1995121243

N95- 27664

A Materials Exposure Facility

Wayne S. Slemp and Don E. Avery
NASA Langley Research Center
Hampton, VA 23681-0001

The objective of the Materials Exposure Facility (MEF) is to provide a test bed in space for conducting long-term (> one year) materials experiments which require exposure to the low Earth orbit (LEO) space environment. The proposed MEF is planned to be an integral part of the agency's Space Environments and Effects Research Program. The facility will provide experiment trays similar to the Long Duration Exposure Facility (LDEF). Each tray location is planned to have a power and data interface and robotic installation and removal provisions. Space environmental monitoring for each side of the MEF will also be provided. Since routine access to MEF for specimen retrieval is extremely important to the materials research, Space Station Freedom (Figure 1) has been chosen as the preferred MEF carrier.

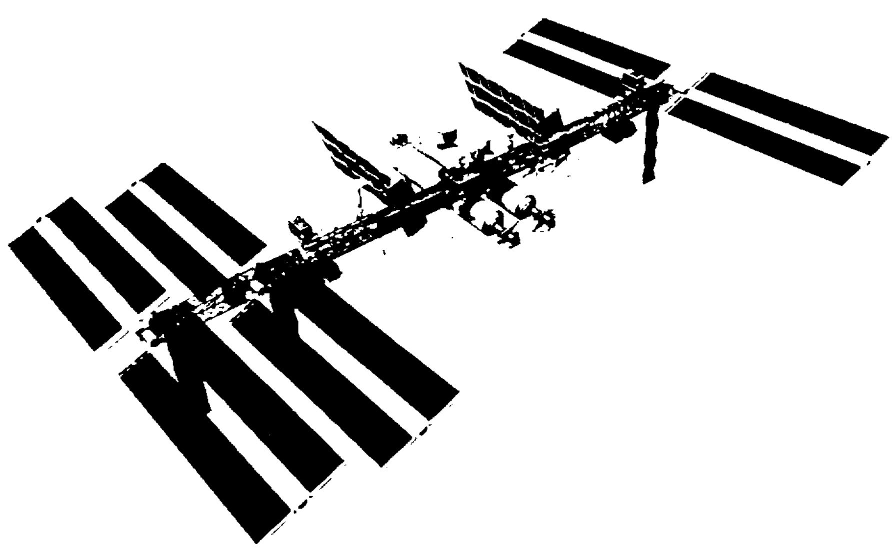

Figure 1 Space Station Freedom

The parameters in the LEO environment which affect materials are atomic oxygen, solar ultraviolet radiation, high vacuum (10^{-7} torr), electron and proton radiation, micrometeoroid and debris impacts, and orbital temperature cycling. Because of the cost and complexity of operation, it is impractical to simulate these parameters simultaneously in ground-based laboratories. Also, the lack of knowledge of the influence of each of these parameters on materials degradation, makes ground-based accelerated testing difficult to interpret.

The results of the LDEF flight experiments point out the subtle, unique differences between long-term (five-year) materials experiments and accelerated, short term (40 hours at 120 nmi altitude which equaled 1-year exposure at normal LEO operational altitude) Shuttle-based flight experiments. The Effects of Oxygen Interactions with Materials-2 (EOIM-2) flight experiment results predicted that graphite-epoxy composites would lose 0.0105 inches in thickness in the Ram fluence of LDEF, but these lost only 0.0055 inches in thickness or about 1/2 the predicted loss. In the case of fluoropolymers like FEP Teflon, the effect was reversed. The EOIM-2 data predicted only a 0.00025-inch thickness loss from the LDEF fluence of AO, but in real-time on LDEF, the actual thickness loss was over four times the predicted value. These two examples serve to illustrate the need for long-term (>1 year), real-time space exposure in conducting flight experiments for design of future long-life spacecraft.

The MEF is being proposed as the first long-term exposure facility with the capability for real-time interaction with materials exposure experiments in actual conditions of orbital space flight. To better understand the mechanisms of materials degradation in space, real-time effects must be evaluated without the annealing effects caused by exposure to Earth's atmosphere and the long delay of three to six months before evaluation due to experiment de-integration. With power and data capability available active experiments can be conducted to evaluate the physical, chemical, and optical changes in materials as these changes occur. This should provide significant insight into space environmental effects mechanisms. Since these materials will also be returned to Earth for further evaluation, additional studies of the effects this environmental change has on material properties can be conducted. This type of materials research should provide the data needed to design materials and coatings that are resistant to the LEO environment for use in the next generation of spacecraft as well as for long-term performance prediction of current materials in the LEO environment.

The current concept for the MEF is shown in figure 2 with eight experiment trays on the leading and trailing faces, four trays on each side, and two trays on the Earth facing, bottom side for a total for 26 experiment trays. The experiment trays will be 39.4 inches (1m) by 39.4 inches (1m) by 12 inches (0.3 m) in depth and designed for robotic removal and exchange. The MEF is proposed to utilize Space Station Freedom's payload attachment site P1-F6-B1&B2 (Port Truss Segment 1-Truss Face 6-Truss Bays 1 and 2) to provide nearly full Ram, Wake, and Nadir exposure.

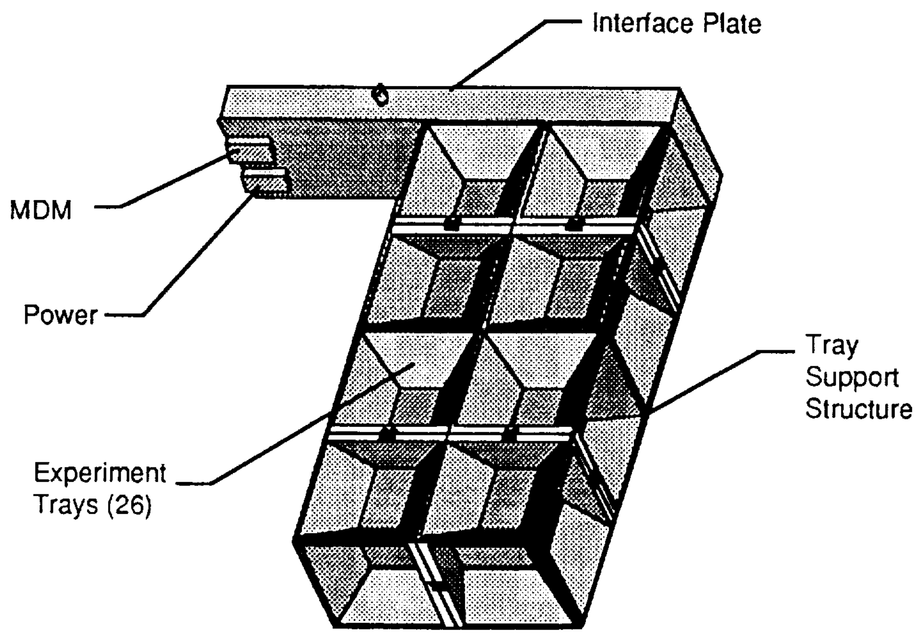

Figure 2 Materials Exposure Facility

The MEF is proposed to be launched on Utilization Flight UF-2, currently scheduled for late 1997. This facility will be fully integrated with experiments prior to launch and be robotically attached to Space Station Freedom (Figure 3) at which time power and data interfaces will be established. Change-out of individual experiments can be scheduled for intervals of six months to several years.

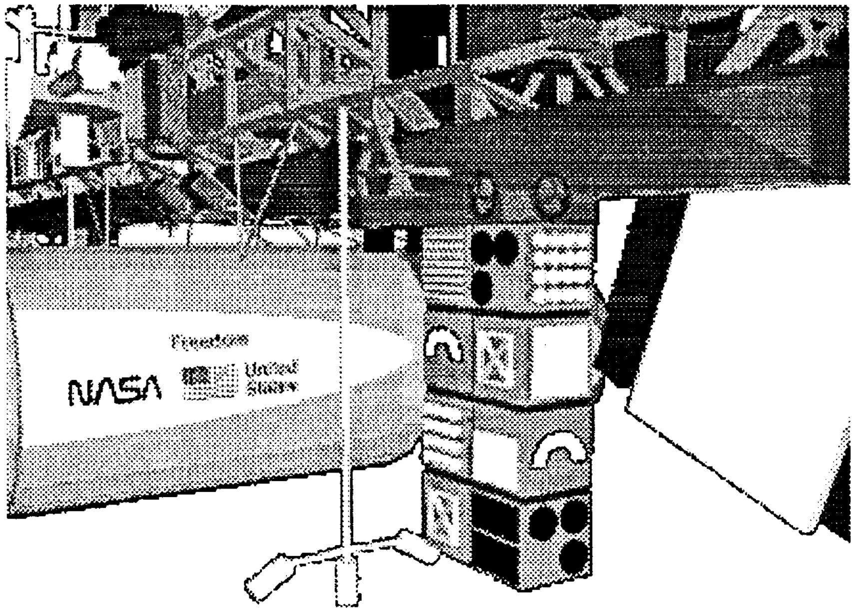

Figure 3 Space Station payload attachment site P1-F6-B1&2

Langley Research Center will design, fabricate and manage the MEF project. The electrical and data systems design teams will utilize standard Space Station Freedom developed components where possible. The project office will sponsor an MEF Announcement of Opportunity to select MEF experiments. The cost proposal includes the design, fabrication, integration through launch and initial operations but does not include experiment development funding, long-term facility operations, integration facilities, data collection facilities or data archiving.

Considerable Phase A MEF conceptual design work has been completed. However, Phase A funding is being requested to complete definition of requirements for engineering, contamination, documentation, integration, data retrieval and operations. These studies are required to develop the planning documentation needed for efficient MEF development and operation.

OTHER SPACECRAFT