Estimated Environmental Exposures for MISSE-3 and MISSE-4

Miria M. Finckenor
NASA / Marshall Space Flight Center

Dr. Gary Pippin
The Boeing Company

William H. Kinard
NASA / Langley Research Center

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MISSE-3 and -4

- Originally planned for 3 year exposure
- Changed to 1 year exposure after MISSE-1 and -2 were in space for 4 years
- Located on Quest Airlock
  - Deployed August 3, 2006
  - Retrieved August 18, 2007
- ISS in mostly LVLH XVV attitude
  (Local vertical local horizontal, X-axis in velocity vector)
Locations of MISSE-3 and MISSE-4
MISSE-3 and -4 Environmental Exposure
Low Earth Orbit Space Environment

- Atomic Oxygen
- Ultraviolet Radiation
- Particulate Radiation
- Thermal Cycling
- Vacuum
- Plasma
- Meteoroid / Space Debris Impact

Also contamination associated with proximity to an active space station
Solar UV fairly uniform (~1,695 to 1,750 ESH)
Solar UV exposure on wake side much less than ram side

655 to 790 ESH
MISSE-4 AO-UV SIDE

AO fluence

Increase

Decrease

Solar UV varied from 1,200 to 1,590 ESH

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Shadowing of MISSE
Solar UV varied from 825 to 995 ESH
ISS ram view from MISSE-1 (Similar for MISSE-3)

Representation of extent of AO beam, +/- 15° due to thermal velocity spread

MISSE-3 angled up, 30° off ram, larger fraction of unit sphere blocked by ISS
ISS wake view from MISSE-1 (Similar for MISSE-3)

MISSE-3 angled down, 30° off ram, increased view factor to Earth
ISS ram view from MISSE-2 (Similar for MISSE-4)
ISS wake view from MISSE-2 (Similar for MISSE-4)

Boeing Houston
ISS Environments Team
### Atomic Oxygen Fluences for MISSE 3 & 4

<table>
<thead>
<tr>
<th></th>
<th>Calculated (x 10^{21} atoms/cm^2)</th>
<th>Measured (x 10^{21} atoms/cm^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MISSE-3 Ram</td>
<td>1.50</td>
<td>1.2 – 1.3</td>
</tr>
<tr>
<td>MISSE-3 Wake</td>
<td>0.294</td>
<td>0.19</td>
</tr>
<tr>
<td>MISSE-4 Ram</td>
<td>1.82</td>
<td>2.06</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.14*</td>
</tr>
<tr>
<td>MISSE-4 Wake</td>
<td>0.364</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Both mass loss and thickness loss were measured.
Periodic orientation changes of ISS lowered exposure to specimens on MISSE-3 & MISSE-4

*Glenn Research Center data, courtesy of Kim de Groh and Sharon Miller*
Determination of solar UV exposure levels

MISSE-3 & MISSE-4
“Monte Carlo” model used to estimate ESH on each surface
Divided each surface into 2” x 2” areas
Model accounts for range of solar beta angles
Exposure period of ~1 year

<table>
<thead>
<tr>
<th>Nominal Exposure</th>
<th>Range of ESH (total)</th>
<th>Earth-reflected ESH</th>
</tr>
</thead>
<tbody>
<tr>
<td>MISSE-3 AO-UV</td>
<td>1700</td>
<td>120</td>
</tr>
<tr>
<td>MISSE-3 UV</td>
<td>700</td>
<td>250</td>
</tr>
<tr>
<td>MISSE-4 AO-UV</td>
<td>1200-1600</td>
<td>75</td>
</tr>
<tr>
<td>MISSE-4 UV</td>
<td>900</td>
<td>300</td>
</tr>
</tbody>
</table>

MISSE-3 & MISSE-4 solar exposure estimates do not account for shielding by the Space Shuttle
Boeing Dosimetry results from MISSE-1 through MISSE-4 are based on TLD measurements, with a variety of materials used for shielding.

Data was compared to earlier Russian experiment.

Shielding by ISS structure and Earth has significant influence on results – as more hardware has been added, the measured dose has decreased.

Loral radiation dose experiment results were presented at 2007 SAMPE Conference.
MISSE-1 through MISSE-4 TLD Readings, up to 4 yrs at ISS, Dose vs Shield Thickness

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Thermal conditions

MISSE-3 and MISSE-4 LaRC data logger measurements of temperature show thermal cycling ~-40°C to +40°C, with excursions up to +60°C.

Vacuum

10^{-6} torr or less

Plasma

ISS Plasma Contactor Units maintain floating potential between ±40 V.
Meteoroid & Space Debris Impact

Distribution of Impacts on MISSE 3 and 4

Number of Impacts

Approximate Impact Crater Diameter (mm)
Contamination

ISS assembly during MISSE-3 and MISSE-4 exposure

- STS-115  P3 / P4 Truss and Solar Array
- STS-116  P5 Truss
- STS-117  S3 / S4 Truss and Solar Array
- STS-118  S5 Truss and External Stowage Platform

Contamination on samples appeared to be minimal.

Some localized contamination was seen on baseplate.

Ceramic white thermal control coatings have solar absorptances within 0.01 of pre-flight measurements.
Contamination
MISSE-3 Wake Side - AZ93 Thermal Control Coating

![Graph showing reflectance vs wavelength with different coatings and absorptions.]
Nominal Ram-facing surfaces maximum fluence of atomic oxygen <2.2 E+21 atoms/cm².

Solar exposures ranges
~1200 to 1700 ESH on ram sides
~700 to 900 ESH on wake sides

Particulate radiation low, agrees with previous measurements at same altitude and inclination. Dose levels indicate significant increased shielding by ISS structure relative to MISSE-1 and MISSE-2.

Molecular contamination levels generally low, may be significant for certain materials.