Radiation Hardness Assurance (RHA) Guideline

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RHA 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 REAG are the EE 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
- MIL-STD-1500, 38510, 38534, 38535
- Military Handbooks
- MIL-STD-750, MIL-STD-883
- DTRA Documents
- ASTM Standards By Subcommittee
- F1.11, E10.07, E13.09
- EIA/JEDEC Test Methods and Guides
- ESD07, ESD08, EJP153, FOTP-64
- ESA Test Methods and Guides
- ESA/CC No. 22900 and 25100, ESA PSS-01-609

Often Utilized Tools

- Radiation Databases
  - GSFC Radiometer, JPL radcentral, ESA esics
- Environment Modeling
  - SPENVIS, CRÉME, DOMERE, NOVICE
- Radiation effects in devices/materials
  - CRÉME, 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-interrupt 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 coveted performance
- 3D structures
- Complex radiation response
- Experimentation cannot cover state space

Acronyms

- EEE: Electronic Equipments, Layers and Modules
- FDA: Critical Design Review
- ESA: European Space Agency
- ASK: Acceptance Test
- DTRA: Defense Threat Reduction Agency
- OIPC: System Life Cycle Management
- DNA: Defense Nuclear Agency
- NASA: National Aeronautics and Space Administration
- DOD: Department of Defense
- GSE: General Support Equipment
- MEA: Mission Engineering Alliance
- NF: Not Flawed
- TID: Total Ionizing Dose
- SET: Single Event Transient
- SEGR: Single Event Gate Rupture
- SCC: Single Event Burnout
- RLAT: Relative Low Altitude Dose Rate
- H: High
- STD: Standard
- SESFI: Single Event Soft Error Fatigue
- REL: Reliability
- SSD: Single Event Displacement
- MSA: Multi-Stage Acceleration
- JET: Joint Electron Technology
- RHA: Radiation Hardness Assurance
- SEFI: Single Event Soft Error
- CEE: Critical Engineering Evaluation
- RSD: RHA Status Database
- SSC: Space Shuttle Crew
- SEU: Single Event Upset
- CP: Complementary Passivation
- TID: Total Ionizing Dose
- TR: Total Radiation
- F1: Failure
d- CDR: Critical Design Review
- LDR: Low Dose Rate
- RPM: Radiation Part Management
- DB: Data Book
- TOM: Total On-Orbit Dose
- MED: Minimally Exposed Dose
- EMP: Electromagnetic Pulse
- DEC: Decontamination

Mission Timeline and Deliverables

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