INSPECTION OF THE LONG DURATION EXPOSURE FACILITY AND PLANS TO CHARACTERIZE THE DUST ENVIRONMENT IN LOW-EARTH ORBIT

LDEF Meteoroid and Debris Special Investigation Group*.

INTRODUCTION The Long Duration Exposure Facility (LDEF) was deposited at an altitude of 250 nautical miles (nm) in April of 1984, for an intended exposure of 9 months. LDEF has now been retrieved at an altitude of 175 nm, after a total exposure time of 5.7 years. While this unexpectedly long exposure has compromised a few experiments, it has greatly enhanced the scientific return from most. LDEF provides an unparalleled opportunity for characterization of the effects of exposure to the low-Earth environment.

LDEF is a totally passive, cylindrical satellite 30 feet long and 14 feet in diameter. Experiments are accommodated in 84 modular trays, for a total exposure area of 130 m^2. For comparison, Solar Maximum Satellite blankets totaled 3 m^2 and were exposed for 4 years. LDEF was exposed in a gravity-stabilized orientation, with deliberate Earth-, space-, leading-, trailing- and side-facing directions. The 57 different experiments concern basic science (dust, debris, comic rays, interstellar gas, exobiology), spacecraft materials and thermal systems, power and propulsion, and electronics and optics. One quarter of LDEF surfaces are dedicated to dust and orbital debris experiments. However, to make maximum use of LDEF the Meteoroid and Debris Special Investigation Group (M&D SIG) has been organized to permit coordinated analyses of the additional surfaces not already part of dedicated meteoroid or debris instruments. This group is also responsible for the integration of all LDEF meteoroid and debris data (from both the Principal Investigators (PIs) and M&D SIG) into a single data base.

The first purpose of the M&D SIG is elucidation of the meteoroid and debris environment in low-Earth orbit, through characterization of total flux, trajectories, chemistry, mineralogy, isotopic composition and sources. The second purpose is to assess effects of impactors on spacecraft materials through examination of crater formation, projectile penetration and secondary ejecta production, on the widely varied materials and experiment configurations on LDEF.

DOCUMENTATION OF THE IMPACT HISTORY OF ENTIRE LDEF SATELLITE

It is essential to document the entire impact record of LDEF before the component experiment trays are removed to PI laboratories, because many PI analyses will be destructive. Therefore, we will photo-document every large (>1 mm) impact feature on LDEF (trays and structure) using a binocular microscope, digitizing video images for later analysis. We expect to find a few hundred such features. We will also participate in the analysis of approximately 20 thermal protection blankets, which witnessed all pointing directions. Most of these blankets cover cosmic-ray detectors (sponsored by the Dublin Institute for Advanced Studies and the European Space Agency). We will also obtain components from several other experiment trays with desirable characteristics. The most

desirable materials that we have identified include low-density media, foils (stacked or otherwise), optical surfaces, very pure metals, identical materials facing in all directions, experiments with time-dependent mechanisms, and experiments with compartments or irregular geometries (for secondary ejecta and impactor penetration studies). This documentation will permit the population characteristics of the largest fraction of meteoroid and debris grains to be determined. We will present results of these initial inspections at the meeting.

DETAILED SCANNING AND ANALYSIS OF IMPACT FEATURES AND IMPACTORS Selected surfaces will be completely scanned at high magnification on optical scanning tables located at the Johnson Space Center (JSC), the University of Kent and Langley Research Center. These data will permit the mid size-range impactor population to be evaluated. The smallest population of impactors will be characterized by electron optical techniques at the host laboratories of several M&D SIG members and LDEF PIs. Impactor residues will be characterized by a combination of electron beam, ion probe and microparticle INAA techniques (to mention a few).

In many instances, PIs not belonging to the M&D SIG will encounter impact features on their experiment trays of potentially great interest. Where it is impossible for the M&D SIG itself to analyze such features we will mitigate the potential data loss by providing the PI with advice and analytical standards, ensuring that all meteoroid and debris data collected by any LDEF worker will be internally consistent.

DATABASE AND CURATION Meteoroid and debris data collected by PIs will be combined with M&D SIG data into a single database. This database will be maintained by personnel of the Planetary Materials Curatorial Facility at JSC, guided by experience with the Solar Max Database. This database will be available for use by researchers and engineers, and will constitute a baseline for future spacecraft design efforts. Selected impact features of particular interest will be curated at the Curatorial Facility at JSC, along with a representative selection of materials flown on LDEF, serving as a valuable future source of information on the environmental effects of space exposure.

DATA INTERPRETATION The meteoroid and debris data will be used to make flux calculations and spacecraft hazard predictions. The directional nature of LDEF will permit particle trajectories to be included in these calculations, representing a significant advance over what was obtained from all previous investigations, including those of the Solar Max thermal blankets and louvers.

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