NASA Electronic Parts and Packaging (NEPP) Program
Focus, Strategic Collaborations, and Our Path to the Future

Responsive Technology Assurance for Civil Space

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### Acronyms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tbody>
<tr>
<td>AF</td>
<td>Air Force</td>
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<tr>
<td>BoK</td>
<td>Body of Knowledge</td>
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<tr>
<td>BYU</td>
<td>Brigham Young University</td>
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<td>CLT</td>
<td>Capability Leadership Team</td>
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<td>CMOS</td>
<td>Complementary Metal Oxide Semiconductor</td>
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<td>DLA</td>
<td>Defense Logistics Agency</td>
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<td>DMEA</td>
<td>Defense Microelectronics Activity</td>
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<td>DoD</td>
<td>Department of Defense</td>
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<tr>
<td>EEE</td>
<td>Electrical, Electronic, and Electromechanical</td>
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<tr>
<td>ESA</td>
<td>European Space Agency</td>
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<tr>
<td>ETW</td>
<td>Electronics Technology Workshop</td>
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<tr>
<td>FPGA</td>
<td>Field Programmable Gate Array</td>
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<tr>
<td>GaN</td>
<td>Gallium Nitride</td>
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<tr>
<td>GIDEP</td>
<td>Government Industry Data Exchange Program</td>
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<tr>
<td>GPU</td>
<td>Graphics Processing Unit</td>
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<tr>
<td>GRC</td>
<td>Glenn Research Center</td>
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<tr>
<td>GSFC</td>
<td>Goddard Space Flight Center</td>
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<tr>
<td>IC</td>
<td>Integrated Circuit(s)</td>
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<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
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<td>JPL</td>
<td>Jet Propulsion Laboratory</td>
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<td>JSC</td>
<td>Johnson Space Center</td>
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<tr>
<td>LANL</td>
<td>Los Alamos National Laboratory</td>
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<tr>
<td>LaRC</td>
<td>Langley Research Center</td>
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<tr>
<td>MAPLD</td>
<td>Military and Aerospace Programmable Logic Devices (Workshop)</td>
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### Abbreviation | Definition |
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<tbody>
<tr>
<td>MBMA</td>
<td>Model-Based Mission Assurance</td>
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<td>MRAM</td>
<td>Magnetic Random Access Memory</td>
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<td>MSFC</td>
<td>Marshall Space Flight Center</td>
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<td>NEPAG</td>
<td>NASA Electronic Parts Assurance Group</td>
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<td>NEPP</td>
<td>NASA Electronic Parts and Packaging (Program)</td>
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<tr>
<td>NESC</td>
<td>NASA Engineering and Safety Center</td>
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<td>NPD</td>
<td>NASA Policy Directive</td>
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<td>NRO</td>
<td>National Reconnaissance Office</td>
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<td>NSREC</td>
<td>Nuclear and Space Radiation Effects Conference</td>
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<td>NSWC</td>
<td>Naval Surface Warfare Center</td>
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<tr>
<td>OCE</td>
<td>(NASA) Office of the Chief Engineer</td>
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<td>OGA</td>
<td>Other Government Agency</td>
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<td>OSMA</td>
<td>(NASA) Office of Safety and Mission Assurance</td>
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<tr>
<td>POC</td>
<td>Point of Contact</td>
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<tr>
<td>RH</td>
<td>Radiation-hardened</td>
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<td>RHA</td>
<td>Radiation Hardness Assurance</td>
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<tr>
<td>SAPP</td>
<td>Space Asset Protection Program</td>
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<tr>
<td>SEE</td>
<td>Single-Event Effects</td>
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<tr>
<td>SiC</td>
<td>Silicon Carbide</td>
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<td>SMC</td>
<td>Space and Missile Systems Center</td>
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<tr>
<td>SoC</td>
<td>System on a Chip</td>
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<td>STMD</td>
<td>(NASA) Space Technology Mission Directorate</td>
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<tr>
<td>STT</td>
<td>Spin-Transfer Torque</td>
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<tr>
<td>TOR</td>
<td>Technical Operating Report</td>
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Outline

• Continued evolution of NASA Electrical, Electronic, and Electromechanical (EEE) parts management
  – EEE Parts Manager: an evolving role in the Agency
  – NEPP Program structure
  – General NASA EEE parts interfaces

• NEPP Program overview for 2019
  – What’s new in 2019?
  – Key efforts, concerns, and status

• NASA Electronics Parts Assurance Group (NEPAG)
  – Standards development

• Summary
NASA EEE Parts – Evolving Structure

• NASA EEE parts consolidation:
  – Primary Agency test and analysis activities will be at the Goddard Space Flight Center (lead Center) and the Jet Propulsion Laboratory
  – Jonathan Pellish, the Agency EEE Parts Manager, will lead

• NEPP remains virtually the same:
  – Owns the EEE parts assurance processes and related technical efforts
  – NEPP management evolution

• New NASA-wide documents activities
  – NASA Standard 8739.10, released
    • First NASA-wide EEE parts standard since MIL-STD-975 was canceled in May 1998
  – “EEE-INST-003” / NASA-STD-8739.11 unification underway

https://standards.nasa.gov/
NASA EEE Parts Manager – A Recent and Evolving Role

- Manage EEE parts workforce at the Agency level
  - Radiation effects on EEE parts are in scope, as is management of the Agency radiation facility block buy
  - GSFC is lead Center, supported by JPL
- Provide resources for Centers to acquire EEE parts workforce expertise and a forum to coordinate activities with stakeholders (e.g., OCE, OSMA, etc.) and customers
- Track the state of the Agency EEE parts workforce, including Center expertise, demand, and capacity
- Support Agency policy and technical decision-making processes
- Evolve management functions as needed
NASA EEE Parts – Interfaces

Agency EEE Parts

Assurance
- Office of Safety & Mission Assurance
  - NEPP
  - Quality
  - Reliability
  - Workmanship

Development
- Office of the Chief Engineer
  Capability Leadership
  NESC

Facilities
- Flight Projects
  Field Centers
  Mission Directorates

- Mission Support
  Space Environments
  Testing Management
  Office
NEPP Overview – Mission Statement

Provide NASA’s leadership for developing and maintaining guidance for the screening, qualification, test, and reliable use of EEE parts by NASA, in collaboration with other government agencies and industry.

Accessible & Product-Oriented

Note: the NASA Electronic Parts Assurance Group (NEPAG) is a core portion of NEPP
NEPP Program – Organization Chart*

*as of 2019-02-07

NEPP Program Executive
John Evans
NASA OSMA, HQ

NEPP Program Manager
Jonathan Pellish, GSFC
(ACTING)

NEPAG Manager
Michael Sampson / GSFC

Senior NEPAG Staff
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NEPP Deputy Program Manager
Peter Majewicz, LaRC
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Senior NEPAG Staff
(Ken Label, TBR)
Doug Sheldon, JPL

NEPP Systems Administration
Carl Szabo, GSFC/SSAI

GRC POC
Kristen Boomer

GSFC POC
Chris Green
Michael Campola

JPL POC
Doug Sheldon

JSC POC
Carlton Faller

LaRC POC
John Pandolf

MSEF POC
Jeff Martin
(ACTING)
NEPP Charter

Agency Priorities – Independent Support
- Commercial Crew
- Small Mission Reliability
- Coordination with NASA Consolidation, CLTs, NESC, STMD, SAPP, and radiation block buy
- Collaborate with DoD/DOE on space radiation test infrastructure

Technology Evaluation
- Advanced /new EEE parts/technologies
- Ex. Advanced CMOS, GaN, SiC
- Working Groups (NASA, government, aerospace)
- Screening/qualification/test/usage guidelines
- Partnering: NASA, Government Agencies, Industry, University, International

Trusted and RH Electronics
- Collaboration with NASA and other Agency Supply Chain and Trust/Counterfeit Electronics Organizations
- Support DoD efforts on Trust/Assurance (w/ NASA STMD and OGE/Space Asset Protection)
- Support DoD RH efforts

EEE Parts Infrastructure
- NEPAG Telecons and Working Groups
- SME Capabilities
- Communication and Outreach within NASA and to the greater aerospace community

Agency Leadership
- NASA Policies and Procedures
- Agency Guidelines, Body of Knowledge (BOK) documents, and Best Practices
- Coordination of Government and Industry Standards
- Audit Coordination with AF, NRO, DLA
- Partnering within NASA and other Agencies, Industry, University, and International

EEE Parts Problem Investigations
- Agency/Industry-wide problems
- GIDEP and NASA Alert development

Mission Assurance

To be presented by Jonathan Pellish at the Microelectronics Reliability and Qualification Workshop (MRQW) in El Segundo, CA, February 7, 2019.
NEPP Product Delivery

Body of Knowledge
- Technology and product status and gap analysis

Best Practices and Guidelines
- Test, usage, screening, qualification
- Radiation facility studies

NASA EEE Parts Policy and Standards

Government and Industry Standards Representation
- SAE CE11/CE12/JEDEC JC13
- Aerospace TORs

NEPP Standard Products
- Test, summary, and audit reports
- Conference and workshop presentations
- Alerts

Assurance

Unclassified / Open Access
New for NEPP in FY2019

- **Released GPU BoK** (E. Wyrwas et al.)
- **Kicked off SmallSat industrial base assessment** (major support from AF/SMC)
  - Components and systems; production and procurement
- **Increasing focus on advanced packaging**
- **Radiation Hardness Assurance**
  - Building board-level proton test guideline
  - Developing proton electronics testing best practices at medical facilities
  - Examining best practices for test planning and data collection / sharing
  - Planning to release GaN and SiC RHA testing best practices
  - Starting non-volatile FPGA and STT-MRAM radiation evaluation via interagency agreement between NASA and DoD/NSWC Crane
- **Examining opportunities for more significant integration of NEPP documentation into future community-consensus products/standards**
- **Continuing delivery of assurance products** (lots more going on here)
  - BoKs, guidelines, tools, information sharing, and training
  - Unification of NASA documentation (NEPAG)
Field Programmable Gate Arrays (FPGAs), Processors, Systems on a Chip (SOC)

- Best Practices and Guidelines
- Radiation Hardened Processor Evaluation
  - BAE RAD55XX
  - Vorago (microcontrollers)
  - Support High Performance Spacecraft Computing (HPSC)
- Graphics Processor Units (GPUs)
  - Intel, AMD, Nvidia
  - Enabling data processing
- State of the Art COTS Processors
  - Sub-32nm CMOS, FinFETs, etc
  - Samsung, Intel, AMD
  - Neural Networks
- "Space" FPGAs
  - Microsemi RTG4
  - Xilinx MPSOC+
  - ESA Brave (TBR)
  - "Trusted" FPGA (TBR)
- COTS FPGAs
  - Microsemi PolarFire
  - Xilinx Ultrascale
  - Intel Cyclone 10
  - Mitigation evaluation
  - TBD Others
- Partnering
  - Processors: Navy Crane, BAE/NRO
  - FPGAs: AF/SMC, Navy Crane SNL, LANL, BYU
  - Microsemi, Xilinx, Synopsis
  - Cubic Aerospace

Potential task areas: artificial intelligence (AI) hardware, Intel Stratix-10, Xilinx Versal

To be presented by Jonathan Pellish at the Microelectronics Reliability and Qualification Workshop (MRQW) in El Segundo, CA, February 7, 2019.
Memory Devices

New materials/architectures
- Resistive
- Fujitsu/Panasonic
- Spin transfer torque magnetoresistive
- Avalanche, Everspin
- 3-D Xpoint
- Intel, Micron
- Enabling “universal” memories

DRAMs
- DDR4 test capability
- Commercial DDR (various)
- Enabling high performance computing

Commercial Flash
- 3-D
  - Samsung, Hynix, Micron, Western Digital
  - Planar – TBD
  - Enabling data storage density

Partnering
- Navy Crane
- NASA STMD
- Avalanche
- University of Padova

Best Practices and Guidelines

Related task areas: deprocessing for single event testing (also w/processors, FPGAs,...)
Packaging

Best Practices and Guidelines

A NEPP Program task area that will see increased attention in FY19+

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Advanced Technology Evaluation Examples

Angled heavy ion tracks in 3-D NAND Flash
Micron MT29F1T08CMHB
256Gb die, MLC, 32 layers, piece-part testing
T. Wilcox et al., SEE/MAPLD 2018.

Heavy ion cross sections
GlobalFoundries 45 & 32 nm PDSOI, 22 FDSOI
Static Random Access Memories (SRAMs)
M. Casey et al., IEEE NSREC 2018.
Collaboration with DMEA, Sandia, and GlobalFoundries

400 W cooling on bare NVIDIA GTX 1050
E. Wyrwas, 2018 NEPP GPU BOK.

Pace of technology evolution and growth of evaluation requirements continue to generate new demands:
1) diversified subject matter expertise; 2) more access to a wider variety of radiation test facilities
NASA Bolsters SmallSat Science Programs

NASA SMD 06-Aug-2018: SmallSats are the focus of a new initiative that’ll grant $100M/yr to targeted science, tech developments & educational opportunities to enrich the already impressive NASA science SmallSat mission portfolio.
Evolving Landscape for SmallSat Assurance Support

Multiple Collaborations
- Academia
- Industry
- OGAs

Accessibility

Continued focus on Model-Based Mission Assurance (MBMA)

Product Delivery

Linking Program Tasks to Community Focus Areas / Needs

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NEPP Program / NEPAG Standards & Policy Development

• Released NASA-STD-8739.10
  – NASA EEE Parts Assurance Standard

• Updating EEE-INST-002
  – Instructions for EEE Parts Selection, Screening, Qualification, and Derating
  – Will become new Agency standard, NASA-STD-8739.11
  – Goal is to modernize and synthesize existing Agency documents
  – Ongoing throughout FY19

• Updating NPR-8705.4
  – Risk Classification for NASA Payloads
  – Appendix C – Recommended SMA-Related Program Requirements for NASA Class A-D Payloads
  – Goal for EEE Parts is a mapping that recommends parts with respect to payload class (A-D), mission criticality (critical/noncritical) and part grade level (space, military, industrial, COTS, etc.)

NASA Technical Standards: https://standards.nasa.gov/
As Always, Partnering is Essential

• Within:
  – NASA

• With:
  – Academia
  – Government agencies
    • Ex.: Strategic Radiation-Hardened Electronics Council Working Groups
      – Test & Evaluation (member)
      – Workforce Development (lead)
  – Industry
  – International
10th Annual NEPP Electronics Technology Workshop (ETW)

Scheduled dates:
June 17-20, 2019
NASA/GSFC and on-line

https://nepp.nasa.gov/

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