Radiation Hardness Assurance (RHA) Guideline

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RH Definition and Consideration

RHA consists of all activities undertaken to ensure that the electronics and materials of a space system perform to their design specifications after exposure to the space environment.

The subset of interests for NEPP and the RAG, are EEE parts. It is important to register that all of these undertakings are in a feedback loop and require constant iteration and updating throughout the mission life. More detail can be found in the reference materials on applicable test data for usage on parts.

Reference Materials

Heavily Relyed Upon Documentation for RHA

- NASA Documents
  - Guidelines and Lessons Learned found on radhome
- Military Performance Specifications
  - 19590, 38510, 38534, 38535
- Military Handbooks
  - MIL-STD-750, MIL-STD-883
- DTRA Documents
- ASTM Standards By Subcommittee
  - F11, E10, E13.09
- EIA/JEDEC Test Methods and Guides
  - JESD7, JESD89, JEP133, FOTP-64
- ESA Test Methods and Guides
  - ESAC/SC No. 22900 and 25100, ESA PSS-01-609

Often Utilized Tools

- Radiation Databases
  - GSFC radhome, JPL radcentral, ESA escies
- Environment Modeling
  - SPEVOS, CREME, OMERE, NOVICE
- Radiation effects in devices/materials
  - CREME, MRED, GEANT, SRIM, MULASSIS

Drivers for a new approach and Future Considerations

Varied Missions – National Assets to CubeSats

- Risk Tolerant vs. Risk Avoidance
- Low budget, shortened schedule
- Short mission duration
- High data rates
- On board processing
- Multi-instrument dependent datasets
- Data continuity from one satellite to the next

Emerging Technologies and COTS parts usage increasing

- System on a chip solutions, COTS parts are meeting complex needs
- Highly covered performance
- 3D structures
- Complex radiation response

Description cannot cover state space

Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>TID</td>
<td>Total Ionizing Dose</td>
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<tr>
<td>SEL</td>
<td>Single Event Latchup</td>
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<tr>
<td>SEE</td>
<td>Single Event Effects</td>
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<tr>
<td>TID</td>
<td>Total Ionizing Dose</td>
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<tr>
<td>COTS</td>
<td>Commercial Off-the-Shelf</td>
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<tr>
<td>SPENVIS</td>
<td>Strategic Environmental Modeling System</td>
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<tr>
<td>CRÈME</td>
<td>Code for Radiative and Electromagnetic Environment</td>
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<tr>
<td>OMERE</td>
<td>Operational Monitoring and Radio Environment Information System</td>
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<tr>
<td>NOVICE</td>
<td>Numerical Radiative and Vector Environment Code</td>
</tr>
<tr>
<td>PDF</td>
<td>Parts Description Document</td>
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<tr>
<td>3D</td>
<td>Three Dimensions</td>
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Define the Hazard

1. Define the Radiation Requirements
2. Determine the Hazard Probability vs. Risk Tolerance
3. Design Mitigation
4. Evaluate the Design

Hazard Analysis

Evaluate the Hazard

- Probability of TID failure increase over mission life. Still plotted in ordinate.
- 3D Ray Trace can give localized dose through spacecraft shielding.

Applicable Parts Data

- (The good stuff is hard to find)
- Know your parts
- Verify your facility through adequacy in order to understand results, change the right budget based on the physics of future.
- Potentially soft parts with low TID support / displacement damage / and sensitive electronics: checking / electron risk assessments
- Heavy ions: sufficient range Appropriately:
- Gamma Rays / Neutrons / TID / appropriate dose rate
- Remain Radiation hardening of power subcircuits

Comprehend the results

Determine TID levels to be used when assessing parts. Derate power devices to be used throughout mission from instrument dependent datasets.

Documentation of the risks and available data on the part are kept with the official parts identification lists, the as designed lists, and finally the as built lists to incorporate changes in the design as it matures. Risk classification helps with trade studies on whether or not the system requirements are being met and where testing can buy down risk to the project.

Mission Timeline and Deliverables

- During the Proposal/Feasibility Phase
  - Draft Environment definition
  - Draft Hardness assurance requirement
  - Preliminary studies
- At the Preliminary Design Review (PDR)
  - Final Environment definition
  - Electronic design approach
  - Preliminary spacecraft layout for shielding analysis
  - Preliminary analysis
  - Configuration assurance requirement
- At the Critical Design Review (CDR)
  - Radiation test results
  - Final shielding analysis
  - Circuit design analysis
- After CDR
  - Remapping Radiation Of Acceptance tests
  - Approved As Built Parts List
- After Launch
  - Failure Analysis
  - Anomaly Root Cause

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