environments and Effects Program Display

• The SEE Program Office will have a display at the AIAA Conference in Reno from January 6th-9th, 1997. Please stop by to learn more about the program and the ongoing activities.