LDEF'S SPACE EXPOSURE YIELDS HYPERVELOCITY IMPACT PENETRATION
RELATIONSHIPS  J. A. M. McDonnell, Unit for Space Sciences, University of Kent at
Canterbury, Canterbury, CT2 7NR, United Kingdom.

The space exposure of LDEF for 5.75 years, forming a host target in LEO orbit to a wide
distribution of hypervelocity particulates of varying dimensions and different impact
velocities, has yielded a multiplicity of impact features. Although the projectile parameters
are generally unknown and, in fact not identical for any two impacts on a target, the great
number of impacts provides a statistically meaningful basis for the valid comparison of the
response of different targets. Given sufficient impacts for example, a comparison of impact
features (even without knowledge of the project parameters) is possible between
(i) different material types, (for the same incident projectile distribution)
(ii) different target configurations (e.g. thick and thin targets for the same
material projectiles) and
(iii) different velocities (using LDEF's different faces.)

A comparison between different materials is presented for finite targets of Aluminium,
Teflon and Brass exposed in the same pointing direction; the maximum finite-target penetration
(ballistic limit) is also compared to that of the penetration of similar material comprising a
semi-infinite target. For comparison of impacts on similar materials at different velocities, use
is made of the pointing direction relative to LDEF's orbital motion; first, however, care must
be exercised to separate the effect of spatial flux anisotropies from those resulting from the
spacecraft velocity through a geocentrically referenced dust distribution.

Essential to the understanding of these effects is appropriate modelling of the
interception probabilities with LDEF's different faces for both orbital and interplanetary
particles(1); further, and made possible only from this modeling (2) the separation of the particulate impacts into orbital and interplanetary components can be performed, at least on a
statistical basis (3). Discrepancies in alternative approaches to the computations involved in
this modeling (3,4) have now been resolved (score: Zook 30; McDonnell 15!) and attention
can now focus on the quantitative interpretation of penetration data and flux anisotropies.

From the West and space faces, we have a particularly useful configuration with the same incident (and dominantly interplanetary) distribution, but at different velocities. For other
faces, we generally have a differing mixture of particulate sources. Data is also presented
from LDEF analyses on the following areas:

Figure 1  Sample plots comparing (a) the ballistic limit (fmax) for aluminium foils and semi-
infinite targets crater depths (Tc) (leading East faces); (b) Hole perforation diameter Dh in
aluminium foils compared to that in thick targets (Dc); (c) Depth to Diameter ratios for
aluminium clamps; the high variance at small diameters decreases for large craters.
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CRATER MORPHOLOGY. Crater depth ($T_c$) and diameter relationships ($D_c$) for thick Aluminium targets (LDEF clamps, and unperforated thick foils); crater obliquity relationships ($D_{c\max}/D_{c\min}$ for aluminium and Teflon); perforation diameter distribution for aluminium and Teflon foils.

TARGET PENETRATION COMPARISONS. (i) Aluminium, and Teflon: (Thick targets); Aluminium, Brass and Teflon: (thin targets) (iii) Aluminium and Brass: thick and thin targets. Specific examples are shown in Figure 1a, b and c. Modeling of the orbital parameters of possible terrestrial (orbital) and interplanetary (unbound) particulates yields parameters for the (mean) distribution impacting on LDEF: interplanetary particulate velocity at LDEF $=23.5$ km s$^{-1}$; approach velocity to Earth $V_\infty =20.9$ km s$^{-1}$.

LDEF impact velocity (for interplanetary components) resolved normally to surface are listed in Table 1.

<table>
<thead>
<tr>
<th>East</th>
<th>West</th>
<th>North/South</th>
<th>Space</th>
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<tbody>
<tr>
<td>$V = 21.5$</td>
<td>$V = 11.1$</td>
<td>$V = 15.7$</td>
<td>$V = 15.7$</td>
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Table 1. Mean normally resolved velocity (km s$^{-1}$) of impacting interplanetary particles incident on LDEF's faces (true pointing) for geocentric particle velocity 23.5 km s$^{-1}$.

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REFERENCES


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