NEPAG Developments to Improve Component Engineering & Reliability for Space

Components for Military & Space Electronics Conference

February 8 – 11, 2010

Shri Agarwal
Jet Propulsion Laboratory, California Institute of Technology

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

Agenda

- The Space Business
- Communication with Peers
- NEPAG
- Improving Component Engineering
- Reliability for Space
- Summary

NEPAG

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

July 20, 2009: 40th anniversary of the man's landing on the moon

"The exploration of space will go ahead, whether we join it or not, and it is one of the greatest adventures of all time, and no nation which expects to be the leader of other nations can expect to stay behind in this race for space…

We set sail on this new sea because there is new knowledge to be gained and new rights to be won, and they must be won and used for all people…

We choose to go to the moon. *We choose to go to the moon* in this decade *and do the other things*, not because they are easy, but *because they are hard*, because the goal will serve to organize and measure the best of our energies and skills…"

President John F. Kennedy
Address at Rice University on the Nation's Space Effort
September 12, 1962

Not for Public Release or Redistribution. This document has been reviewed for export control and it does NOT contain controlled technical data.

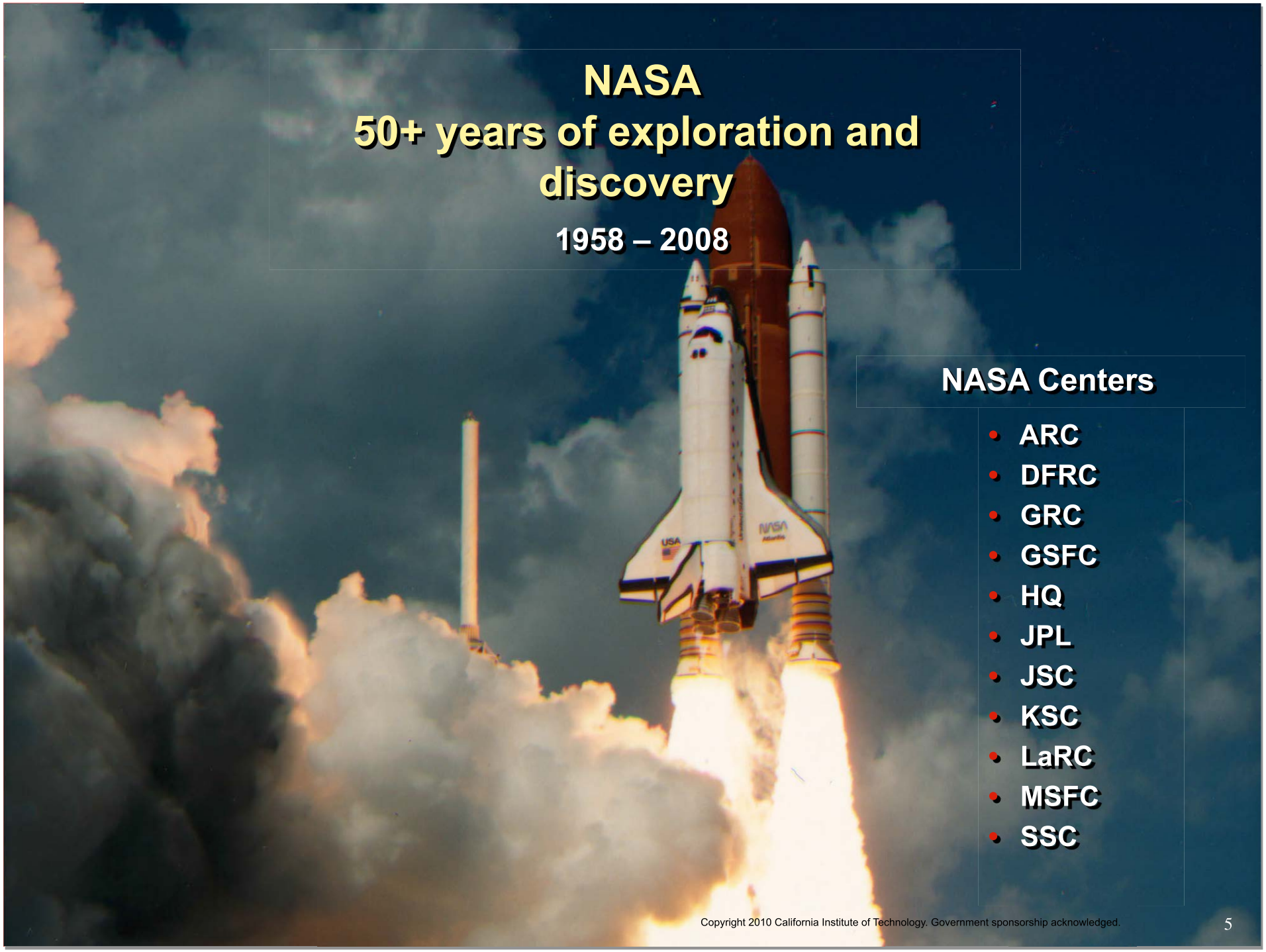
Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

We choose to go to the moon and do other things because they are hard…

- From the outset, our leaders knew that the Space exploration was not going to be easy, it was not for the faint-hearted
- Space presents an unforgiving, harsh environment
- Deep space missions are Non-repairable; can't send a repairman up there
- MARS at night gets very cold
- To cap it all, the money is getting tight
- In spite of hurdles, the space community has done a lot: notable successes of Voyagers, Galileo, Cassini, Hubble, the rovers, and other missions
- Space community must continue to work together to face these challenges
- Together, we shall continue to unravel the mysteries of the Universe

NEPAG

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.



NASA
50+ years of exploration and discovery

1958 – 2008

NASA Centers

- ARC
- DFRC
- GRC
- GSFC
- HQ
- JPL
- JSC
- KSC
- LaRC
- MSFC
- SSC

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

Jet Propulsion Laboratory (JPL)

www.jpl.nasa.gov

- Government (mainly NASA)-funded unit of the California Institute of Technology (www.caltech.edu)
- Charter: Un-manned (robotic) missions

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

NASA/JPL Mission – Mars Rovers

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

Berlin Wall Address

Arriving in Berlin on June 12, 1987, President and Mrs. Reagan were taken to the Reichstag, where they viewed the wall from a balcony. Reagan then made his speech at the Brandenburg Gate at 2 PM. About 45,000 people were in attendance. That afternoon, President Reagan said,

"We welcome change and openness; for we believe that freedom and security go together, that the advance of human liberty can only strengthen the cause of world peace. There is one sign that the Soviets can make that would be unmistakable, that would advance dramatically the cause of freedom and peace. General Secretary Gorbachev, if you seek peace, if you seek prosperity for the Soviet Union and Eastern Europe, if you seek liberalization: Come here to this gate! Mr. Gorbachev, open this gate! Mr. Gorbachev,

tear down this wall!"

NEPAG

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

Tear down this wall…

- For the Space community to come together, the walls that inhibited communication HAD TO COME DOWN!
- That's exactly what three parts engineers working at three different NASA centers did.
- They started communicating with each other on a regular basis. Other centers joined them, other domestic space agencies started to participate, international agencies joined in, and thus **NEPAG** was born!

NEPAG

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

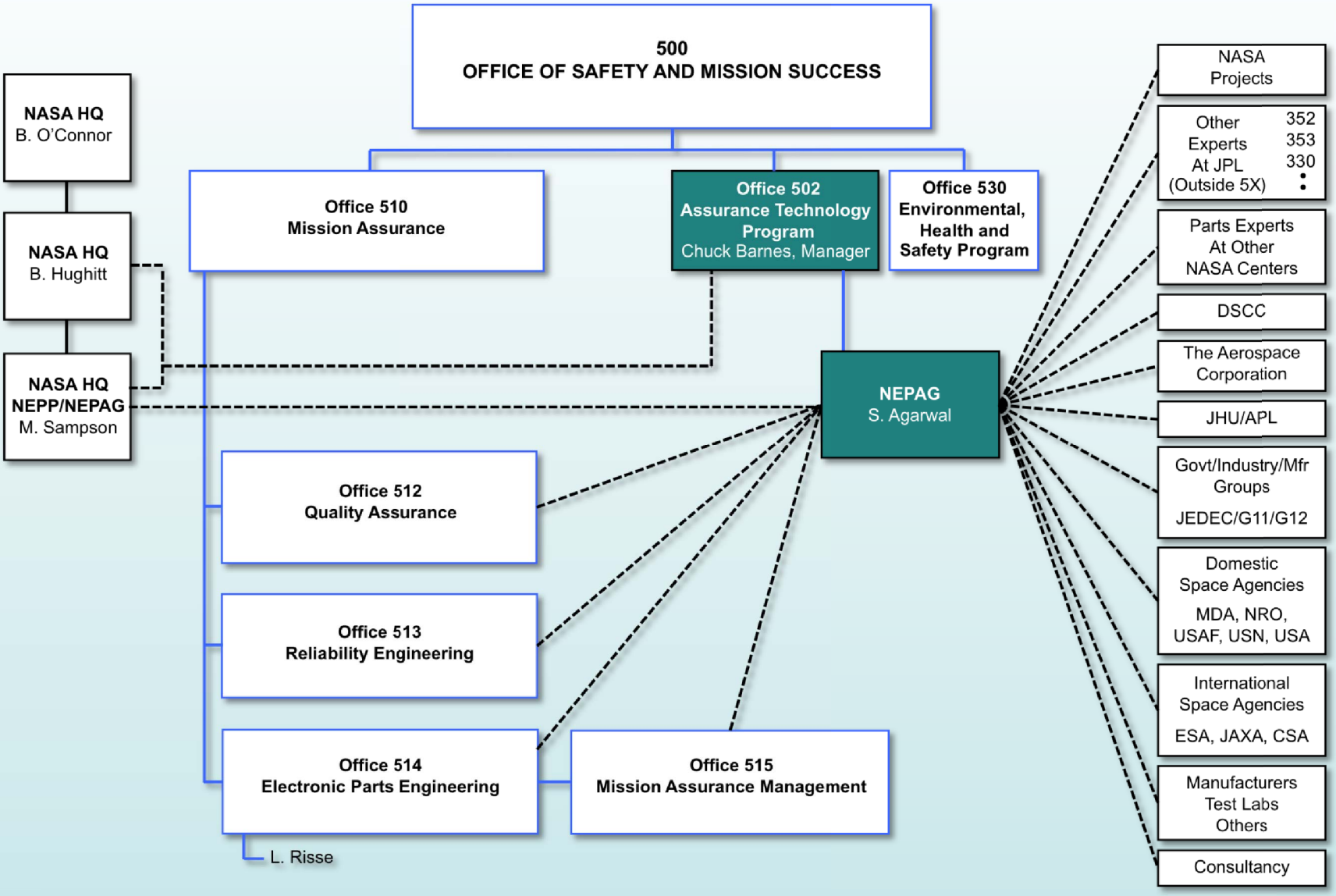
What is NEPAG?

- NEPAG is the acronym for NASA EEE (Electrical, Electronic, Electro-mechanical) Parts Assurance Group.
- It is a forum for the exchange of information on EEE parts across NASA (OneNASA) and the world-wide space community (OneSpace).
- Our Charter is to exchange EEE Parts information of mutual interest on the subjects of quality, reliability, radiation, availability, and technology used in space flight. We also, through consensus, control the necessary industry specifications, coordinate Military Specifications, create tools for estimating microelectronic part risk, mitigate vendor issues, resolve on-going problems, and support DSCC (Defense Supply Center Columbus) audits to ensure reliable hardware.

NEPAG

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

JPL NEPAG Communication



NEPAG

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

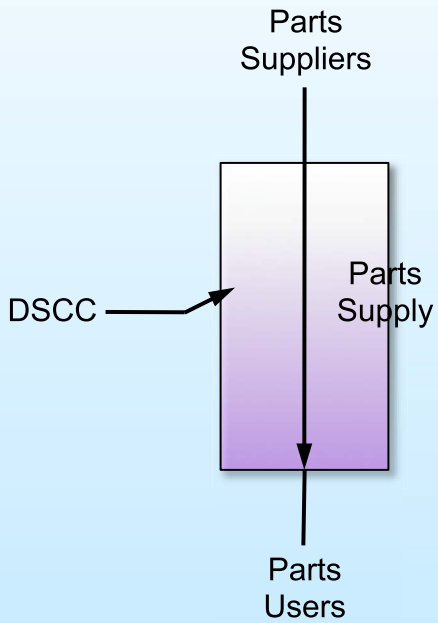
Electronic Parts for Deep Space Missions
Some Considerations

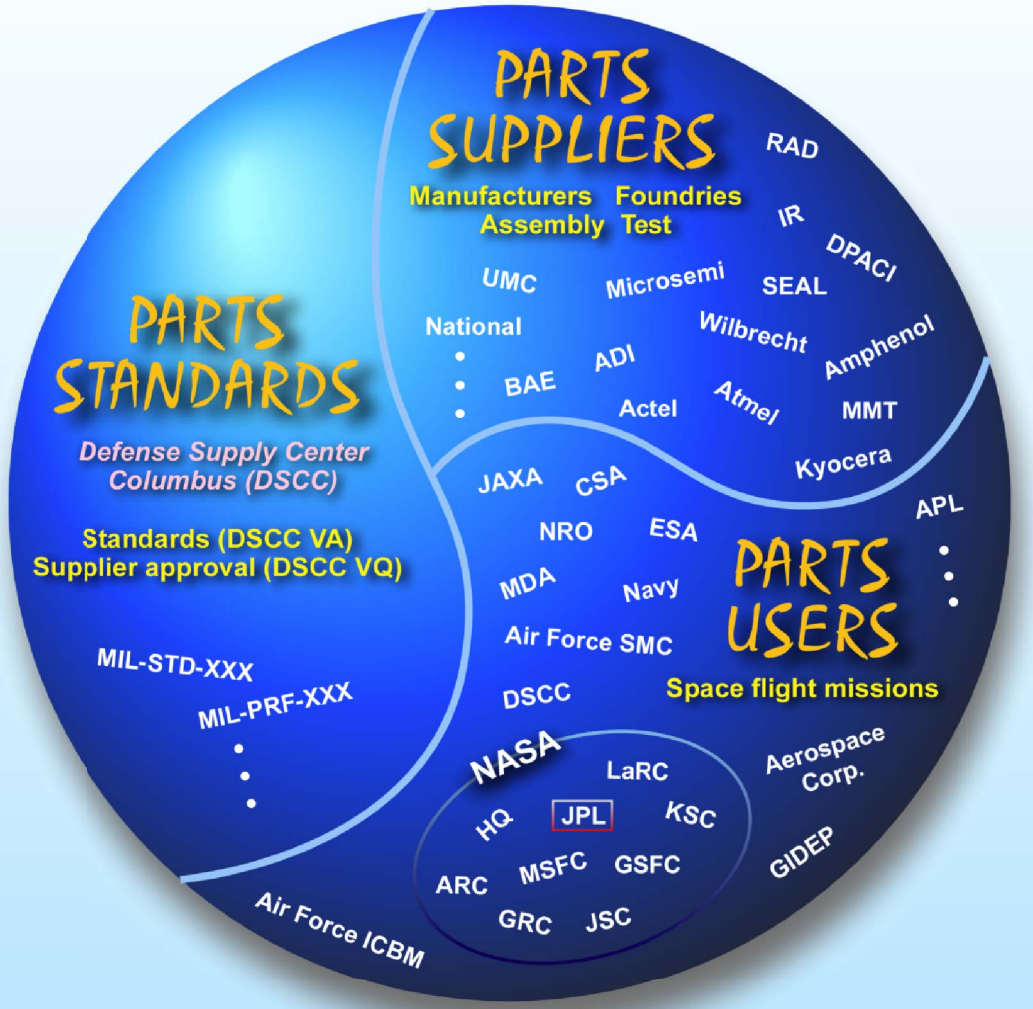
- Strive to save power; design-in low power parts
- Operate in space radiation environment; consider the effects of radiation
- Mission reliability; worse case analysis, derating
- Small, light weight packages; use light weight hardware
- Functional integration; use parts that offer higher functionality
  - An integrated approach is needed; Parts, Packaging, Fabrication must come together to adequately address procurement, screening, qualification, workmanship, etc.
- Adapt new technology for military systems
  - Update MIL-PRF-38535, Appendix H to address new technology evaluation
  - Create new Classes of Space products to adequately address new technology, e.g., Class Y proposed for MIL-PRF-38535 non-hermetic Space products

NEPAG

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

Space Parts World



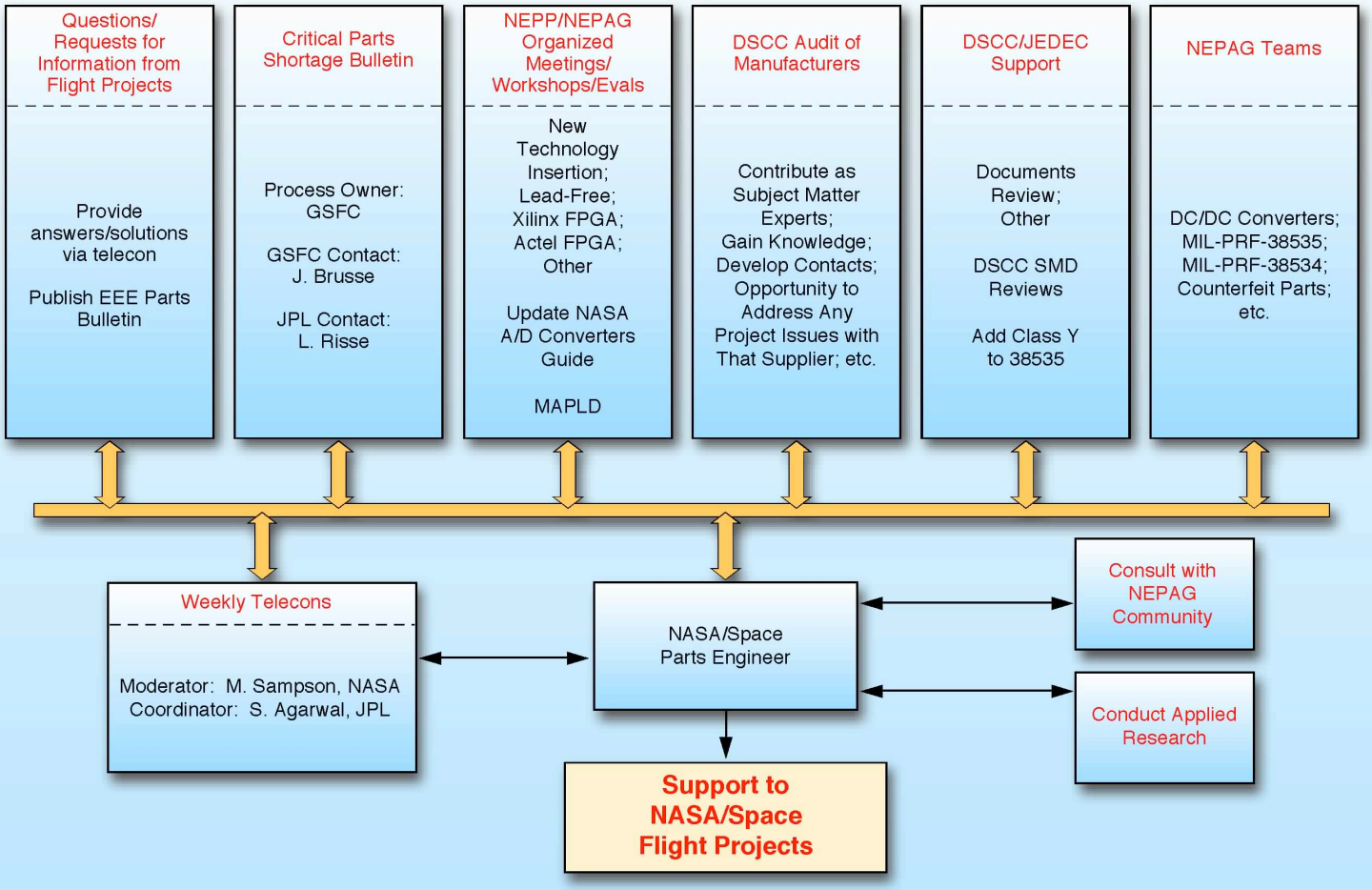


NEPAG brings the world together – parts users and standards organizations join hands to ensure timely delivery of reliable parts from suppliers.

NEPAG

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

NEPAG Activities



NEPAG

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

Improving Component Engineering Discipline

- NEPAG telecons
  - Domestic (weekly) and international (monthly)
  - No. of participants: 45 (domestic), 30 (international)
  - Instant peer review of parts issues – open discussion
- DSCC Supplier audits
  - Parts specialists from NASA , the Aerospace Corp, and other Space organizations participate in DSCC audits. The number of attendees is usually limited.
  - The specialists
    - contribute as subject matter experts
    - gain knowledge
    - make valuable contacts
  - The audits provide an opportunity to address any flight project issues with that supplier

NEPAG

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

Improving Component Engineering Discipline (Contd.)

- Review of Pre-released and Final Documents, and Data
  - Specialists review
    - DSCC drawings and provide comments.
    - new technology evaluation data
    - product qualification data
    - preliminary and final versions of documents written by various task groups
- EEE Parts Bulletins published monthly have articles written by parts specialists
- NEPAG sponsored Parts User Group (PUG) meetings are led by the specialists

NEPAG

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

Improving Reliability for Space

- MIL-PRF-38535 Revision
  - Extensive NEPAG comments were used to update MIL-PRF-38535.
  - DSCC, manufacturers and NEPAG are working to update MIL-PRF-38535, Appendix H. It will require manufacturers to evaluate their own new technology to set activation energies for potential failure mechanisms.
  - A new class of microcircuits (class Y) is being proposed to address non-hermetic space products, such as the Xilinx Virtex-4 FPGAs.
- MIL-PRF-38534 Revision (Hybrids)
  - Extensive comments were made by the NEPAG community. Being worked.
- MIL-STD-981 Revision (Magnetics)
  - Extensive comments were made by MSFC.
  - DSCC setting up a meeting in Feb, 2010 to discuss updates.

NEPAG

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

Improving Reliability for Space (Contd.)

- Telecons
  - Weekly NEPAG domestic (GSFC/JPL)
  - Monthly NEPAG international (GSFC/JPL)
  - Monthly DC/DC Converter (LaRC)
  - Other subject matter specific telecons, as needed
    - CHLD (MSFC)
- Counterfeit Parts
  - Supported G12 effort
  - Supported NASA/SAE effort
  - Review GIDEP advisories on telecons
- Diodes Availability
  - Timely delivery of Microsemi diodes was a big problem.
  - In FY10, DSCC, with NEPAG support, is moving aggressively to get more sources certified/qualified.
- Rad Hard MOSFETs
  - Addressed MOSFET availability issues
  - Worked with DSCC and manufacturers to better define SOA curves in the slash sheets

NEPAG

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

Improving Reliability for Space (Contd.)

- Single die hybrids/multi-die monolithics
  - Hybrid manufacturers building Class H and K hybrids with single microcircuit die.
    - Current status: One of the major hybrid suppliers has requested DSCC for QMLV certification, so that they can start offering single die parts as QMLV or Q
  - Microcircuit manufacturers use capacitors next to the die inside package
    - Current status: DSCC has initiated an EP (Engineering Practice) study to address the screening, qualification and workmanship
- NESC Sponsored Tasks
  - Connectors evaluation.
  - Low voltage capacitors evaluation
- Walk-in project issues
  - Critical parts shortage.
  - Queries added as Topics on NEPAG Telecons

NEPAG

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

Improving Reliability for Space (Contd.)

- Enhancements made to DSCC Microcircuits Audits
  - Added counterfeit parts mitigation, electrical test program review, self audit, optimization, burn-in circuit review
    - On a recent audit, NEPAG wrote a testing related deficiency action report (DAR). That will affect 99 SMD drawings.
- DSCC Audits
  - The participation on DSCC audits is decided on the telecons.
  - On completion of each audit, the auditors report their findings to the NEPAG community.
  - A high level summarized version of NASA audit report is inputted into the SAS data base maintained at JSC.
- Military Drawings Reviews
  - Some of the findings include:
    - Use of passives with undefined requirements for their screening/qual
    - Ambiguous test conditions
    - No post Group C tri-temp testing called out

NEPAG

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

Improving Reliability for Space (Contd.)

- Technical Bulletins
  - EEE (Electrical, Electronic, Electro-mechanical) Parts Bulletins
  - Provides a quick update on topics of immediate interest
  - Published monthly
- Technical Meetings (NEPP/NEPAG)
  - Sponsored PUG Meeting at JPL
  - Organized MAPLD at GSFC
  - Sponsored/Participated in NSREC, NVMS, MRQW, SEE Symposium, and others
- JEDEC/G11/G12
  - Attended/participated in meetings (3 times/yr)
  - Reviewed documents
  - Sponsored specialists to the meetings

NEPAG

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

Summary

- NEPAG is like a big component engineering group representing the world wide space community.
- Together, we are continuing to work towards improving the quality of EEE parts used on space flight hardware.

NEPAG

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

Watch for Advertisement Violations

From EEE Parts Bulletin (Nov-Dec 2009):

Microcircuits, FPGAs: Is it really 'V' Level (Space grade)?

There have been a few cases in which microcircuit manufacturers, including FPGA manufacturers, claimed their products have been screened and qualified as V-level products based on the MIL-PRF-38535 standard without DSCC approval. These manufacturers have not been certified for QMLV products, but they are advertising their products as such. DSCC has been informed of such cases, and corrective action is being taken to remedy the situation. There have been instances where a non-space grade product was designed in based on the manufacturer's claim that It was a QMLV product. Projects should check the latest status of approved V-level manufacturers by contacting Ramin Roosta at 818-354-7385.

NEPAG

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

EEE Parts Bulletins

National Aeronautics and Space Administration

EEE Parts Bulletin

Electrical, Electronic, and Electromechanical

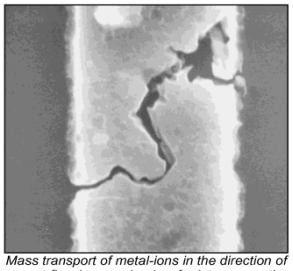
A periodic newsletter of the JPL/OSMS Assurance Technology Program Office (ATPO), NASA EEE Parts Assurance Group (NEPAG), and Section 514, of the Jet Propulsion Laboratory.

September 2009 • Volume 1 • Issue 4

Plant Closings and Relocations – Minimizing Impact

A working group will convene to formulate requirements military and space part manufacturers must follow when closing or relocating a plant. The rules would ideally minimize critical parts shortages recently experienced with diodes. Contact: Shri Agarwal 818-394-5598.

A Look at Failure: Electro-Migration



Mass transport of metal-ions in the direction of current flow is a mechanism for interconnection failure. Failure results from the flux divergence of the migrating ions and is accelerated by current density and temperature.

Surge Current Testing: Tantalum Capacitors

Test methods in MIL-PRF specifications, such as MIL-PRF-55365 and 39003, for tantalum capacitors do not specifically state whether capacitors can be surge current tested in parallel or individually. Some manufacturer technical reports show testing the capacitors in parallel can result in much higher stresses to parts closest to the power supply or capacitor bank. For more details, contact Ray Smith 818-393-7547.

Using Non-Mil Capacitors in Critical Applications

It is tempting to choose non-MIL capacitors for applications requiring small package size, higher capacitance or higher voltage, cautions Mike Sampson, GSFC. Caution is urged as these parameters can compromise part performance. Any non-MIL capacitor should be thoroughly qualified, including life testing, DPA, voltage temperature coefficient testing, and full electrical including hot insulation resistance. Only a small number of factors in the basic capacitor equation: C = KA/t can be varied. Increasing the dielectric constant K, is an obvious way to increase C, but high K dielectrics can be less reliable over time and less stable over temperature. Increasing active area A, without increasing the chip footprint means reducing edge margins, which increases the risk of voltage breakdown failures. Reducing dielectric thickness t, risks dielectric breakdown. The result is usually a compromise, using the highest K that meets the temperature coefficient (temperature, voltage coefficient for MIL parts) with the narrowest margins that can withstand the voltage breakdown requirements and the thinnest dielectric that can pass life test. Commercial manufacturers are not constrained to follow MIL type testing. The MIL life test is for 2,000 hrs at 2X rated voltage. The commercial manufacturer can do 1000 hrs at 1.5X once a year or less if they choose. Life test indicates the robust nature of the parts, but it does not provide reliability or failure rate information. For details contact Mike Sampson 301-614-6233.

Test Data on JANS Parts

Thermal impedance data for JANS diodes may not be included in data packs unless specifically requested on the purchase order to the manufacturer. For details contact Ed Powell 818-354-3188.

Counterfeit Parts – New Blacktopping Material in Use

A semiconductor distributor recently found two instances of suspect counterfeit parts that use a new blacktopping material designed to evade detection. The substance passes visual inspection and is immune to acetone—so many quality control technicians might not suspect the part is counterfeit. Parts were bought from brokers. A GIDEP advisory will be issued. Contact Phil Zulueta 818-354-1566.

Remarking of Parts

A recent procurement of a commercial microcircuit by a broker from an authorized distributor revealed the parts were remarked by the manufacturer to a lower grade part number. The manufacturer acknowledged that this is their practice when a part fails a higher specification but still meets a lower level spec. Notification would be helpful when parts are remarked. Military/Aerospace QML microcircuits may be remarked when properly documented and MIL-PRF-38535, para. A.3.6.13, requirements are met. Remarking semiconductors is also permitted and must meet MIL-PRF-19500 requirements when a higher-product-assurance-level part is substituted for a lower-assurance-level part (see para. 1.3.8). There are no regulations for remarking commercial microcircuits. Contact Lori Risse 818-354-5131.

Recent DSCC Audits supported for NASA by JPL Specialists

BAE Systems; Pacific Aerospace & Electronics; International Rectifier (Santa Clara); and Kyocera America Inc.

GIDEP 6E-P-09-01 Suspect Counterfeit: Leaded Small Signal Transistor

Parts marked JANTX2N2920 with date code 0309 purchased from an unauthorized source are suspected to be counterfeit. Contact: Ed Powell 818-354-3188.

GIDEP C7E-A-09-01 Suspect Counterfeit: Microcircuit, 32Kx8 nvSRAM

Parts marked STK14C88-N351 date code 0307 purchased from an unauthorized source are suspected to be counterfeit. Contact: Ramin Roosta 818-354-7385.

Upcoming Meetings:

- Military and Aerospace Programmable Logic Devices Aug. 31-Sept. 3 http://nepp.nasa.gov/mapld_2009
- JEDEC Joint Electron Devices Engineering Council JC-13 Meeting, Columbus, OH Sept. 21 - 24 http://www.jedec.org/default.cfm

Contacts

NEPAG
http://atpo.jpl.nasa.gov/nepag/index.html
Shri Agarwal 818-354-5598
Shri.g.agarwal@jpl.nasa.gov
Lori Risse 818-354-5131
Lori.a.risse@jpl.nasa.gov

ATPO http://atpo.jpl.nasa.gov
Chuck Barnes 818-354-4467
Charles.e.barnes@jpl.nasa.gov

Section 514 http://parts.jpl.nasa.gov
Rob Menke 818-393-7780 Robert.j.menke@jpl.nasa.gov

Previous Issues:
http://atpo/nepag/index.html

www.nasa.gov

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

© 2009 California Institute of Technology. Government sponsorship acknowledged.

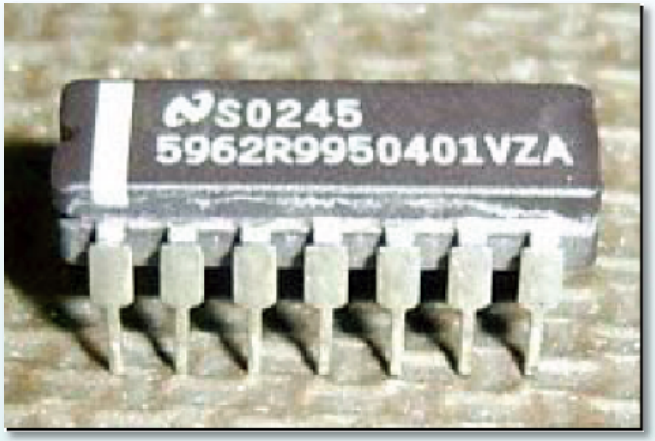
A project engineer wrote, “Thanks, important EEE parts issues in a Bulletin format is a wonderful sight to see. Great information!”

B. Hughitt wrote that the JPL/NEPAG EEE Parts bulletins are outstanding. He asked that they be distributed to all QLF (Quality Leadership Forum) members.

NEPAG

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

Counterfeit Parts Awareness



Space Level LM124 100 KRad in gull wing package.
The "Z" in the part number indicates "gull wing" shaped leads. During receiving inspection, the part was found to be side brazed dip, not gull wing. The marks are not of the original manufacturer's date code. The assembly identification code is incorrect. Also, the parts were not serialized.

Counterfeit parts have been a hot topic on NEPAG telecons.
To bring awareness of this issue to the Mil/ Arospace community, one of the NEPAG partner agencies made a presentation at one of the JEDEC meeting.
Mike Sampson brought it up in his presentation at the NASA QLF Forum.
Shri Agarwal issued an internal JPL email and made recommendations on JPL procured items.
Supported SAE team, G-12 task. Monitoring NROA Enterprise Counterfeit Analysis Center (ECAC) effort.
Lastly, JPL has a Counterfeit Parts Working Group, chaired by Phil Zulueta.

NEPAG

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.

NEPAG – OneSpace Community

Copyright 2010 California Institute of Technology. Government sponsorship acknowledged.