SEE Bulletin
Developing Tomorrow's Space Technologies Today
NASA's Space Environments and Effects Program
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Spread Spectrum Receiver Electromagnetic Interference (EMI) Test Guide (NASA/CR –1998-208535)

by Dawn Trout
Marshall Space Flight Center

The NASA Space Environment and Effects Program (SEE) funded a task to develop a test guide specific to spread spectrum receiver immunity. Historically, space system receivers were evaluated for front-end electromagnetic interference using military testing standard. These standards included methods that tested for intermodulation, crossmodulation, and rejection of undesired signals. The methods were primarily applicable for fixed frequency, tunable superheterodyne receivers. These tests evaluated the effects of

- out-of-band signals combining to form an in-band response,
- out-of-band modulation being transferred to in-band, and
- response to signals outside of the intentional passband of the receiver.

Information from these tests was used to evaluate system level electromagnetic compatibility for each receiver to the on-orbit and ground-based transmitter produced environment.

Since the more complex spread spectrum receivers have become more common, these tests are not as applicable and the military has deleted the detailed front-end receiver procedures from the military standards. Instead, manufacturer procedures are referenced. These manufacturer procedures may or may not be complete, especially for out-of-band testing, and many NASA specifications left receiver immunity tests out since there were no clear criteria for requirement verification. This is especially a problem for space systems that are exposed to a large number of receivers and transmitters.

The SEE Spread Spectrum EMI Test Guide developed by Mark Wheeler at the Georgia Tech Research Institute provides a general test procedure applicable for all direct sequence spread spectrum receivers, the most common type of spread spectrum receiver in use by NASA. Spread spectrum receivers have a communication advantage by spreading the bandwidth of transmission, which can provide:

- increased transmit power efficiency,
- multiple use of a designated frequency band,
- reduced probability of intercept,
- and increased interference resistance.

This increase interference resistance has led some to believe that these receivers are totally immune to EMI. The guide includes a description of direct sequence receiver characteristics and an analysis showing that EMI to spread spectrum receivers is plausible. The test methods in the guide include:

- a receiver sensitivity test,
- in-band interference margin test, cross-correlation test,
- near and out-of-band signal rejection tests,
- and out-of-band intermodulation test.

A general method is given for each of these tests and then an example of how tailoring could be done for a specific system is provided using the NASA Tracking and Data Relay Satellite System receivers and transponders as a case study. Reasonable levels for out-of-band susceptibility limits are also provided since the electromagnetic environment is not always specified.

This guide was based on analytical assessments and practical knowledge of spread spectrum receivers. Further work is needed to verify all of these procedures via testing with a direct sequence spread spectrum receiver. In addition, evaluating other types of spread spectrum receivers would be helpful to the space industry.

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Material Selection Guidelines to Limit Atomic Oxygen Effects on Spacecraft Surfaces*

by Miria Finckenor
Marshall Space Flight Center

The NASA Space Environments and Effects Program funded an effort to update "Material Selection Guidelines to Limit Atomic Oxygen Effects on Spacecraft Surfaces." This NASA publication, TM-100351, was published in 1989 and is still being used in spacecraft definition. A wealth of information on material performance in the atomic oxygen environment has been gained in the last decade, thanks to the Long Duration Exposure Facility, the Hubble Space Telescope, other satellites, and development tests for the International Space Station. "Material Selection Guidelines to Limit Atomic Oxygen Effects on Spacecraft Surfaces" has now been updated with not only new materials and AO reactivity data, but also web addresses for the latest available models, databases, and test facilities. This document is not intended to be a comprehensive guide to spacecraft materials but rather an overview for the designer not well-versed in atomic oxygen effects. The handbook discusses atomic oxygen effects on metals, composites, polymer films, optical materials, and thermal control coatings as well as the synergistic effects in the space environment. Guidelines are given for laboratory AO exposures to ensure adequate exposure and consistent results.

Request: NASA / SEE ASTM 1559 Database and NASA / SEE Space Flight QCM Database

by Bob Wood, Sverdrup

The NASA/SEE Program is currently working with personnel at PSI, Inc., Sverdrup Technology, Inc. and the Johns Hopkins University / Applied Physics Laboratory to establish two databases as a resource for the aerospace community. The databases will contain information on materials outgassing and flight observations of mass accumulations. Specifically:

1)An ASTM 1559 Database and

2) A Space Flight QCM Database

Both of these databases will include quartz crystal microbalance (QCM) data. The ASTM 1559 Database will include the outgassing data obtained using this relatively new standard. The intent for this database is to complement the data archived by NASA Goddard Space Flight Center using the ASTM-595 standard (NASA Reference Publication 1124). ASTM Standard 1559 provides the time dependent material outgassing properties for three collector temperatures. We are requesting that anyone using the new standard provide us with any/all nonproprietary data for inclusion in this database. In particular, we are looking for data generated by chambers such as the Vacuum Outgassing Deposition/Kinetics Apparatus (VODKA) that is being marketed by QCM Research of Laguna Beach, CA or chambers with similar capabilities. This database, once established, will be available to you and the entire community, and will provide a valuable source of material outgassing information useful to those working in the Contamination area for mission design and materials specification. We also plan to include links to publications relating to the data that are included in the database.

Similarly, the Space Flight QCM Database will include QCM data that have been collected on satellites operating in space. This will include data from, among others, NASA programs including Shuttle, DOD (including the MSX program), Canadian Space Agency, European Space Agency, Russian MIR space station, and eventually the International Space Station. The format of the data that will be stored for each QCM will be: Time (or elapsed time), QCM Frequency (or QCM Mass), and QCM Temperature. (Note: Since QCM mass is a function of QCM fundamental frequency, please indicate the QCM's fundamental frequency.) If you have data matching either of these two categories and are willing to include your results, please call Bob Wood at 931-454-7719 or Email: wood@hap.arnold.af.mil . Your efforts in contributing to this database will result in a valuable resource to you and all in our community. We appreciate your assistance.

Multi-Layer Insulation Guidelines*

by Miria Finckenor
Marshall Space Flight Center

"Multi-Layer Insulation Guidelines" combines the MLI definitions for Space Shuttle, International Space Station, Spacelab, Hubble Space Telescope, and other satellites into a comprehensive guide to MLI materials and MLI blanket design. This document is intended to assist spacecraft designers in material selection and address other concerns for MLI blankets besides thermal insulation performance. A extensive list of suitable outer covers, reflector layers, threads, fasteners, tapes, and other materials is included with mechanical and optical property data, where available. Concerns such as space environmental effects, billowing, venting, tie downs, seam finishing, grounding, and contamination control are discussed. Applicable NASA, military, federal, and ASTM documents, specifications, and procedures are listed, such as the flammability requirement of NHB 8060.1C and the vacuum stability requirement of SP-R-0022 that MLI blankets must meet.

**** Both publications should be available around 4/1/99***

Trapped Radiation Models — Uncertainties for Spacecraft Design

by Tony Armstrong, SAIC

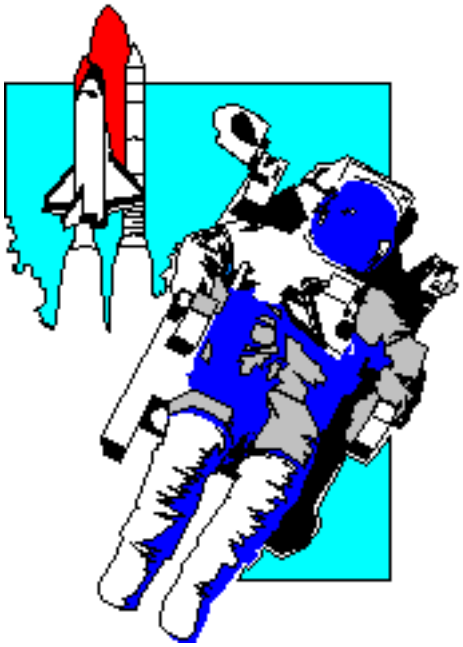
The models normally used for predicting trapped radiation environments (AP8 for protons, AE8 for electrons) are based on old and incomplete flight data collected 2-3 decades ago. To help designers confronted with specifying spacecraft and mission requirements and radiation designs using these old models, the SEE Program funded Science Applications International Corporation (SAIC) and Eril Research, Inc. to evaluate AP8 and AE8 model uncertainties. The models are often not in agreement with current flight data and SAIC and Eril Research Inc. developed empirical correction factors which can be applied to make the AP8 and AE8 model results more consistent with recent flight measurements.
This work will provide the following products:

1) A report containing AP8 and AE8 model altitude and inclination dependent correction factors, with supporting analysis documentation, based on model comparisons with various sets of satellite data (APEX, CRRES, DMSP, NOAA, LDEF, etc.). Also included will be model/model comparisons for the standard AP8 and AE8 versions, the European Space Agency versions of AP8 and AE8, and Russian trapped radiation models.

2) A report summarizing the extensive Russian and FSU ionizing radiation environment and effects measurements in LEO with assessments related to the suitability of data sets for model validation applications.

3) PC versions of the standard and European Space Agency versions of the AP8 and AE8 models with a convenient Visual Basic 6 user interface, an accurate orbit code needed for calculating trapped environments for highly elliptical orbits, and user documentation.

These products are in the final stages of completion and will be available for distribution in the near future through the SEE Program Office.



AIAA Space Technology Conference and Exposition

The AIAA Space Technology Conference and Exposition will be held at the Albuqerque Convention Center in Albuqerque, New Mexico from September 28-30th, 1999. This meeting will be a premier forum for the presentation of recent progress in space systems and technologies and planning matters affecting the future direction of the U.S. space program. It will offer a venue for researchers, system developers, and management personnel from government, industry, and academia to interact.

Originally, there were seven "Topic Areas" approved for paper submittals. Just recently, an eighth "Topic Area" was approved titled "Enabling Technologies". The SEE Program was given the opportunity to sponsor a three hour block of time in this new area. The SEE Program plans to accept this offer and the title of the block of time will probably be "Space Environments and Effects".

The original deadline for abstract submittal has passed but an extension has been granted for this new area. Please have Extended Abstracts, 3-6 pages in length, with graphics as appropriate in by February 15th, 1999 and submit to:

AFRL/VS Attn. AIAA Conference, 3550 Aberdeen Ave SE, Kirtland AFB, NM 87117-5776. Upon abstract receipt, the author(s) will be notified by mail. Abstracts will be reviewed by the Technical Program Committee. Notice of acceptance will be sent to authors no later than April 15, 1999. Please include author full name(s), author affiliation(s), address and paper title with submitted abstracts.

For more information, please visit the following web address:

http://www.aiaa.org/calendar/stce99cfp.html

Coming in Spring 1999 Issue...

- *NASA (Code SM) Changes Prompt Restructuring of SEE Program NRA Process*

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E-Mail: *belinda.hardin@msfc.nasa.gov*
Fax: (256) 544-8807

Previous issues and current information can be found by visiting our homepage at:

http://see.msfc.nasa.gov/

Miscellaneous

- High School Meteoroids and Orbital Debris Lesson Plan

http://see.msfc.nasa.gov/see/sparkman_intro.htm

SEE Program Office
Mail Stop EL23
Marshall Space Flight Center, AL 35812

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