

NASA Electrical, Electronic, Electromechanical, Electro- Optical (EEEE) Parts Selection Process

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Acronyms

AEC	Automotive Electronic Council	MDA	Missile Defense Agency
CAPSTONE	Cislunar Autonomous Positioning System Technology Operations and Navigation Experiment	MEAL	Mission, Environment, Application, and Lifetime
COTS	Commercial Off the Shelf	MIL-HDBK	Military Handbook
DLA	Defense Logistics Agency	MIL-SPEC	Military Specification
DPA	Destructive Physical Analysis	MSFC	Marshall Space Flight Center
DPPM	Defective parts per million	NASA	National Aeronautics and Space Administration
ECP	Established COTS Part	NEPP	NASA Electronic Parts and Packaging (Program)
ECPL	Established COTS Parts List	NPR	NASA Procedural Requirement
EEE	Electrical, Electronic, and Electromechanical	NSWC	Naval Surface Warfare Center
EEEE	Electrical, Electronic, Electromechanical, and Electro-optical parts	PA Lab	Parts Analysis Lab
ELDRS	Enhanced Low Dose Rate Sensitivity	Pb	Lead
ESDMD	Exploration Systems Development Mission Directorate	PEAL	Parts Evaluation and Analysis Lab
FBC	Faster, Better, Cheaper	PEM	Plastic Encapsulated Microcircuit
FIT	Failures in time	PIND	Particle Impact Noise Detection
FY	Fiscal Year	PMIC	power management integrated circuits
GRC	Glenn Research Center	PPAP	Production Part Approval Process
GSFC	Goddard Space Flight Center	QML	Qualified Manufacturers List
IC	Integrated Circuit	QPL	Qualified Products List
ILPM	Industry Leading Parts Manufacturer	RHA	Radiation Hardness Assurance
JAN	Joint Army-Navy		Restrictions on the use Of certain Hazardous Substances
JPL	Jet Propulsion Laboratory	RoHS	
JWST	James Webb Space Telescope	SMD	Standard Microcircuit Drawing
LaRC	Langley Research Center	STD	Standard
LAT	Lot Acceptance Testing	TM	Test Method
		USA	United States of America
		USAF-SD	United States Air Force-South Dakota

Purpose

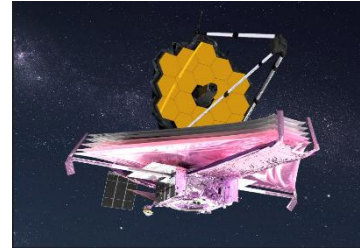
- NASA flies hardware built from Electrical, Electronic, Electromechanical, Electro-Optical (EEEE), and has a history going back over 50 years in parts selection.
- The parts selection process evolved with changes in the electronics industry, from partnering with other government agencies to establish some of the first US MIL specifications (1960s/1970s), then leveraging MIL specifications to selectively adding space level requirements, to more recent consideration of commercial/alternate grade parts where appropriate.
- This talk will provide the current approach at NASA for EEEE parts selection, based on NASA-STD-8739.10, EEE-INST-002, and the upcoming NASA-[TBD]-8739.11



1958 January: Drs. Pickering, van Allen and von Braun.

USA launch and deployment of Explorer 1

After a series of failures



December 2021:

One of the most complex NASA missions
James Webb Space Telescope (JWST)

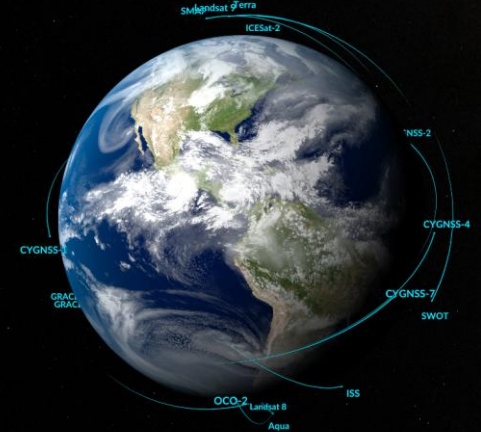
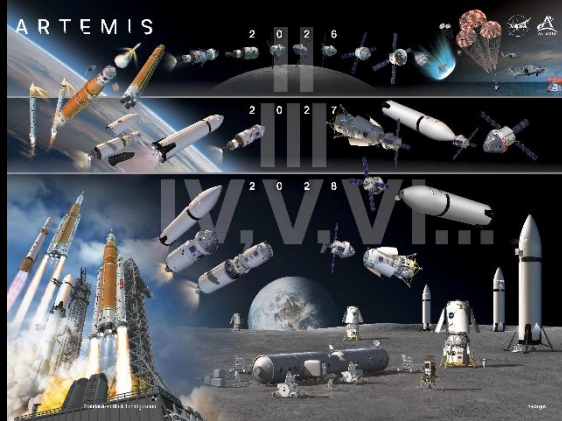
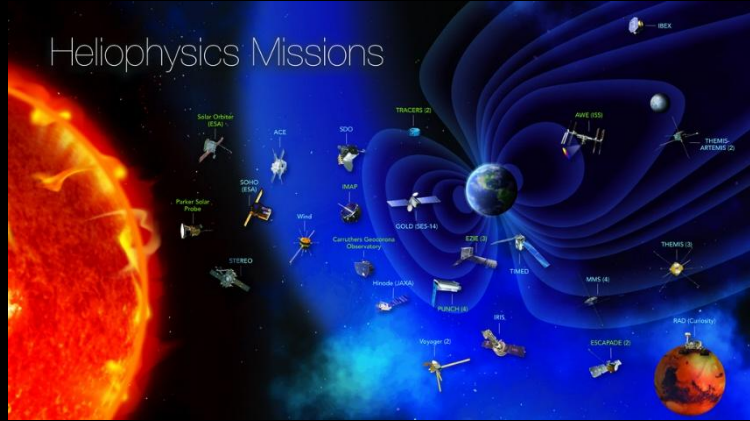
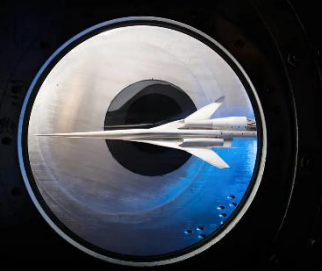
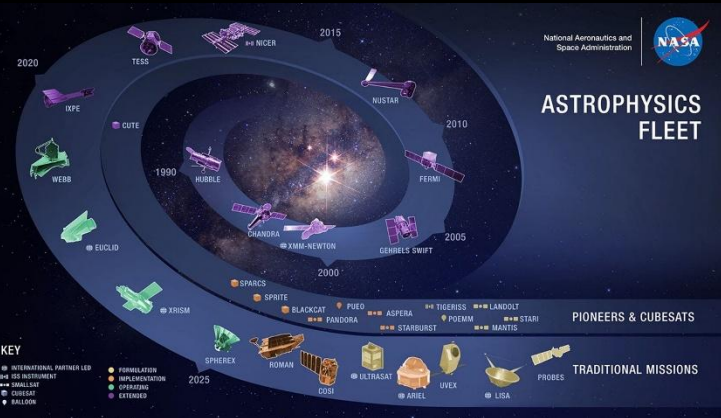


Early 2028:

Artemis IV
Humanity's return to the lunar surface

Outline

- **NASA's missions**
- **A bit of history of EEE(E) parts at NASA**
- **NASA Documents for Parts Selection**
- **Going Forward: EEEE Part Options**



Images: NASA

A Bit of History of EEE(E) Parts at NASA

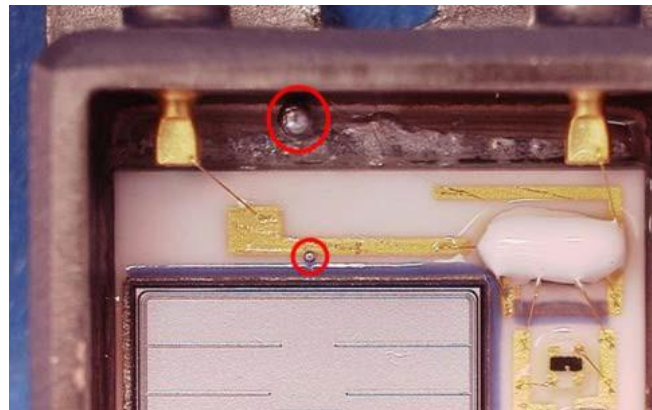
The 1960s

The First Specifications & Products Specifically for Spaceflight Use

- 1962: NASA MSFC developed the 85MO microcircuit requirements
- 1962: Preferred Parts Lists PPL-100 (MSFC), PPL-1 (GSFC)
- 1968: NASA developed MIL-STD-976
 - Certification Requirements for JAN (Joint Army-Navy) Microcircuits
- 1968: MIL-STD-883 Test Method Standard for Microcircuits
- 1969: MIL-M-38510 (microcircuits)
 - Established Class Levels A and B.
 - NASA MSFC certified the first compliant lines
- 1969: MSFC published the first visual inspection std for transistors and diodes
- 1969: MIL-STD-883 test method 2018 Particle Impact Noise Detection (PIND)
 - Solder balls were a serious threat in the early days

Application specific features

Electricals and environmental from -55°C to 125°C or wider	
Hermetic packaging	Resistance to flammability and outgassing
Strict visual inspection	High vibration and shock levels
Conservative derating	Radiation tolerance



Solder Balls

NASA GSFC PA Lab Report J12121

The 1970s

EEE Parts Standardization for Space Begins

- **1970:** MSFC promoted development of the tantalum cased wet slug capacitor, CLR79, to replace the silver-cased CLR65, which tended to short circuit
- **1970:** MIL-STD-883 TM 2020 for scanning electron microscope (SEM) inspection
- **1970:** JPL Preferred Parts List published
- **1972:** NASA hybrid line certification program was established
- **1972:** Class S* was added to MIL-S-19500 (Discrete Semiconductors)
- **1973:** USAF-SD published MIL-M-0038510 for Class S* microcircuits
- **1975:** Class A in MIL-M-38510 was changed to Class S* so USAF-SD could cancel M0038510
- **1976:** MIL-STD-975, the NASA Standard Parts List was published
- **1978:** Novel test methods were developed to reduce the risk of low voltage failures in plastic film capacitors
- **1978:** MIL-HDBK-978, NASA Parts Application Handbook was published, in five volumes

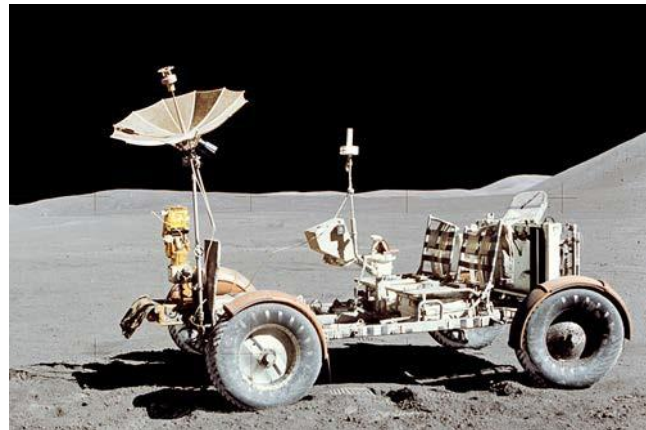


Image credit: NASA

*Class S indicates space grade

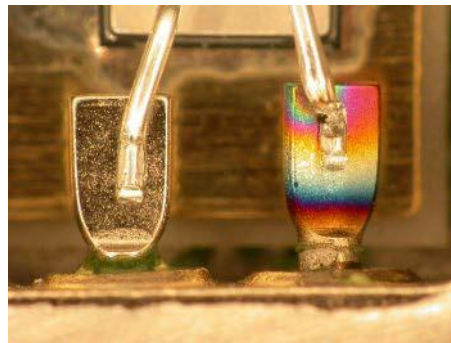
Originally presented by Michael Sampson at NEPP Electronics Technology Workshop, Goddard Space Flight Center on June 17, 2019

The 1980s

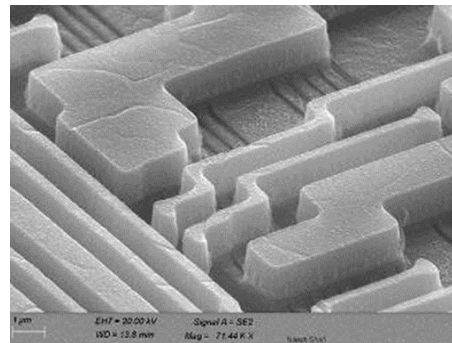
Decade of Transformative Space-Focused Documentation Influenced by NASA

- MIL-STD-1546: Parts, Materials, And Processes Control Program For Space And Launch Vehicles – USAF-SD
- MIL-STD-1547: Military Standard For Space And Launch Vehicles – USAF-SD
- MIL-STD-1580: DoD Test Method Standard: Destructive Physical Analysis (DPA) for EEE Parts – USAF-SD
- MIL-STD-1772: Certification Requirements For Hybrid Microcircuit Facilities And Lines
- Class S* Capacitors
 - MIL-C-87217: (metallized film-CHS)
 - MIL-C-87164: (mica- CMS)
 - MIL-C-123: (ceramic-CKS)

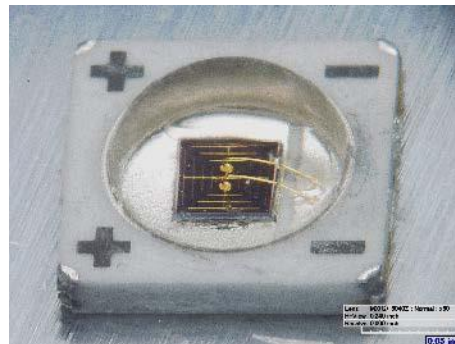
*Class S indicates space grade



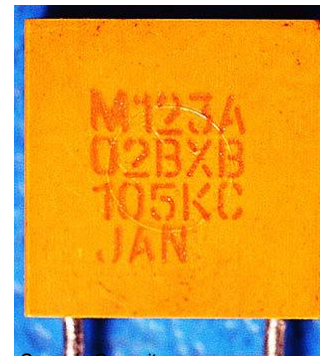
Power Rectifier
NASA GSFC PA Lab Q60698



Microcircuit
NASA GSFC PA Lab J16093



Optocoupler
NASA GSFC PA Lab J16233



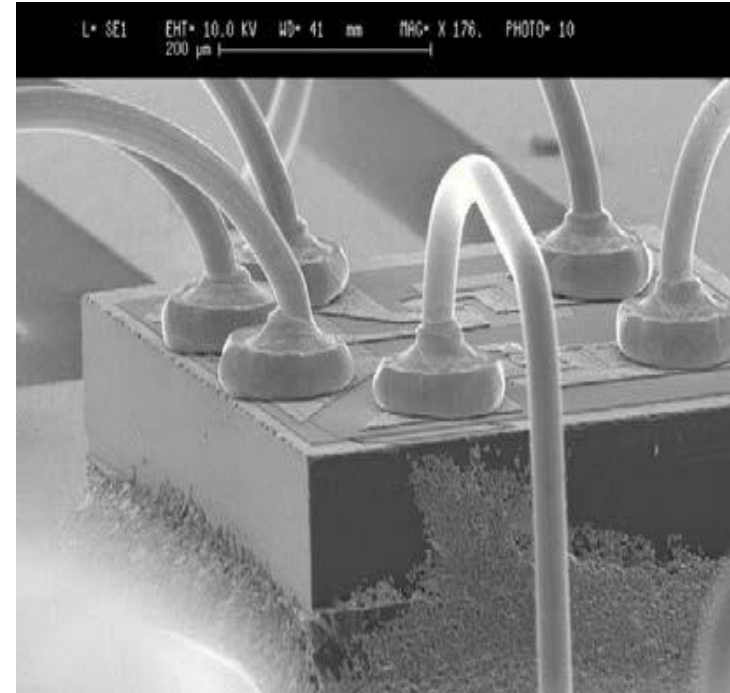
Ceramic Capacitor
NASA GSFC PA Lab J14094

NASA EEE Parts Concerns (1987)

From a NASA Status Report

- Inadequate availability of Class S* and B military parts
 - Vendor-screened parts or SCDs almost mandatory for most programs
- High dropout rates observed during “rescreening” of vendor-screened devices (i.e., vendor “883 compliant”)
- “Off-Shore” Manufacturing Risks
 - Quality control of processes and lines unknown
 - Changes in critical quality factors and production methods can occur without knowledge of the user
- Manufacturers show little interest in providing EEE parts to NASA quality levels due to fragmented procurements and low quantity buys
- Increased frequency of “particle” issues due to poor contamination controls at some suppliers
- Low priority of funds for conference travel and specialized training preclude keeping pace with changes and advancements in parts industry
- NASA Centers extremely thin in expertise in many areas

*Class S indicates space grade

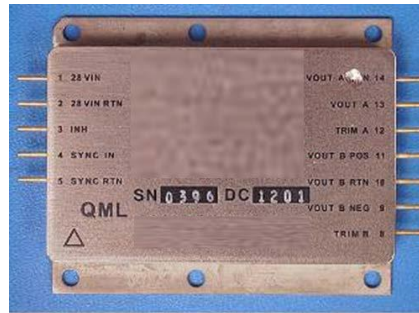


Microcircuit
NASA GSFC PA Lab Q50006

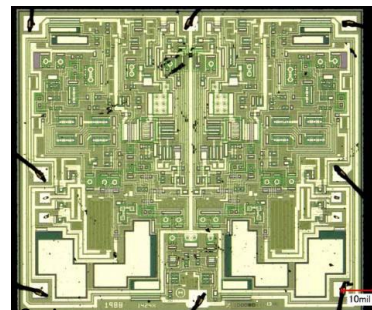
The Early 1990s

Transformation from QPL to QML for Military Hybrids and Microcircuits QML-38534-1 (1989) & QML-38535-1 (1990)

- A revolutionary change intended to
 - Reduce manufacturing costs
 - Encourage qualification of a wider span of microcircuit technologies and types
 - Speed that qualification
 - Accommodate offshore supply chain elements
 - Encourage the standardization of new technologies
 - Generally facilitate participation in a vibrant QML program for Class K* hybrids and Class V* microcircuits



Hybrid Microcircuit
NASA GSFC PA lab J12147



Op Amp
NASA GSFC PA lab J18235

*Class K and V indicate space grade

Originally presented by Michael Sampson at NEPP Electronics Technology Workshop, Goddard Space Flight Center on June 17, 2019

But Then There Was ...

- **1992:** Faster, Better, Cheaper (FBC) for NASA
 - Initiative of Daniel Goldin/NASA Administrator
 - Inside Agency Comment -- “Pick 2”
- **1994:** Acquisition Reform for the Military
 - The “Perry Memo” – William Perry/Secretary of Defense
 - Also driven by Faster, Better, Cheaper although not stated as such
 - Directed the greater use of commercial and performance specs
 - Military Specifications canceled or converted to Performance Specifications “unless no practical alternative exists to meet the user’s needs”
 - “If it is not practicable to use a performance specification, a non-government standard shall be used.”
 - Waivers required for the use of Military Specifications and Standards
 - Attempted purge of all “how to” content, content often based on more than 30 years of painful experience
 - Memo encouraged formation of “partnerships with industry associations to develop non- government standards for replacement of military standards where practicable.”

THE SECRETARY OF DEFENSE
WASHINGTON, DC 20301-1000
29 Jun 94

MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS
CHAIRMAN OF THE JOINT CHIEFS OF STAFF
UNDER SECRETARIES OF DEFENSE
COMPTROLLER
ASSISTANT SECRETARY OF DEFENSE (COMMAND, CONTROL,
COMMUNICATIONS, AND INTELLIGENCE)
GENERAL COUNSEL
INSPECTOR GENERAL
DIRECTOR OF OPERATIONAL TEST AND EVALUATION
DIRECTORS OF THE DEFENSE AGENCIES
COMMANDER-IN-CHIEF, U.S. SPECIAL OPERATIONS
COMMAND

SUBJECT: Specifications & Standards - A New Way of Doing Business

To meet future needs, the Department of Defense must increase access to commercial state-of-the-art technology and must facilitate the adoption by its suppliers of business processes characteristic of world class suppliers. In addition, integration of commercial

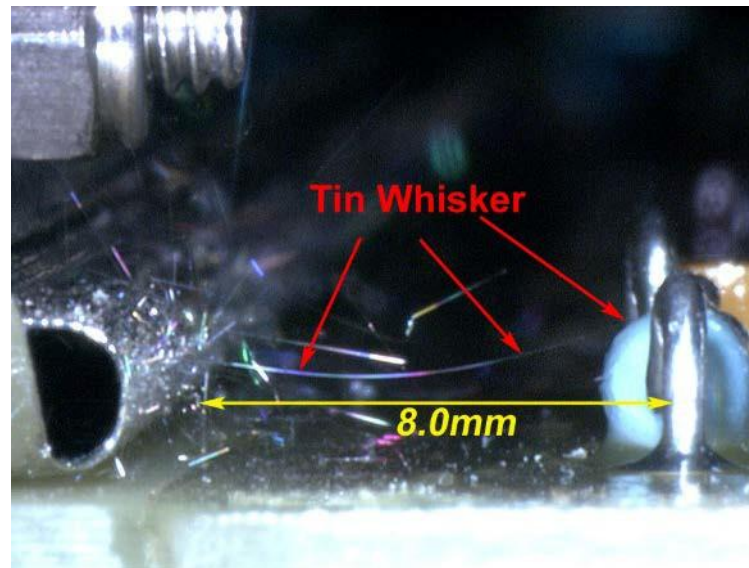
Acquisition Reform Shook the Industry

- EEE parts management responsibility delegated to each NASA Center. These Center-Specific Parts Selection Documents persist in some form
 - GSFC: 311-INST-001 (now EEE-INST-002) also used by LaRC and GRC
 - MSFC: MSFC-STD-3012
 - JSC: SSP 30312, Space Station document
 - JPL: JPL-D-20348, IPPR (Institutional Parts Program Requirements). Later the Parts Engineering Technical Standard (PETS) which borrows from EEE-INST-002
- **1995:** Cancellation of MIL-HDBK-978 NASA Parts Application Handbook
- **1997:** Predecessor of NEPP released the on-line NASA Parts Selection List (NPSL) to capture important content from MIL-STD-975 before it was lost
 - The NPSL captures “standard” EEE parts lessons learned
 - Not intended to be contractually imposed
- **1998:** Official cancellation of MIL-STD-975, NASA Standard EEE Parts List

2000s

Global Supply Chain Issues

- RoHS –Restrictions On the use of certain Hazardous Substances (European Union) Forces Others to Develop
 - Pb-free Electronics Risk Control Plans
 - Tin Whisker Mitigation
 - Prohibited Materials Analyses
- Counterfeit Parts Control Plans
- Non-Hermetic Microcircuit Packaging
- COTS, Automotive Grade Parts for Space?
- ELDRS and other Radiation Effects Concerns
- Obsolescence Management
- Challenges Looking Ahead
 - Commercial vs. Government Space
 - Copper Bond Wires
 - Free flow of communication with International Partners
 - Complexity of semiconductor technologies at the nanometer scale

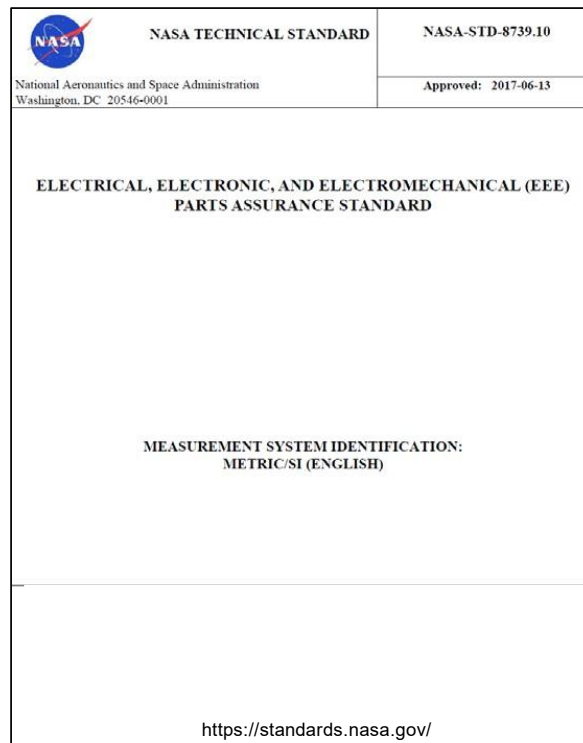


Tin Whiskers on Tin-Plated Printed Circuit Card Guides Space Shuttle Endeavour (~2006)

2010s

NASA EEEE Parts Standardization

- Agency EEE parts manager position created
- Lead/coordinate of primary EEE test and analysis activities to be carried out at Goddard Space Flight Center and Jet Propulsion Laboratory
- NEPP Program remains the same:
- Owns the EEE parts assurance processes and related technical efforts
- NEPP Program management changes
- New NASA-wide document activities
- NASA-STD-8739.10 released
- NASA-[TBD]-8739.11 draft in place to replace EEE-INST-002 (approval in process). Addition of electro-optical parts (EEEE).
- Continued updates to NPR 8705.4 Risk Classification for NASA Payloads
- The Government Working Group (GWG) was stood up in 2017 to focus on standardization of space level requirements, both government and industry
 - Members include NASA centers and JPL, Aerospace Corporation, US Air Force, US Navy (NSWC Crane), US Army (Redstone -AMRDEC), Missile Defense Agency (MDA), DLA Land & Maritime



The first half of 2020s

- NASA Engineering Safety Center (NESC) **COTS study** : Phase I and II
 - Set out framework for Industry Leading Parts Manufacturers (ILPM)
 - Propose reduction of screening and radiation testing in cases where evidence of sufficient quality and reliability exists for COTS parts
 - Examine Mission, Environment, Application and Lifetime (MEAL) for selective testing as needed
- Aerospace Corporation **ATR-2023-01935**: Expanding Space Design Options Using COTS
 - Intent of document is to lower the risk of inserting COTS parts into space systems by:
 1. Selecting COTS suppliers with prescribed best practices (section 4) and use parts within their datasheet limits
 2. Apply risk mitigations, when unsure of supplier's component assurance, or limitations in component design/testing/application (section 5)
 3. Automotive Electronic Council (AEC) passive (AEC-Q200) and discrete (AEC-Q101) where Level 3 Production Part Approval Process (PPAPs) data is reviewed by user are considered low risk for most missions
- NASA initiates **ILPM** process:
 - First manufacturer added in 2024 <https://nepp.nasa.gov/pages/ilpm/establishedparts.cfm>
- EEE-INST-002 will be replaced with a NASA-[TBD]-8739.11

ILPM Criteria

- | | | | |
|--|---|---|--|
| 1. Must have at least one Established COTS Part category | 2. Willing to share parts quality and reliability data with NASA (DPPM, FIT) and how those statistics are derived | 3. Willing to provide NASA documents substantiating parts quality and reliability | 4. Willing to work with NASA or prime contractors to maintain a strong customer-manufacturer relationship (preference for on-site visit) |
|--|---|---|--|

Evolution of NASA Parts Management

YEAR	Activity	Comments
1950s and 1960s	Assurance and Reliability requirements evolve at the individual Center Level	
1975	NASA Standard Parts Program	Responsible for MIL-STD-975, NASA Standard EEE Parts List
1984	Program moved to GSFC	Focus realigned to assurance
1987	MSFC Annual Report	List of Concerns still valid today
1992	Packaging effort begins	Recognition of the growing challenges
1995	NASA Parts Project Office transition to the NASA Parts and Packaging Program	Impact of Acquisition Reform and Faster Better Cheaper
1996	Program now called NASA EEE Parts Advanced Interconnect and Radiation Program (EEE/AI/RAD)	Focus on new and emerging technologies
1998	NASA Electronic Parts and Packaging Program (NEPP)	Post Acquisition Reform realignment. Included radiation hardness assurance (RHA)
2000	NASA EEE Parts Assurance Group (NEPAG) formed	Focus supply chain, standardization and EEE part failure investigation
2003	NEPAG becomes part of the NASA Electronic Parts and Packaging Program (NEPP)	Combined NEPP focus on advanced technologies and RHA with NEPAG's focus on current technologies and standardization
2017	NEPP continues as an OSMA Delegated Program	NEPP Focuses on assurance of EEE parts from TRL 4-9
2018	NASA EEEE Parts Standardization	Emphasizes cross-center EEEE parts standardization under NASA-STD-8739.10. Creation of NASA EEEE Parts Manager position. Working on successor of EEE-INST-002
2025	NASA Industry Leading Parts Manufacturer (ILPM) and Parts Evaluation and Analysis Laboratory (PEAL)	Path to systematically integrate COTS EEEE parts into all NASA missions

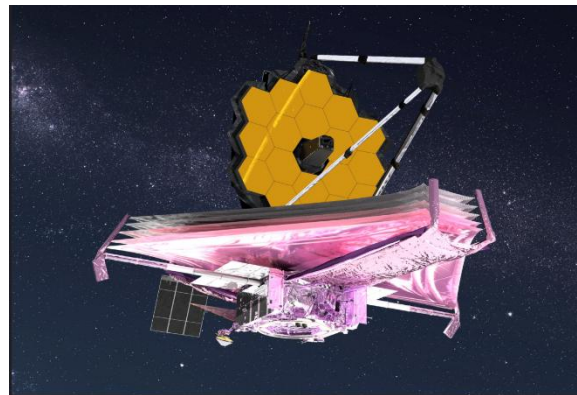
NASA Documents for Parts Selection

NASA Missions Risk Classification

NPR 8705.4B: Risk Classification for NASA Payloads

Purpose: Establishes risk-based mission classifications that determine how strictly parts and systems must be controlled

- **Four Mission Classes (A through D):** NASA categorizes missions from Class A (highest priority, lowest risk tolerance - like flagship missions) to Class D (lower priority, higher risk tolerance - like technology demonstrations). Mission class drives how rigorously components are selected and controlled.
- **EEE Parts Assurance Levels Matched to Mission Class:** Each mission class requires a corresponding EEE parts "Assurance Level" (1-4). Class A missions require Assurance Level 1 parts (most stringent screening/qualification), while Class D missions can use Assurance Level 4 parts (minimal requirements). This is defined in the referenced standard NASA-STD-8739.10.
- **Flexibility in Parts Selection:** Allowed to use higher-grade parts if already available without additional testing, but NASA discourages requiring unnecessary upgrades (e.g., don't mandate Assurance Level 1 parts for a Class C mission just to be "extra safe").
- **Mission Classification Factors:** Class designation considers mission priority, lifetime (>5 years vs. <1 year), complexity, and cost - not just a single factor. The Mission Directorate officially assigns the class early in the project.
- **Complete SMA Framework:** Beyond EEE parts, covers all Safety and Mission Assurance areas (testing, quality, materials, software, reliability) with tailored requirements for each class - providing a complete risk management framework.



James Webb Space Telescope (JWST)



Cislunar Autonomous Positioning System Technology Operations and Navigation Experiment (CAPSTONE)

Images credit: NASA

NASA Mission Risk Classification Matrix

Classification Factor	Class A	Class B	Class C	Class D
Risk Tolerance	Lowest	Low	Moderate	High
Primary Driver	Technical objectives	Technical objectives more than programmatic constraints	Technical objectives more than programmatic constraints	Programmatic constraints more than technical objectives
Overall Description	Very high priority mission with very high complexity	High priority mission with high complexity	Medium priority mission with medium complexity	Lower priority mission with medium to low complexity
Priority (Relevance to Agency Strategic Plan, National Significance, Significance to Agency and Strategic Partners)	Very High	High	Medium	Low
Primary Mission Lifetime	Long (> 5 Years)	Medium (5 Years > – > 3 Years)	Short (3 Years > – > 1 Year)	Brief (< 1 Year)
Complexity and Challenges (Interfaces, International Partnerships, Uniqueness of Instruments, Mission Profile, Technologies, Ability to Reservice, Sensitivity to Process Variations)	Very High	High	Medium	Medium to Low
Life-Cycle Cost	High	Medium to High	Medium	Medium to Low

Human-Rating Requirements

NPR 8705.2C: Human-Rating Requirements for Space Systems

Purpose: Defines requirements for systems that will carry humans into space (different focus than risk classification)

- **Human-Rating vs. Robotic Missions:** Addresses the fundamental question: "What's different about systems carrying people versus expensive robotic payloads?" The answer: human-rated systems must accommodate human needs, use human capabilities effectively, and provide crew escape/recovery options from hazardous situations.
- **Not About Parts Grades - About Safety Philosophy:** Unlike NPR 8705.4B's parts assurance levels, this directive focuses on system-level safety: hazard analysis, fault tolerance, crew survivability, and the ability to safely abort missions. It's a different lens than component-level part selection.
- **Certification Process Required:** Before any crewed flight, the NASA Administrator must grant "Human-Rating Certification" after the program demonstrates the system can safely conduct human missions through rigorous design reviews, testing (including flight tests), verification, and validation.
- **Lifecycle Integration:** Human-rating isn't a one-time check - it's embedded throughout the entire program from design through operations, including configuration management, anomaly resolution, and continuous risk assessment after each flight.
- **"State of Mind" Culture:** Emphasizes that human-rating is more than requirements and paperwork - it requires leadership to instill a mindset where every team member feels personally responsible for crew safety and their specific piece of the design.

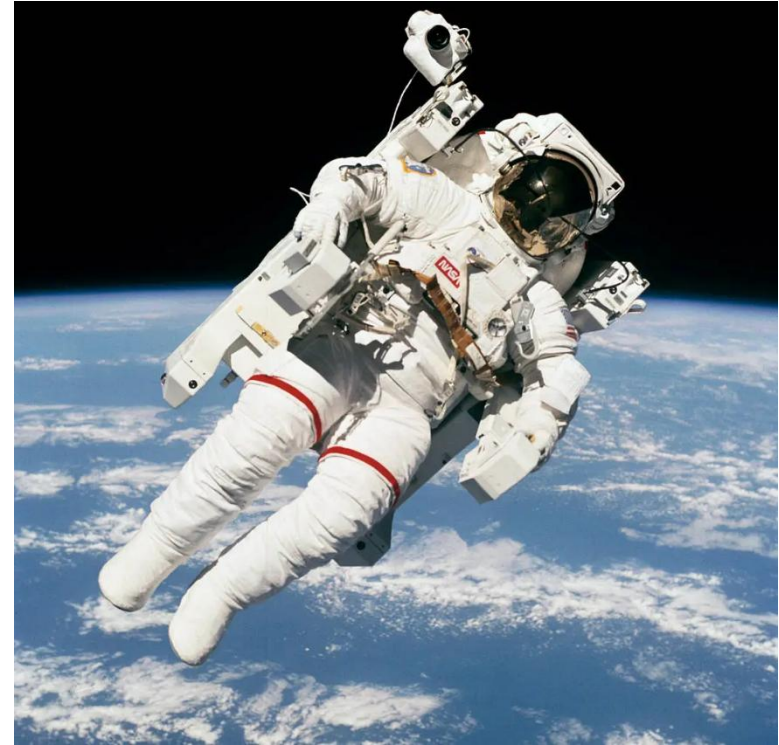


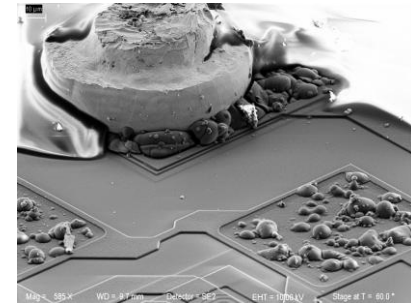
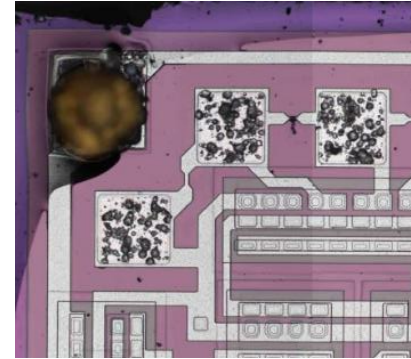
Image credit: NASA

NASA-STD-8739.10

NASA-STD-8739.10: Electrical, Electronic, and Electromechanical (EEE) Parts Assurance Standard

Purpose: The detailed technical standard that defines how to select, procure, test, and manage EEE parts for NASA space missions

- **Four Parts Grades/Assurance Levels (1-4):** This is the technical specification that NPR 8705.4B references. Grade 1 parts have the highest in-process controls and screening (space quality, intended for critical missions like life support systems), while Grade 4 are commercial/COTS parts with lowest screening (suitable for CubeSats, experiments, or non-critical applications). Each grade has different cost, screening requirements, and typical uses.
- **Risk-Based Selection, Not Blanket Requirements:** The standard explicitly states it does *not* mandate specific grades for particular applications. Provides guidance for programs/projects to make their own decisions based on mission criticality, safety requirements, and failure analysis (FMECA/Fault Tree Analysis). Selection of the appropriate grade is based on what the circuit does, not just mission class.
- **Complete Lifecycle Management:** Procurement from authorized sources (to avoid counterfeits), qualification and screening testing, radiation hardness assessment, storage and handling (ESD controls, humidity), obsolescence management, and documentation requirements.
- **"Upscreening" Trade-offs:** Lower grade parts may seem cheaper initially but often cost more in the long run due to additional testing, analysis, and potential redesign. However, if using lower grade parts (Grade 3 or 4), consider adding additional screening tests normally done on higher grades (like PIND testing, X-ray inspection) to increase reliability.
- **Flexibility with Heritage and COTS:** Guidance for use of Commercial Off-The-Shelf (COTS) assemblies, plastic encapsulated microcircuits (PEMs), and heritage hardware, including when assembly-level qualification is acceptable versus part-level testing. Requirements for managing counterfeit parts through traceability and authorized distributors.



COTS part 'stored to death' and why do Destructive Physical Analysis (DPA). Corrosion inside microcircuit that lost hermeticity.

EEE-INST-002

EEE-INST-002: Instructions for EEE Parts Selection, Screening, Qualification, and Derating

Purpose: To establish baseline criteria for selection, screening, qualification, and derating of EEE parts for use on NASA GSFC space flight projects.

- Published in 2003, with Addendum in 2008
- Covers 18 part types in individual sections
- Three Quality Levels** : Parts are categorized into three levels based on mission risk and duration. Level 1 requires the strictest manufacturing controls and testing for low-risk, long-duration missions (>5 years); Level 2 balances moderate risk with cost constraints for medium-duration missions (1 to 5 years); and Level 3 covers commercial or high-risk parts with no standardized testing, acceptable only for short or risk-tolerant applications.
- Mandatory Screening and Qualification**: Before a part can be used, it must undergo specific testing protocols based on its reliability tier. Screening involves tests designed to weed out nonconforming parts with "infant mortality" defects, while Qualification consists of mechanical, electrical, and environmental tests to verify the long-term reliability of the part's design and materials.
- Derating to Extend Operational Life**: Derating practices require engineers to intentionally operate EEE parts below their maximum manufacturer-rated limits (such as voltage, current, and temperature). This reduces stress on the components and significantly increases their longevity in the harsh space environment.
- Radiation Hardness Considerations**: Active components (especially those used in Level 1 and Level 2 applications) must be strictly evaluated for radiation hardness. If pre-existing radiation data is not available for a specific part, physical radiation testing must be performed prior to selection.
- Other NASA centers have similar versions.

Part Type	Document Section
General Instructions for All Part Categories	1
Capacitors	C1
Connectors and Contacts	C2
Crystals	C3
Crystal Oscillators	C4
Fiber Optics, Passive	
Filters	F2
Fuses	F3
Heaters	H1
Magnetics	M1
Microcircuits, Hybrid	M2
Microcircuits, Monolithic	M3
Microcircuits, Plastic Encapsulated (PEMs)	M4
Relays, Electromagnetic	R1
Resistors	R2
Semiconductor Devices, Discrete	S1
Switches	S2
Thermistors	T1
Wire and Cable	W1

EEE-INST-002 Covers 18 part types

NASA-[TBD]-8739.11

NASA-[TBD]-8739.11: Electrical, Electronic, Electromechanical, and Electro-optical (EEEE or quad-E) Parts Selection, Testing, and Derating

Purpose: Establish baseline criteria for selection, screening, Lot Acceptance Testing (LAT), and derating of EEEE parts for use on NASA spaceflight projects.

- Undergoing final decision before release
- **Covers 24 Sections:** Includes sections for new part types: Capacitors (now include Polymer Tantalum Capacitors), Detectors, Laser, FR and Microwave, Hybrid Microcircuit (non-hermetic), Optoelectronics, Plastic Encapsulated Semiconductor Devices. Contains MIL-SPEC “plastic” classes (e.g., class P, class JANPS).
- **Four (4) Assurance Levels:** Parts are categorized from most stringent requirements in Assurance Level 1 to no requirements in Assurance Level 4.
- **Screening and Lot Acceptance Testing (LAT) for replaced “Qualification”:** Applicable to Assurance Levels 1-3. LAT is meant to be used to accept a lot of parts and represent a subset of what may be required by full qualification tests. No LAT testing for Assurance Levels 3 & 4, No screen testing for Assurance Level 4.
- **Outlining ILPM:** Use of COTS parts through ILPM process is use-as-is, although for higher Assurance Levels, a parts previously approved through ILPM may require review of recent changes at manufacturer.

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Table 1. PLASTIC ENCAPSULATED SEMICONDUCTOR DEVICE REQUIREMENTS^{1,2}

Assurance Level	Semiconductor Type	Specification	Use As Is	Screening	LAT	DPA ^{3,4}
Level 1	JANPS	MIL-PRF-19500				X
	JANPTXV	MIL-PRF-19500		X		X
	ILPM Established COTS Part	NESC-RP-19-01490	X ⁷			R ⁶
	Automotive , Commercial, SCD	SCD		X ⁸	X ⁸	X
Level 2	JANPS	MIL-PRF-19500	X			
	JANPTXV	MIL-PRF-19500				X
	JANPTX	MIL-PRF-19500				X
	ILPM Established COTS Part	NESC-RP-19-01490	X ⁷			R ⁶
	Automotive ,Commercial, SCD	VICD, SCD		X ⁸	X ⁸	X
Level 3	JANPS, JANPTXV, JANPTX	MIL-PRF-19500	X			
	ILPM Established COTS Part	NESC-RP-19-01490	X ⁷			R ⁶
	Automotive	AEC-Q101	X ⁵			
	Commercial, SCD	VICD, SCD, AEC-Q101	X ⁵	X ⁸		X

Section S2 Semiconductors, Plastic Encapsulated

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Note 1: The character "X" designates a requirement.

Note 2: SCD and VICD shall be generated to meet project/program requirements.

Note 3: DPA shall be performed per the requirements of S-311-M-70.

Note 4: PESs utilizing copper (Cu) wire bonds shall be subjected to additional testing as required by the PCB.

Note 5: For Assurance Level 3: User has verified DPPM, FIT, LATF 16949 certification (QMS), data from Level 3 PPAP, AEC-Q004 Zero Defect Framework related practices, continuous reliability monitoring/testing data, sales volume of parts to date and on orders, and design operating life. In the event existing manufacturer data does not cover the lifetime for the mission, additional testing or analysis (e.g. life, accelerated, dynamic testing) to determine long-term reliability estimation shall be required.

Note 6: Unless already performed as part of the ILPM baseline, a CA is recommended to verify materials and processes used in manufacturing.

Note 7: The NASA ILPM team (<https://nepp.nasa.gov/pages/ilpm/establishedparts.cfm>) shall be consulted for requirements for using ILPM Established COTS Parts. In the event existing manufacturer data does not cover the lifetime for the mission, additional testing or analysis (e.g. life, accelerated, dynamic testing) to determine long-term reliability estimation shall be required.

Note 8: Screening and/or Lot Acceptance Testing may be reduced or eliminated for parts where manufacturer-provided evidence satisfies some or all the requirements of ILPM as detailed in NASA/TM-20220018183. Each deviation from the tests listed in Table 2 and Table 3 shall be documented with supporting evidence and rationale for the deviation. Each deviation shall be reviewed and approved by the project or program

Radiation Concerns

- Parts levels in EEE-INST-002 and equivalent documents **do not indicate the level of radiation tolerance**, and thus the selection of parts level 1, 2, or 3 does not imply or provide any type of radiation hardness or mitigation of radiation effects.
- MIL-SPEC parts **may or may not include a radiation hardness designator** signifying TID performance but may be sensitive to SEE.
- Lot-to-lot variation of radiation sensitivity may be larger for non-radiation-hardness-assured (non-RHA) parts than for RHA parts, since space radiation tolerance is typically not designed and optimized for parts without radiation addressed in their datasheets.
- RHA mitigations must include system-level techniques and not depend solely on part-level robustness.

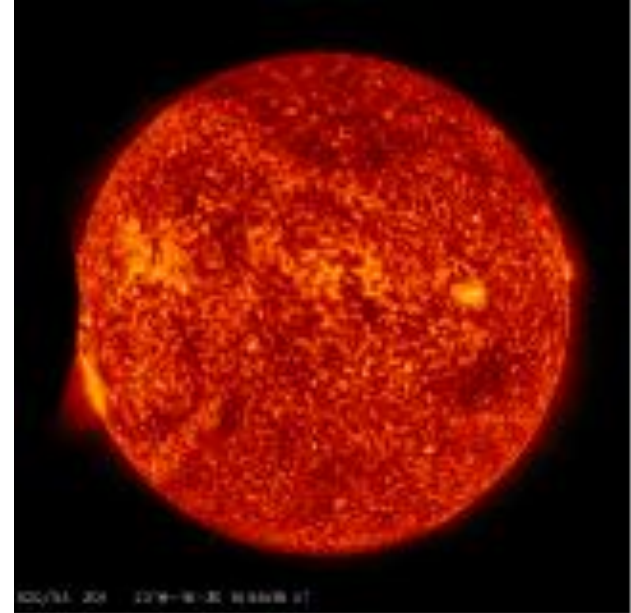
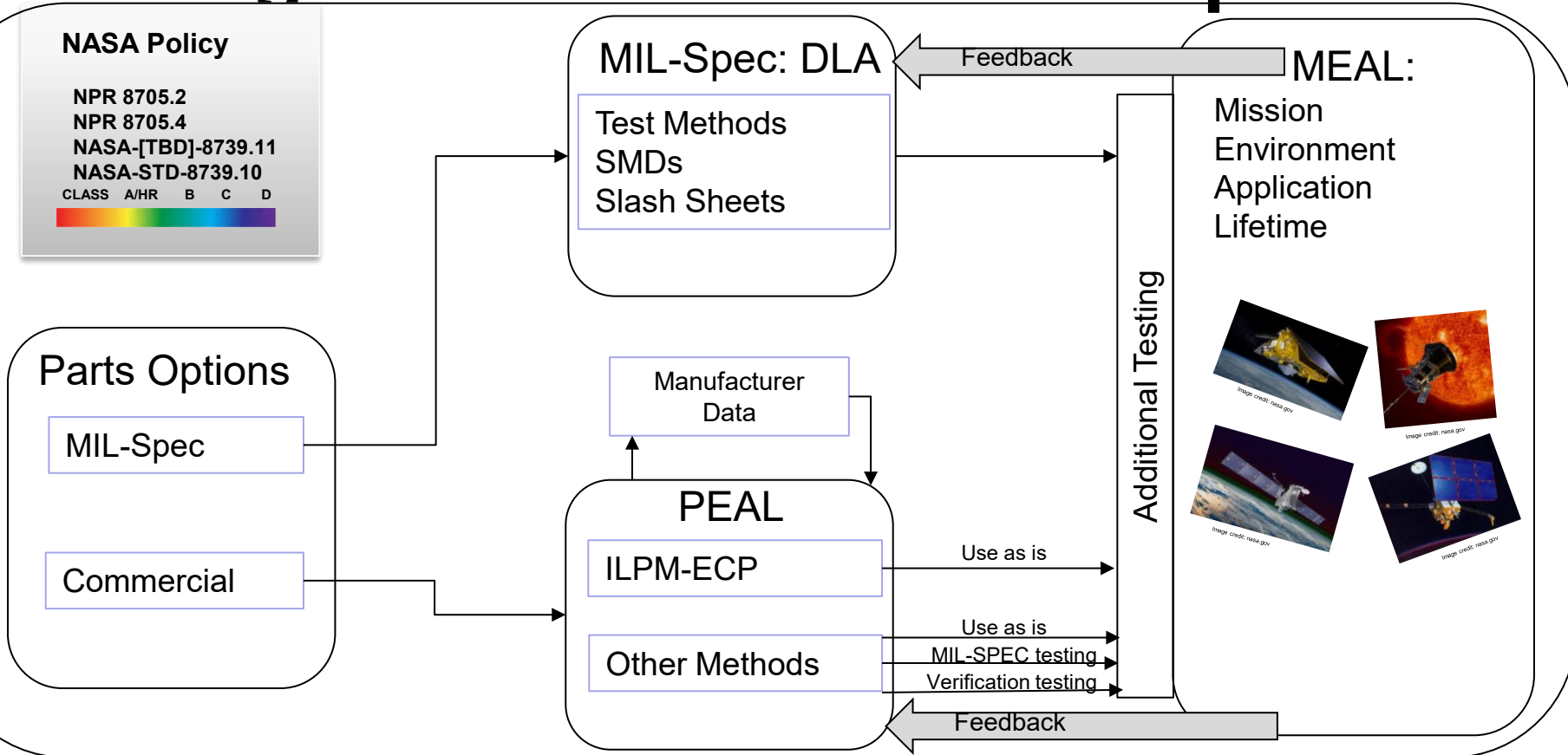


Image credit: NASA

Going Forward: Quad-E Part Options

Going Forward: EEEE Part Options



Adopted from: P. Majewicz, JEDEC, 20-May 2026

PEAL & ILPM Update

- ILPM: Industry Leading Parts Manufacturer
 - Result of NESC Technical Assessment Report Recommendations on the COTS EEE Parts for NASA Missions
 - Goal is to verify quality based on manufacturer data (no additional testing) based on criteria specified in NESC report
- PEAL: Parts Evaluation and Assessment Laboratory
 - Test parts due to gaps in testing
 - Test parts due to other criteria not being met
 - Radiation characterization
- 2025: Pilot Program funded by NASA Science Mission Directive (SMD)
- 2026: Pilot Program funded by Exploration Systems Development Mission Directorate (ESDMD)

PEAL Fiscal Year 2025 Pilot

- Strategic targeting of COTS/automotive parts characterization to provide real solutions for known supply chain constraints:
 - Same form/fit/function of long lead parts commonly used among projects,
 - Of a specific commodity with known radiation or reliability issues, or
 - Of a commodity with little to no current space “qualified” solutions
- Test results will demonstrate reliability and/or radiation performance of COTS parts for applicability in space application
- Parts targeted for testing in FY25 include automotive grade and enhanced plastic COTS:
 - High precision chip resistors
 - Polymer tantalum & ceramic chip capacitors
 - MOSFETs
 - 30+ microcircuits: voltage regulators, power management ICs (PMICs), data converters, operational amplifiers, microcontrollers, transceivers, isolators, low noise amplifiers, nonvolatile and volatile memory
 - DC-DC converters

PEAL/ILPM Fiscal Year 2026 Pilot

- Focus on ILPM parts assessments for selected NASA hardware parts lists, in support of Artemis / Moon to Mars
 - Working with 22+ part manufacturers
- A single PEAL team member selected to lead the ILPM activity for each manufacturer, with data review/assessment support from other members
- Peak activity in FY26 Q2
- Important to note that not all manufacturers will meet ILPM criteria and/or will want to participate in the program

PEAL/ILPM Forward Work

- Continue establishing new ILPMs under the PEAL Pilot program in FY26 and grow the ILPM Established COTS Parts List (ECPL)
- NEPP/NASA has implemented ILPM acceptance options in the drafted (not yet released) NASA-[TBD]-8739.11 EEEE parts assurance standard
 - PEAL to produce a white paper for further guidance to users on the utilization process for ILPM ECPs and verification parts will meet the Mission Environment, Application, and Lifetime (MEAL), or establish additional test as needed
 - Functional criticality may still warrant some level of additional testing based on the mission risk posture and part-level verification obtained
- Obtain further PEAL funding to provide the necessary NASA infrastructure, for effective implementation of ILPM ECP acceptance methods into programs and enable the success of NASA missions and corresponding commercial space developers providing NASA spaceflight hardware

Conclusions

- **NASA's approach to EEEE parts selection evolved with the evolution of parts**
- **Currently NASA identifies four (4) Assurance Levels with risk-based selection of EEEE parts, instead of blanket requirements for part levels**
- **Work underway to standardize use of COTS parts for NASA missions along with the traditional military and source control drawings parts**

Links to Documents Discussed

- NPR 8705.2C
 - https://nodis3.gsfc.nasa.gov/npg_img/N_PR_8705_002C/N_PR_8705_002C_Chapter2.pdf
- NPR 8705.4B
 - https://nodis3.gsfc.nasa.gov/npg_img/N_PR_8705_004B/N_PR_8705_004B_.pdf
- NASA-STD-8739.10
 - <https://standards.nasa.gov/standard/NASA/NASA-STD-873910>
- EEE-INST-002
 - https://nepp.nasa.gov/DocUploads/FFB52B88-36AE-4378-A05B2C084B5EE2CC/EEE-INST-002_add1.pdf
- NESC Recommendations on Use of COTS Parts for NASA Missions
 - Phase I <https://ntrs.nasa.gov/citations/20205011579>
 - Phase II <https://ntrs.nasa.gov/citations/20220018183>
- NASA ILPM and ECPL
 - <https://nepp.nasa.gov/pages/ilpm/about.cfm>
 - <https://nepp.nasa.gov/pages/ilpm/establishedparts.cfm>