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JPL INSTITUTIONAL PARTS PROGRAM REQUIREMENTS

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CHANGE INCORPORATION LOG

Rev Letter	Release Date	Approval Initials	Description of Change
A	2/26/2003	RK	**Added:** Paragraph 1.3, "Definitions" defining the use of Shall, Will, and Should. **Changed:** Paragraph 2.1 to differentiate JPL Applicable Documents and JPL Reference Documents. **Deleted:** Paragraph 2.1, references to the NASA Parts Selection List (NPSL). **Added:** Paragraph 2.1 references to NASA GSFC 311-INST-001 in place of the NPSL. **Added:** Paragraph 2.3, The availability and cost/risk effectiveness of Level 1 parts shall be considered before COTS parts become the design baseline (Design Principle 2.22). **Added:** Paragraph 2.3.1, references to NASA GSFC 311-INST-001 Level 1 and Level 2. **Deleted:** Paragraph 2.3.1, reference to crystal oscillator specification CS515574. **Added:** Paragraph 2.3.2, qualification to PEMs requirement. **Added:** Paragraph 2.4.1, Stuck-at-Fault and IDDQ coverage requirement for ASIC functions. **Changed:** Paragraph 2.4.1, IDDQ node toggle coverage reduced from 99% to 95%. **Added:** Paragraph 2.4.1, test requirements at room temperature and maximum hot and cold temperatures. **Changed:** Paragraph 2.4.2, SPICE modeling and verification requirement to model comparison with test data. **Added:** Paragraph 2.4.2, For Mixed-signal ASICs with large monolithic digital elements that amount to more than 10% of the design and more than 500 gates, these digital elements shall meet the requirements in paragraph 2.4.1. **Added:** Paragraph 2.4.2, For Mixed-signal ASICs which are predominantly analog circuits with

			intermingled flip-flops, registers and counters that amount to less than 10% of the overall design complexity and less than 500 gates, these intermingled digital elements are exempt from the requirements in paragraph 2.4.1. **Added:** Paragraph 2.4.2, test requirements at room temperature and maximum hot and cold temperatures. **Deleted:** Paragraph 2.5, requirements for LTCC substrates. **Deleted:** Paragraph 2.6, post programming burnin. **Added:** Paragraph 2.6, any device that fails to program correctly on the first attempt shall be rejected without exception. After programming DC parametric and at-speed functional testing shall be performed at three temperatures: at room temperature and maximum specified hot and cold temperatures. **Added:** Paragraph 2.6, The at-speed functional tests shall verify all functions, operating modes, fault responses (including initialization and resets) and the specified performance of the design. **Deleted:** Paragraph 2.7, DPA requirement for Grade 2 and lower EEE parts. **Added:** Paragraph 2.7, dielectric thickness requirement for ceramic capacitors. **Deleted:** Paragraph 2.8, statement that Grade 1, Class S cavity devices do not require PIND. **Added:** Paragraph 2.10, Use of existing radiation data shall require approval by the Radiation Specialist. **Added:** Paragraph 2.10, Radiation data should show 90& confidence that the population probability of survivability is at least 99%. **Added:** Paragraph 2.10, The effects of Total Ionizing Dose and Displacement Damage are not independent. The combined effects of TID and DD shall meet the RDF requirements of paragraph 2.2. **Deleted:** Paragraph 2.10.1, Radiation data should show 90 & confidence that the population probability of survivability is at least 99%. **Deleted:** Paragraph 2.10.1, reference to JPL. **Changed:** Paragraph 2.10.2 to Paragraph 2.10.2.1.

			Changed: Paragraph 2.10.2, dose rate requirement from 0.01 rad(Si)/s to 0.005 rad(Si)/s. **Deleted:** Paragraph 2.10.2, RDF of 3 requirement. **Added:** Paragraph 2.10.2, requirement to test (when required) both biased and unbiased conditions. **Changed:** Paragraph 2.10.3, to Paragraph 2.10.2. **Changed:** Paragraph 2.10.3, RDF reference to reference to paragraph 2.2. **Changed:** Paragraph 2.10.4 to Paragraph 2.10.3. **Changed:** Paragraph 2.10.4, RDF reference to reference to paragraph 2.2. **Changed:** Paragraph 2.10.5 to Paragraph 2.10.4. **Added:** Paragraph 2.10.5, Single Event Transients (SEL). **Deleted:** Paragraph 2.10.6, Reference to evaluation of latchup protection circuitry for application and environmental acceptability. **Added:** Paragraph 2.10.7, V_{DS} to evaluation requirement. **Added:** Paragraph 2.10.7, Added table for ion range requirements. **Added:** Paragraph 2.10.8: ion range requirement to penetrate depletion depth at maximum voltage. **Changed:** Paragraph 3.1, Parts Interface Engineer to Project Interface Engineer. **Added:** Paragraph 3.1, Each project shall generate a Project Parts List for tracking potential parts application issues and stress. The Project shall keep the parts list current and has it reviewed for risk assessment prior to build and periodically throughout the development process. **Deleted:** Paragraph 3.1.3, reference to revision 1 of waiver procedure. **Added:** Paragraph 3.1.4, " In order for non-standard parts to obtain approval…". **Changed:** Paragraph 3.1.5, recommendation to requirement that the ASIC Parts Specialist be a member of the ASIC design team.

			Changed: Paragraph 3.1.5, recommendation to requirement that ASICs have special reviews. **Changed:** Paragraph 3.1.5, recommendation to requirement that the Hybrid/MCM Parts Specialist be a member of the ASIC design team. **Changed:** Paragraph 3.1.6, recommendation to requirement that Custom Hybrids/MCMs have special reviews. **Changed:** Paragraph 3.1.7, "The JPL Parts Specialist will..." to "The FPGA Specialist shall review all test fixtures, test board schematics, specifications and procedures prior to test performance.". **Added:** Paragraph 3.1.9, Parts Specialist to be included in MRB. **Changed:** Paragraph 3.2.4, reference from EPQA to Procurement Quality Assurance organization. **Added:** Paragraph 3.2.5, screenings and testing. **Changed:** Paragraph 3.3.4, "will to shall" in: Analysis will be carried to the point that lot dependency of the failure mode can be determined. **Added:** General, references to JPL's Design Principles and Plight Project Practices.

Approvals:

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1. Introduction

This document is the JPL baseline Institutional Parts Program Requirements (IPPR). This document shall act as a template for preparing and tailoring[1] the Project Parts Program Requirements (PPPR) for Spacecraft, JPL Facility Science Instruments, and PI Science Instruments in conformance with Project requirements.

1.1 Purpose

Every Electrical, Electronic and Electromechanical (EEE) part intended for use in space flight shall be reviewed and approved for compatibility with the intended space environment and mission life. This document defines the baseline parts program requirements for all JPL missions, including both spacecraft and instruments. Additional parts requirements may be necessary as a function of mission success requirements. Deviations resulting in the elimination or reduction of the parts requirements specified herein shall be documented in the Project Implementation Plan (PIP) accompanied with the IPPR Compliance Matrix, (JPL Rules! DocID 59353). Once the PPPR has been approved by both the Electronic Parts Engineering Office and Project organizations, deviations from the PPPR shall be documented via a Category B waiver.

1.2 Scope

The EEE parts program requirements specified herein shall apply to each organization, both internal and external to JPL, supplying EEE parts used in flight hardware. The implementation requirements of Section 3 apply to the JPL implementation of the Parts Program. System Contractors are required to submit to JPL their Parts Program Implementation Plan. Throughout this document, the term "EEE parts" refers to the flight EEE parts intended for use in flight hardware.

1.3 Definitions

The following definitions are used throughout this document:

"**Shall**" defines a requirement that requires a waiver (Category A for identified Flight Project Practices and Design Principles, Category B otherwise) if not performed. These requirements are included in the IPPR Requirements Matrix (DocID 59353 in JPL Rules).

"**Will**" defines a function that is expected to be performed during the implementation of the Project's Parts Program, however does not require a waiver when not performed.

"**Should**" defines a "best practice" and is strongly recommended but does not require a waiver when not performed.

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[1] Flight Project Practice 7.5.1

2. Technical Requirements

2.1 Applicable Documents

The following documents of the issue in effect on date of invitation for bids, or request for proposal, or product manufacture, form a part of this document to the extent specified herein. In case of conflict, this document shall take precedence.

JPL Applicable Documents

JPL Rules! DocId 59353	Institutional Parts Program Requirements Compliance Matrix
JPL D-1348	Standard for Electrostatic Discharge (ESD) Controls
JPL D-8545	JPL Derating Guidelines
JPL D-19426	Plastic Encapsulated Microcircuits (PEMS) Reliability/Usage Guidelines for Space Applications

JPL Reference Documents

JPL Rules! DocId 58792	Parts Review Board Charter
JPL D-15032	Procedure – Category A and B Waivers.
JPL QAP 144.1	Quality Assurance Material Review Board Action (QAP 144.1), Rev. C

JPL Adopted Documents

(International Space Station Documents)

SSQ 25000	Destructive Physical Analysis (DPA) Requirements

NASA and Military Documents

NASA GSFC 311-INST-001	Instructions for EEE Parts Selection, Screening, and Qualification
MIL-STD-883	Test Methods and Procedures for Microelectronics
MIL-PRF-19500	General Specification for Semiconductor Devices
QPL-19500	Qualified Products List of Products Qualified under MIL-PRF-19500, General Specification for Semiconductor Devices
MIL-PRF-38534	General Specification for Hybrid Microcircuits
QML-38534	Qualified Manufacturers List for Hybrid Microcircuits
MIL-PRF-38535	General Specification for Manufacturing Microcircuits
QML-38535	Qualified Manufacturers List of Microcircuits

MIL-PRF-55365	General Specification for Capacitor, Fixed, Electrolytic (Tantalum), Chip, Nonestablished Reliability, Established Reliability
MIL-PRF-39003	General Specification for Capacitor, Fixed, Electrolytic (Solid Electrolyte), Tantalum, Established Reliability

2.2 Mission Requirements and Environments

The parts requirements are driven by the mission life requirements and the thermal and radiation requirements specified in the Project Environmental Requirements Document (ERD). All parts requirements shall satisfy the mission environmental requirements as specified in the Project ERD.

2.3 Parts Selection and Standardization Requirements

Only parts of acceptable quality, reliability, and radiation compliance, as demonstrated through test and/or analysis that meet or exceed the mission performance and reliability requirements, will be selected for use. Each supplier of flight electronics and EEE parts will ensure that part selections are appropriate for specific assembly requirements and are consistent with the overall parts program requirements. The availability and cost/risk effectiveness of Level 1 parts shall be considered before COTS parts become the design baseline[2]. Standard Parts

For the project, standard parts shall be defined as those that meet or exceed any of the following reliability standards:

1) NASA GSFC 311-INST-001, Level 1
2) MIL-PRF-38534 Class K QML Source
3) MIL-PRF-38535 Class V, QML-38535
4) MIL-PRF-19500 JANS, QPL-19500
5) NASA GSFC 311-INST-001, Level 2,
6) MIL-PRF-38534, Class H, QML-38534 (MIL-PRF-38510, Class B) with PIND, DPA and radiographics upscreening
7) MIL-PRF-38535, Class Q, QML-38535
8) MIL-PRF-19500, JANTXV, QPL-19500
9) Military Established Reliability (ER) passive devices, Failure Rate Level S or R

2.3.1 Non-Standard Parts

Parts not meeting the minimum quality and reliability criteria of standard parts in 2.3.1 are defined as non-standard parts. Unique, custom parts (e.g., ASICs and Custom Hybrids) and commercial parts (COTS, PEM's, etc.) are considered non-standard. All non-standard parts shall be upgraded/screened to the standards of 2.3.1 and as specified on individual NSPAR's (Non-Standard Part Approval Request) by the Parts Engineering and Radiation Specialists.

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[2] Design Principle 2.22

Plastic parts shall be screened and qualified in accordance with JPL D-19426, Plastic Encapsulated Microcircuits (PEM's) Reliability/ Usage Guidelines for Space Applications, or contractor equivalent.

2.4 Application Specific Integrated Circuit (ASIC) Requirements

2.4.1 Digital ASIC Test Requirements

Digital logic circuitry in ASICs (including microprocessor, microcontroller and all custom designs) shall be tested to at least 95% stuck-at fault coverage as is defined by MIL-STD-883, Method 5012. In addition, each major functional element of the design shall be tested to at least 90% stuck-at fault coverage.

Quiescent current (all vector Iddq method) tests shall be based on a set of vectors that will toggle 95% of the nodes. In addition, each major functional element of the design shall be tested to at least 90% node toggle coverage.

Additional tests shall be conducted at room temperature and at maximum rated (hot and cold) temperature [3] that include:

1) Operating speed (or maximum testable speed) functional test to verify all functions of the design and,

2) DC and AC parametric test vectors in compliance with the ASIC specification.

2.4.2 Mixed-signal ASIC Test Requirements

For Mixed-signal ASICs with large monolithic digital elements that amount to more than 10% of the design and more than 500 gates, these digital elements shall meet the requirements in paragraph 2.4.1.

For Mixed-signal ASICs which are predominantly analog circuits with intermingled flip-flops, registers and counters that amount to less than 10% of the overall design complexity and less than 500 gates, these intermingled digital elements are exempt from the requirements in paragraph 2.4.1.

Analog, digital, and mixed signal ASICs shall be modeled or simulated and compared with test data[3].

Additional tests shall be conducted at room temperature and at maximum rated (hot and cold) temperature[3] that include:

1) Operating speed (or maximum testable speed) functional test to verify all functions of the design and,

2) DC and AC parametric test vectors in compliance with the ASIC specification.

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[3] Design Principle 2.22

2.5 Custom Hybrid, MCM and HDI Microcircuits

Custom hybrid devices designed and fabricated by non-QML sources shall be in conformance with requirements of Class K reliability level of MIL-PRF-38534. Custom hybrid QML sources shall be in conformance with Class H reliability level of MIL-PRF-38534 with a recommended additional 10-piece Class K element evaluation for each device type. Pre-cap visual inspection and document review (e.g. element evaluation, burn-in data and rework travelers) prior to seal shall be required for all hybrids.

To ensure high yields in small lot production runs, all substrates for use in custom hybrids or MCMs, shall be subjected to MIL-PRF-38534 substrate element evaluation.

The Hybrid Parts Specialist will identify in-process inspection points commensurate with Project requirements and will be called out in the travelers and inspected by QA.

2.6 Post-Programming Tests for Programmable Devices

For "one time" programmable devices (i.e. PROMs and FPGAs) any device that fails to program correctly on the first attempt shall be rejected without exception. After programming DC parametric and at-speed functional testing shall be performed at three temperatures: at room temperature and maximum specified hot and cold temperatures.

The at-speed functional tests shall verify all functions, operating modes, fault responses (including initialization and resets) and the specified performance of the design [4]

2.7 Destructive Physical Analysis (DPA) and Residual Gas Analysis (RGA)

DPAs and RGAs shall be performed per the requirements of SSQ25000 of each manufacturing lot date code when required. Ceramic capacitors rated at < 100V and used in < 10V applications shall be subjected to DPA. The dielectric thickness shall be verified to be a minimum of 0.8 mils.

2.8 Particle Impact Noise Detection (PIND)

When required, PIND shall be performed in accordance with MIL-STD-883, Method 2020, Condition "A". Parts being PIND tested will be subjected to one pass only. Rejects will be removed from the lot and the remainder of the parts will be considered to be acceptable.

2.9 Solid Tantalum Style Capacitor Additional Screening

All solid tantalum capacitors shall be subjected to 100% surge current testing. The CWR type capacitors shall be tested in accordance with test option B of MIL-PRF-55365, the CSS type capacitors shall be tested in accordance with the appropriate slash sheet of MIL-C-39003.

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[4] Design Principle 2.22

2.10 Radiation Requirements

All parts shall be evaluated for radiation Total Ionizing Dose (TID), Displacement Damage (DD) and Single Event Effect (SEE) sensitivity, relative to the radiation requirements as defined in paragraph 2.2.[5] Use of existing radiation test data shall require approval by the Radiation Specialist. Where no radiation data are available, all candidate radiation-sensitive parts shall undergo characterization testing and/or lot acceptance testing or be shown by analysis based on test data to be compatible with the application radiation levels. The effects of Total Ionizing Dose and Displacement Damage are not independent. The combined effects of TID and DD shall meet the RDF requirements of paragraph 2.2.

2.10.1 Radiation Lot Acceptance Testing (RLAT)

Device types that are not fabricated on a radiation hardened process shall be subjected to RLAT. Use of existing radiation test data in lieu of RLAT shall be approved by the Radiation Specialist. Radiation related testing and evaluations shall be done in accordance with MIL-STD-883, Method 1019 or JPL approved equivalent. Radiation data should show 90& confidence that the population probability of survivability is at least 99%.

2.10.2 Total Ionizing Dose (TID) Level

All flight parts shall operate within post-irradiation specification limits following exposure to the expected total dose environment including the RDF specified in paragraph 2.2. Radiation characterization should be performed beyond the total dose environment, including the RDF as defined in paragraph 2.2, to account for lot variation. The TID radiation environment includes all radiation components, X-rays, gamma rays, protons, electrons, neutrons and heavy ions.

2.10.2.1 Enhanced Low Dose Rate Sensitivity (ELDRS)

All linear bipolar and BiCMOS ICs shall be evaluated for susceptibility to ELDRS by the Radiation Specialist. Where testing is required (i.e., when no recent data exists), tests shall be performed at a dose rate less than or equal to 0.005 rad(Si)/s to the required radiation level, as defined in paragraph 2.2. Testing shall be in accordance with MIL-STD-883, Method 1019.7 except that the dose rate shall be as specified above. Furthermore, such testing shall be performed on both biased as well as unbiased parts, since in many cases, the unbiased case is the most sensitive. Parametric degradation due to ELDRS should be accounted for in the circuit worst case analysis.

2.10.3 Displacement Damage (DD)

All devices shall be evaluated for susceptibility to DD. All devices shall operate within specification limits following exposure to the expected environment, including the RDF, as specified in paragraph 2.2. Potentially susceptible parts include, but are not limited to,

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[5] Flight Project Practice 7.5.4 and Design Principle 2.22

optical devices, photo-detectors, charge-coupled devices, optocouplers, LEDs, laser diodes and precision bipolar linear devices.

2.10.4 Single Event Upset (SEU)

All microcircuits containing bistable elements (e.g. flip-flops, counters, RAMs, microprocessors, etc.) shall be characterized so that an upset rate calculation can be performed. All parts shall be tested to a fluence of 10^7 ions/cm².

The requirements for parts SEU acceptability are:

- No upsets observed during SEU testing to an LET of 75 MeV-cm²/mg, or
- Verification of device bit error rate of 10^{-10} per day or better in the galactic cosmic ray environment, or
- Calculation of a device's upset rate shall be equal to or less than the required circuit upset rate as determined by circuit SEU analysis.

2.10.5 Single Event Transient (SET)

Single Event Transients (SET) occur on both digital and analog microcircuits due to protons and heavy ions. Parts for which an SET would unacceptably impact system operation shall be evaluated for SET.

2.10.6 Single Event Latchup (SEL)

All CMOS and BiCMOS devices (including those with epitaxial layers) shall be subject to latchup evaluation. When testing is required, parts shall be tested to a fluence of 10^7 ions/cm² or after 100 events have been recorded, whichever occurs first.. The beam angle will not exceed 60 degrees and test ions will have an effective range greater than 35 microns. Bias will be at specified maximum voltage. Tests will be performed at room ambient and at elevated temperature of 125°C or the maximum specified operating temperature of the part.

The requirements for parts SEL susceptibility are:

- No latchup to an LET of 75 MeV-cm²/mg, or
- Verification that the device latchup probability in the mission environment be $< 10^{-4}$ /device-year for parts that exhibit latchup between 35 Mev-cm²/mg and 75 MeV-cm²/mg.

Devices that are used in flight and utilize latchup protection circuitry shall be evaluated for acceptability in the application and the environment as specified in paragraph 2.2.

2.10.7 Single Event Gate Rupture (SEGR)

All power MOSFETs operated in the off-mode may be susceptible to, and shall be evaluated for, single event gate rupture (SEGR) at the worst case application V_{GS} and V_{DS} values. The survival voltage (V_{DS}) shall be established from exposure to a minimum fluence of 10^6 ions/cm² of an ion with a minimum LET of 37 MeV-cm²/mg and with a range based on

device voltage rating as shown in the table below. Testing will be performed with normal beam incidence and at room ambient temperature. The application voltage shall be derated to 75% of the established survival voltage.

Table 1

Ion Range as a Function of Rated V_{DS}

Maximum Rated Drain-Source Voltage	Minimum Ion Range (microns)
≤ 100	30
100 to 250	40
250 to 400	80
400 to 1000	200

2.10.8 Single Event Burnout (SEB)

All power transistors operated in the off-mode may be susceptible to, and shall be evaluated for, single event burnout (SEB) at the worst case application V_{BE} (for bipolar devices) or V_{GS} (for MOS devices). The survival voltage (V_{CE} or V_{DS}) shall be established from exposure to a minimum fluence of 10^6 ions/cm² of an ion with a minimum LET of 37 MeV-cm²/mg and with a range that is sufficient to penetrate the depletion depth of the device at its maximum voltage (the previous table is applicable for MOSFETs). Testing will be performed with normal beam incidence and at room ambient temperature. Test requirements for single event burnout are similar to those for SEGR except that the drain current (or collector current for bipolar transistor) must be measured to determine if burnout occurs. The application voltage shall be derated to 75% of the established survival voltage.

3. Implementation Requirements (JPL In-House)

3.1 Management Requirements

The JPL Project EEE Project Interface Engineer (PIE) will be responsible for the management of the EEE Parts Program. All EEE parts used on the project shall be reviewed by the appropriate Parts Specialist. The review results are to be in writing to the PIE. Each project shall generate a Project Parts List for tracking potential parts application issues and stress. The Project shall keep the parts list current and has it reviewed for risk assessment prior to build and periodically throughout the development process[6]. The PIE will provide a written risk-rating summary to the project based on the review results.

[6] Flight Project Practice 7.5.6

Suppliers of JPL subcontracted flight hardware with EEE parts shall provide the JPL PIE with a parts program plan describing their implementation of the requirements specified herein. The plan should, at a minimum, include the supplier's approach and schedule and shall be approved by the PIE for compliance to requirements prior to the supplier initiating their parts program. Each supplier and their management will assure that the necessary support is allocated for the implementation of their parts program plan.

3.1.1 Parts Review Board

The JPL Parts Review Board (PRB), a quality-control implementation internal to the Electronic Parts Engineering Office, per JPL Rules! DocId 58792, will review all JPL generated Project Parts Program Requirements, parts budgets, work agreements for compliance and costing consistency with this document. The PRB will also review all parts waivers for Office approval.

3.1.2 Monthly Reviews

The JPL PIE will provide a summary review of the parts program on a monthly basis to the project and to Section 514 Management. The monthly review summary will include part selection, changes made to the parts lists, procurement status, status on EEE related waivers, status on applicable Alerts and resolution, problem descriptions and resolutions. Action items will be documented, tracked and reported as part of the monthly status.

3.1.3 Waivers

The Project PIE will present high-risk parts waivers to the PRB for review. The JPL internal procedure for waivers against the PPPR is defined in Category B Waiver Request/Approval, Procedure, (JPL Rules! DocId 53052).

3.1.4 Non-Standard Part Approval

In order for non-standard parts to obtain approval for use a JPL NSPAR form (attachment 1) shall be submitted with full supporting data including procurement Source Control Drawings (SCD's), screening specifications, reliability test data/analysis, and radiation test data/analysis. NSPAR's shall be reviewed and approved by the JPL Parts Engineering and Radiation Specialists. A Parts Pedigree Traveler (PPT) with all required screens and qualification testing will be prepared and approved by the appropriate Parts Specialist.

3.1.5 Application Specific Integrated Circuit (ASIC) Requirements

The ASIC Parts Specialist shall be a member of the design team and attend ASIC Design team meetings. ASIC design guidelines to monitor the design and test vector generation will be documented and reviewed by the ASIC Parts Specialist. All ASIC developments for the project shall have Preliminary Design Reviews, Critical Design Reviews, Manufacturing Readiness Review, and Monthly Management Reviews to monitor technical, budget, and schedule progress[7]. The Parts Interface Engineer and Parts Specialists will participate in all reviews.

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[7] Flight Project Practice 7.5.8

The design reviews will address as a minimum, derating requirements, parts screening and qualification, radiation effects evaluation, verification of controlled engineering materials, processes, thermal and other design analysis as applicable to mission requirements.

3.1.6 Custom Hybrid, MCM and HDI Microcircuits

The JPL Hybrid Parts Specialist shall be a member of the design team and attend Hybrid Design team meetings to monitor the design and test methodology. All projects requiring hybrid microcircuits shall have Preliminary Design Reviews, Critical Design Reviews, Manufacturing Readiness Review, Peer Reviews and Monthly Management Reviews[7]. The Parts Interface Engineer and Parts Specialists will participate in all reviews. The design reviews will address, as a minimum; derating requirements, element evaluation and quality levels, radiation effects evaluation, verification and control of materials, processes, thermal and other design analysis as applicable to mission requirements.

3.1.7 Post-Programming Verification for Programmable Devices

The FPGA Specialist shall review all test fixtures, test board schematics, specifications and procedures prior to test performance.

3.1.8 Destructive Physical Analysis (DPA) and Residual Gas Analysis (RGA)

DPAs and RGAs will be performed at a JPL approved Laboratory using only JPL approved DPA and RGA specifications, which meets a minimum requirement of SSQ25000. The results of the DPA and RGA should be evaluated by procuring activity and the lot shall be accepted or rejected based on the criteria of the specification.

3.1.9 Non-Compliant Parts

Whenever a standard or non-standard part fails to comply with the requirements established herein, an Inspection Report (IR) shall be generated. IR's will be resolved by Material Review Board (MRB), including the Parts Specialist, concurrence per Quality Assurance Material Review Board Action (QAP 144.1). Non-conformances to the PPPR shall also be accompanied by a Category B waiver as determined by the PRB.

3.1.10 Parts List Review

A list of part types considered by the design organization to be design candidates should be submitted in Excel format. The submittal of the preliminary design list will be at least 30 days prior to PDR to the JPL PIE. A final "As-designed" list should be submitted at a minimum of 30 days prior to CDR of each System Element. All additions or modifications will be highlighted and submitted within one month of the change.

The parts lists should include:

- part number
- value/tolerance/rating
- part specification/source control drawing number

- generic part number
- part description (e.g., ceramic capacitor, or quad nor gate)
- proposed part manufacturer
- the review and approval status for nonstandard parts
- the review and approval status of any waivers
- an estimate of the quantities to be used
- application usage notes that can aide the specialist in reviewing parts

3.1.11 As-Built Parts List

The JPL Parts Specialist will review the As-Built Parts List for risk assessment. . In addition to the information required in the parts lists, the as-built parts list should include for each different part the following:

- actual part marking
- part number
- manufacturer
- lot date code
- serial number (for serialized parts)
- procurement specification number

The as-built parts list should be supplied to the JPL PIE in Microsoft Excel electronic format.

3.1.12 Radiation Requirements

Acceptance levels, RLAT specifications and requirements shall be reviewed and approved by the JPL Radiation Specialist. The Parametric degradation data will be incorporated in circuit worst case analyses.

3.2 Parts Acquisition

3.2.1 Parts Procurement

Parts for flight equipment shall be procured directly from the approved part manufacturers or authorized distributor when traceability to the manufacturer can be established. Purchase orders and/or purchase requisitions shall not contain exceptions to referenced specifications or requirements unless approved via the NSPAR.

3.2.2 Traceability

All flight parts purchased shall be traceable to a specific manufacturer, part number, and lot number or lot date code. In addition, parts requiring serial numbers will have traceability to test data associated with the same lot. [8]

3.2.3 Parts Data Requirements and Data Retention

The manufacturer's or vendor's certificate of conformance for each electronic part lot shall be obtained by the procuring activity and retained for a period of launch plus three years or as directed by the Project. The parametric data will be traceable to each serialized part. All variables and attributes data generated in compliance with the specification will be delivered to the procuring activity. The data shall be reviewed by the procuring activity for technical acceptability and completeness. The read and record data may be required when the project needs to establish worst case circuit analysis parametric data points. This will be included in the parts procurement as requested by the project. All test and evaluation data will be submitted to the PIE for review (electronic format is preferred).

3.2.4 Customer Source Inspection (CSI)

When parts are procured by JPL, pre-seal visual inspection shall be performed by JPL's Procurement Quality Assurance organization on all packaged flight ASICs, hybrid microcircuits, MCMs, crystal oscillators, and relays by the procuring agency

3.2.5 Electronic Parts Quality Assurance (EPQA)

All incoming flight piece parts shall be inspected by EPQA prior to final storage in Flight Stores. All piece parts requiring upgrades, screenings or or testing shall be inspected by EPQA prior to shipping to the vendor and shall be re-inspected by EPQA upon their return.

3.3 Electronic Parts Application and Derating

3.3.1 Parts Derating

Each part used in flight equipment shall be applied in a manner such that the temperatures experienced and electrical stresses produced when it is operating do not exceed the derating criteria defined in JPL D-8545[9].

3.3.2 Handling / Storage / Electrostatic Discharge (ESD) Control Requirements

ESD damage or degradation may occur in static-sensitive electronic parts during handling of the parts from procurement through incoming inspection, testing, screening, storing and final assembly/test. To protect static-sensitive parts from ESD, handling of parts shall be controlled by the requirements of JPL D-1348, or JPL approved equivalent.

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[8] Flight Project Practice 7.5.7

[9] Flight Project Practice 7.5.2 and Design Principle 2.22

3.3.3 NASA Advisories and Government Industry Data Exchange Program (GIDEP) Alerts

All hardware-delivering design agencies, both internal and external to JPL, shall assure the implementation of a system to review NASA Advisories and GIDEP Alerts, take appropriate action, and notify their respective Alert coordinators of significant parts problems that may warrant issuance of new Alerts. This activity shall continue throughout the Project's lifecycle[10].

Design agencies which do not presently receive Alerts directly should request distribution from the Defense Supply Center Columbus (DSCC), GIDEP Operations Center or the JPL Alert Coordinator. The design agency is responsible for reviewing all Alerts, and for immediately reporting corrective action for applicable Alerts (i.e. for parts used in the hardware) to the project and appropriate Alert Coordinator.

The design agency will present a review matrix of all Advisories and Alerts at the CDR, and at the Pre-Ship Review, that lists all of the Alerts which are pertinent to the parts used in the flight design, the possible impact should the part fail, and the actions proposed and those taken. It is the responsibility of the design agency to avoid the use of defective parts in flight equipment.

3.3.4 Failure Analysis

Failure analysis shall be performed for all part failures that occur during screening (for custom devices and parts that require upscreening) and subsequent to screening. The Parts Interface Engineer will be notified in writing within 3 days of any failure occurrence. The only exceptions are parts damaged by human error (e.g., improper installation). Analysis shall be carried to the point that lot dependency of the failure mode can be determined[11]. Failure analysis reports will be written to document the analysis approach, the determined failure mode and mechanism (i.e., cause) responsible for the failure, and the corrective actions required to prevent recurrence of the failure. If a lot dependency is found, the Parts Specialist will disposition the parts using an Inspection Report (IR).

4. Contractors

System contractors and their subcontractors, JPL Subcontractors and Partners shall be subjected to all requirements of this document unless exempted according to the provisions of Section 1.0 herein. All System contractors, JPL subcontractors and Partners shall submit to JPL, for review and approval, an implementation plan addressing how they will meet the technical requirements of Section 2.0 and shall include their internal processes addressing the implementation of paragraph 3.1.2 through paragraph 3.3.4. The implementation plan shall also address how these requirements will be flowed down to sub-tier contractors. This implementation plan shall be submitted to the JPL PIE for review and approval. All contractor parts lists shall be reviewed and risk rated by the JPL Electronic Parts Engineering Office.

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[10] Flight Project Practice 7.5.5

[11] Flight Project Practice 7.5.3

5. Acronym List

The following is a list of the acronyms and their meanings used in this document:

Acronym	Meaning
ASIC	Application Specific Integrated Circuit
COTS	Commercial Off-the-Shelf
CSI	Customer Source Inspection
DPA	Destructive Physical Analysis
DSCC	Defense Supply Center Corporation
ESD	Electrostatic Discharge
EEE	Electrical, Electronic, and Electromechanical
ELDRS	Extreme Low Dose Rate Susceptibility
EPPP	Electronic Parts Program Plan
EPQA	Electronic Parts Quality Assurance
ESD	Electrostatic Discharge
FPGA	Field Programmable Gate Arrays
GIDEP	Government Industry Data Exchange Program
HDI	High Density Interconnect
IR	Inspection Report
LET	Linear Energy Transfer
MCM	Multi-Chip Module
MeV	Mega (Million) Electron Volts
MMR	Monthly Management Review
MRB	Material Review Board
NSPAR	Non-Standard Parts Approval Request
PAPL	Program Authorized Parts List
PEM	Plastic Encapsulated Microcircuits
PIND	Particle Impact Noise Detection testing
PPE	Parts Program Engineer
PIE	Project Interface Engineer
PPPR	Project Parts Program Requirements
PRB	Parts Review Board
PPBI	Post Programming Burn-In

PPS	Parts Program Specialist
PROM	Programmable Read Only Memories
QA	Quality Assurance
RDF	Radiation Design Factor
RGA	Residual Gas Analysis
RLAT	Radiation Lot Acceptance Test
SCD	Source Control Document
SEB	Single Event Burnout
SEE	Single Event Effect
SEGR	Single Event Gate Rupture
SEL	Single Event Latch-up
SET	Single Event Transient
SEU	Single Event Upset
TID	Total Ionizing Dose

ATTACHMENT 1 – NSPAR Form

JPL

NONSTANDARD PART APPROVAL REQUEST
(NSPAR)

I	1 PROJECT			2 DATE SUBMITTED
	3 CONTRACTOR	4 CONTRACT NUMBER:		5 NSPAR NO Rev
	6 SUBCONTRACTOR	7 SUBCONTRACT NUMBER:		8 JPL/NASA LOG NO Rev
	9 SYSTEM / SUBSYSTEM / ASSEMBLY/CKT ("WHERE USED")			
II	10 TID REQUIREMENT	11 SEU REQUIREMENT	12 LATCHUP REQUIREMENT	13 PART GRADE:
III	14 PART DESCRIPTION			
	15 MANUFACTURER PROCUREMENT NO		16 GENERIC PART NO	
	17 MANUFACTURER(S)			
	18 PROCUREMENT SPEC			REV
	19 SCREENING SPEC			REV
	20 RADIATION TEST SPEC			REV
	21 CLOSEST STANDARD PART			
	22 TECHNICAL RATIONAL FOR NOT USING STANDARD PART			
	23 TECHNICAL BASIS FOR ACCEPTANCE			
	(Requesting Activity) 24 PREPARED BY	DATE	25 APPROVED BY	DATE
IV	26 JPL PART'S SPECIALIST REVIEW	DATE	APPROVED ☐	CONDITIONALLY APPROVED ☐ DISAPPROVED ☐
	CONDITIONS/NOTES			
	27 ODEP ALERT YES ☐ NO ☐	28 ODEP NUMBER(S):		
	29 JPL RADIATION (TID & SEE) REVIEW	DATE	APPROVED ☐	CONDITIONALLY APPROVED ☐ DISAPPROVED ☐
	CONDITIONS/NOTES			
V	30a CERTIFICATION OF MEETING NSPAR REQUIREMENTS	TITLE PARTS SPECIALIST		DATE
	30b CERTIFICATION OF MEETING NSPAR REQUIREMENTS	TITLE RADIATION SPECIALIST		DATE

INSTRUCTIONS FOR ENTERING DATA ON NONSTANDARD PARTS APPROVAL REQUEST

This NSPAR form is used to request approval of use of a nonstandard part as defined by JPL D-5357

I. Requester fills in:

Block 1 - Enter the Project name.

Block 2 - Enter the date submitted or resubmitted, as applicable.

Block 3 - Enter the name of the system or instrument contractor, as applicable.

Block 4 - Enter the contract number assigned by JPL.

Block 5 - Enter the initiating organization's NSPAR number.

Block 6 - Enter the name of the subcontractor, as applicable.

Block 7 - Enter the subcontract number as assigned by JPL.

Block 8 - Leave this blank. JPL will fill in this Log Number when the NSPAR arrives at JPL Section 514.

Block 9 - Enter the name of the system, subsystem and assembly, in which the part is being used. (Example: communication system, wideband transmitter, power supply.)

II. Requestor fills in Requirements and part quality:

Block 10 - Enter the Total Ionizing Dose requirement for this assembly.

Block 11 - Enter the Single Event Upset requirement for this assembly.

Block 12 - Enter the Latchup requirement for this assembly.

Block 13 - Enter the grade of the part in question.

III. Requestor fills in Part specifications:

Block 14 - Enter the part description (example: capacitor, solid tantalum; resistor, wire wound power.)

ONLY ONE PART TYPE PER NSPAR IS PERMITTED.

Block 15 - Enter the part number, which uniquely identifies the part. If it is a nonstandard military part, enter the military part number. If it is procured by to an existing Source Control Drawing (SCD), enter the part number as identified in the SCD. Otherwise, use the commercial designation.

Block 16 - Enter the generic number for the part.

Block 17 - Enter the name and location of the manufacturer of the part or device. Multiple source listings may appear on a single NSPAR form.

Block 18 - Procurement Specification: the spec. to which the part is procured (example: SCD, CS, ST).

Block 19 -

Block 20 -

Block 21 - Enter the closest standard part.

Block 22 - Enter the technical reason for not using a standard part.

Block 23 - Enter the technical basis for acceptance of a nonstandard part. This basis should include qualification and radiation status, reports, and part grade.

Block 24 - Requester signs and dates.

Block 25 - Requester's approving activity, as applicable, signs and dates here.

IV. JPL Section 514 Fill in:

Block 26 - JPL Parts Specialist approved/conditionally approved/disapproved, signature, date and review Comments.

Block 27 - JPL Parts Specialist enters yes or no for existing GIDEP alerts for part or device.

Block 28 - JPL Parts Specialist will identify GIDEP number(s) applicable.

Block 29 - JPL Radiation approved/conditionally approved/disapproved, signature, date and review comments.

V. Certifying Activity fills in:

Block 30a & 30b - Certification by parts quality assurance activity, certifying that all parts referenced by this NSPAR have been subjected to and meet all the requirements of the specifications listed in Blocks18-20; and, where DPA is required,

the results were reviewed by the procuring activity and found acceptable. JPL Electronic Parts Quality Assurance certifies that NSPAR Completion after closure of the JPL Parts Pedigree Traveler. Contractor parts quality assurance activity shall certify NSPAR completion as described in its Parts Program Plan.