General

JMR-012A

ELECTRICAL, ELECTRONIC, AND ELECTROMECHANICAL PARTS PROGRAM STANDARD

Rev. A February 3, 2014

Japan Aerospace Exploration Agency

This is an English translation of JMR-012A.
If there is anything ambiguous in this document, the original document (the Japanese version) shall be used for clarification.

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Contents

1 General

1.1 Purpose

This Electrical, Electronic, and Electromechanical Parts Program Standard (hereinafter referred to as "this standard") specifies basic requirements relevant to the parts program planned and implemented mainly by the counterparty of the contract (hereinafter referred to as "contractor") of development (including design, manufacturing and test) contracts for satellites / probes (hereinafter referred to as "spacecraft"), launch vehicles, and their equipment of the Japan Aerospace Exploration Agency (JAXA).

1.2 Scope

1.2.1 Applicability

This standard applies when:

(1) this standard is cited in a contract document, procurement specifications or other relevant documents;

(2) JAXA approves the request of the contractor to carry out a parts program according to this standard;

(3) this standard is cited in the Request for Proposal by JAXA; and

(4) JAXA agrees to apply this standard in a joint development agreement or other relevant documents.

1.2.2 Relation with Other Contractual Requirements

(1) When a requirement of this standard conflicts with the contract document and / or procurement specifications, the contract document and procurement specifications shall take precedence.

(2) This standard does not require operations overlapping with other contractual program requirements including to safety, reliability, maintainability, quality assurance and testing requirements, but complement them.

1.2.3 Tailoring

(1) JAXA may tailor the requirements of this standard for each contract depending on the purpose, function, importance and cost of the applicable project.

(2) The contractor may propose proper tailoring during contract negotiation. A tailoring proposal shall be made after examining the purpose, function, importance, cost and other relevant elements of the applicable project, and shall be approved by JAXA.

2 Related Documents

2.1 Applicable Documents

The following documents shall be part of this standard within the scope specified by this standard, and the latest version at the time of the contract shall be applied unless otherwise specified.

In case of a conflict between this standard and the following documents, this standard shall take precedence.

2.1.1 JAXA Documents

(1) JMR-004 Reliability Program Standard

(2) JERG-0-034 Outgassing Data of Organic Materials for Space Use

(3) JERG-0-039 Standard for Soldering Process for Space Use
(4) JERG-0-043 Standard for Surface Mount Soldering Process for Space Use

2.1.2 Overseas Standards

(1) EEE-INST-002	Instructions for EEE Parts Selection, Screening, Qualification, and Derating
(2) ECSS-Q-ST-30-11	Space product assurance - Derating - EEE components
(3) ECSS-Q-ST-60	Space product assurance - Electrical, electronic and electromechanical (EEE) components
(4) ESCC 22900	TOTAL DOSE STEADY-STATE IRRADIATION TEST METHOD
(5) ESCC 25100	SINGLE EVENT EFFECTS TEST METHOD AND GUIDELINES
(6) JEDEC JESD57	Test Procedures for the Measurement of Single-Event Effects in Semiconductor Devices from Heavy Ion Irradiation
(7) MIL QPL / QML	Qualified Product List (QPL) and Qualified Manufacturers List (QML)
(8) MIL-STD-750	TEST METHOD STANDARD TEST METHODS FOR SEMICONDUCTOR DEVICES
(9) MIL-STD-883	TEST METHOD STANDARD MICROCIRCUITS
(10) MIL-STD-1580	DESTRUCTIVE PHYSICAL ANALYSIS FOR ELECTRONIC, ELECTROMAGNETIC, AND ELECTROMECHANICAL PARTS
(11) MIL-HDBK-217	RELIABILITY PREDICTION OF ELECTRONIC EQUIPMENT
(12) NASA-RP-1124	Outgassing Data for Selecting Spacecraft Materials
(13) NPSL	NASA Parts Selection List

2.1.3 Others

(1) CREME-MC	Cosmic Ray Effects on Micro-Electronics - Monte Carlo

2.2 Reference Documents

The latest versions of the following documents shall serve as a reference for this standard.

(1) JERG-0-035	NASDA Parts Application Handbook
(2) JERG-0-036	Electrostatic Discharge Control Handbook for Handling of Electronic Parts / Equipment
(3) JERG-0-050	Quality Assurance Handbook for Imported Parts
(4) JERG-0-051	Quality Assurance Handbook for Imported Equipment
(5) JERG-0-052	Handbook of the Use of Commercial EEE Parts in Space Applications (General Purpose)
(6) JERG-1-010	Handbook of the Use of Commercial EEE Parts in Space Applications (Rocket)
(7) JERG-2-023	Handbook of the Use of Commercial EEE Parts in Space Applications (Long Life Satellite)

3 Terms and Definitions

(1) EEE parts

"EEE parts" is a generic term for electrical, electronic and electromechanical parts and represents the following items in this standard.

1. Integrated circuits (including hybrid ICs)
2. Transistors
3. Diodes
4. Capacitors
5. Resistors
6. Connectors
7. Crystals and Crystal oscillators
8. Filters (RFI filters, EMI filters, feedthrough filters etc.)
9. Relays
10. Switches (including thermal switches)
11. Transformers and Coils
12. Wires and Cables
13. Solar cells
14. Printed wiring boards
15. Thermistors
16. Heaters
17. Sensors (platinum temperature sensors, pressure sensors, CCD sensors etc.)
18. Fuses
19. RF devices (RF isolators, attenuators, couplers, mixers, circulators, SAW filters, terminators, dividers / combiners, LPFs, HPFs, BPFs, etc.)
20. Others

(2) Other terms and definitions

The terms and abbreviations used in this standard are shown in Appendix 1.

4 General Requirements

4.1 Basic Requirements

4.1.1 Basic Requirements

The contractor shall plan and implement an EEE parts program to properly select, procure and apply the parts necessary for launch vehicles and spacecraft.

The requirements of this standard call for the followings.

(1) Implementation of effective, systematic and well-planned parts program management to satisfy the requirements of this standard.
(2) Technical requirements for establishing parts requirement specifications
(3) Management work for procurement of parts that meet requirements

4.1.2 Practices and Rights of JAXA

(1) JAXA maintains the right to confirm all the operations, data and documents of the contractor for applicable contract.
(2) The contractor shall accommodate inspectors visiting the facility of the contractor to perform inspections.

4.2 Parts Program Management

The contractor shall perform effective, systematic and well-planned management in accordance with the followings.

4.2.1 Organizational Structure

The contractor shall define the organizational structure to implement the parts program and the manager in charge to satisfy the following requirements.

(1) Operations shall be allocated to the most appropriate departments in order to conduct parts programs effectively.

(2) The department responsible for the parts program shall have the right and independency to report and offer suggestions to the person in charge of the contract in order to solve problems in parts program implementation.

(3) The contractor shall appoint a person in charge of implementation of parts program management. The person in charge shall regularly report to his / her superior on the status and validity of the program.

4.2.2 Parts Program Plan

The contractor shall prepare and maintain a parts program plan to meet the parts program requirements specified in the contract and implement the parts program in accordance with the plan. The parts program plan may be included in the reliability program plan that will be established separately. The following shall be included in the parts program plan.

(1) The plan shall include the responsibilities and functions of the organization dealing with the plan, evaluation, review and implementation of the parts program.

(2) If the contractor tailors the requirements of this standard, the description of tailoring and the rationales shall be stated.

(3) The contractor shall confirm that the operation plan and schedule conform with the requirements of this standard and describe it in the program plan.

4.2.3 Supplier Control

(1) The contractor shall implement proper control of the suppliers in accordance with the applicable reliability program plan. Details of the parts program plan to be required of and implemented by the suppliers shall be described in the procurement document of the contractor. The parts program plan in accordance with this standard as specified in 4.2.2 shall allso be required of the suppliers of subsystems and equipment.

(2) In order to prevent nonconformances attributed to EEE parts procured from overseas sources and ensure quality, activities requiring special care in selection of EEE parts to be used in domestic (Japanese) equipments, in setting technical and management requirements in their procurement, in selection of types and suppliers of the EEE parts, and in their quality assurance, are described in JERG-0-050 in 2.2 (3). This handbook shall be referred to in setting a parts program of EEE parts for suppliers.

(3) Suppliers of equipments that are procured from overseas shall be managed as a part of a quality program and / or reliability program referring to JERG-0-051 in 2.2 (4). A proper parts program management shall be implemented on the EEE parts that are used in overseas equipments referring to (2) above.

5 Parts Quality Requirements

For the parts selected and procured by the contractor, parts quality requirements shall be established in accordance with 5.1.1 considering the purpose, function, importance, reliability, scale, cost and so forth of the applicable launch vehicles, spacecraft and their equipment to which the parts are assembled.

5.1 Parts Quality Assurance Level

5.1.1 General

Parts quality assurance level is roughly divided into three levels as shown in Table 5-1.

The contractor shall select parts in accordance with the quality assurance level of the parts shown in Table 5-1.

(1) When quality assurance level of parts is specified in relevant documents including development specifications, parts shall be selected in accordance with the relevant documents.

(2) When quality assurance level of parts is not specified, parts at a proper quality assurance level shall be selected considering their purpose, function, importance and other elements.

(3) Quality assurance level of the parts shall be determined after confirmation of JAXA.

5.1.2 Parts Quality Assurance Level

5.1.2.1 Class I Parts

Class I parts are at the highest quality assurance level and at the lowest risk. Specifically, Class I parts are those at a quality assurance level applicable to the Class I column for standard parts and the Class I-equivalent column for non-standard parts of Table 5-1 “Definition of Quality Assurance Level and Standard Parts / Non-Standard Parts” or parts at either the same or higher quality assurance level.

5.1.2.2 Class II Parts

Class II parts are at the next-highest quality assurance level after Class I parts and at a lower risk. Specifically, Class II parts are those at a quality assurance level applicable to the Class II column for standard parts and the Class II-equivalent column for non-standard parts of Table 5-1 “Definition of Quality Assurance Level and Standard Parts / Non-Standard Parts” or parts at either the same or higher quality assurance level.

5.1.2.3 Class III Parts

Class III Parts are at the quality assurance level lower than the Class II parts and at a high risk. Specifically, Class III parts are those at a quality assurance level applicable to the Class III column for standard parts and the Class III-equivalent column for non-standard parts of Table 5-1 “Definition of Quality Assurance Level and Standard Parts / Non-Standard Parts” or parts at either the same or higher quality assurance level.

5.1.2.4 Qualified Parts List of Class I, II and III Standard Parts

The source lists of qualified parts applicable to Class I, II, and III standard parts in Table 5-1 are shown in Table 5-2. The list shall be used in searching and selecting parts.

Table 5-1 Definition of Quality Assurance Level and Standard Parts / Non-standard Parts

	Quality Assurance Level		Class I	Class II	Class III
Standard parts	Definition		Class I parts are officially qualified parts at the highest quality assurance level and at the lowest risk.	Class II parts are officially qualified parts at the next-highest quality assurance level after Class I parts and at a lower risk.	Class III parts are officially qualified parts at the quality assurance level lower than the Class II parts and at a high risk.
	Minimum Quality Class (typical example)	Integrated circuits (including hybrid ICs)	JAXA QML qualified parts MIL Class S, Class V, Class K ESCC Level B	JAXA-qualified Class II hybrid ICs MIL Class B, Class Q, Class H ESCC Level C	MIL Class M
		Discrete semiconductors	JAXA QML qualified parts MIL JANS ESCC Level B	MIL JANTXV ESCC Level C	MIL JANTX
		Passive parts	JAXA QML qualified parts MIL "T" Level MIL failure rate level (FRL) S, R or C GSFC S311, ESCC Level B, C	MIL failure rate level (FRL) R, P or B	MIL failure rate level (FRL) M, L
	Part Specifications		Official specification of JAXA, MIL, GSFC, and ESCC falling under Class I level	Official specification of JAXA, MIL, GSFC, and ESCC falling under Class II level	Official specification of JAXA, MIL, GSFC, and ESCC falling under Class III level
	Parts Qualification		Official qualification of JAXA, MIL, GSFC, and ESCC falling under Class I level	Official qualification of JAXA, MIL, GSFC, and ESCC falling under Class II level	Official qualification of JAXA, MIL, GSFC, and ESCC falling under Class III level
	Traceability		Serial number or lot	Lot	Lot
	Screening		100%	100%	If specified
	Quality Conformance Inspection (Lot Assurance Test)		Applicable	Applicable	Applicable
	Supply Source		Officially qualified manufacturer	Officially qualified manufacturer	Officially qualified manufacturer
	Radiation Test or Analysis		Applicable	Applicable	Applicable

	Quality Assurance Level		Class I-equivalent	Class II-equivalent	Class III-equivalent
Non-standard parts	Definition		Class I-equivalent parts are the parts without official qualification at the highest quality assurance level and at the lowest risk.	Class II-equivalent parts are the parts without official qualification at the next-highest quality assurance level after Class I parts and at a lower risk.	Class III-equivalent parts are the parts without official qualification at lower quality assurance level after Class II parts and at a high risk.
	Minimum Quality Class (typical example)	Proven non-standard parts (Note 1)	[1] Non-standard parts that are proven to be equivalent to the Class I standard parts with minimum quality class (typical example) of Class I [2] Class II standard parts that are proven to be upscreened to Class I-equivalent level in accordance with EEE-INST-002 etc.	[1] Non-standard parts that are proven to be equivalent to the Class II standard parts with minimum quality class (typical example) of Class II [2] Class III standard parts that are proven to be upscreened to Class II-equivalent level in accordance with EEE-INST-002 etc.	[1] Non-standard parts that are proven to be equivalent to the Class III standard parts with minimum quality class (typical example) of Class III
		Non-standard parts to be newly qualified or evaluated (Note 2)	Non-standard parts to be approved after qualification test or evaluation test that have the equivalent level of minimum quality class (typical example) of Class I standard parts	Non-standard parts to be approved after qualification test or evaluation test that have the equivalent level of minimum quality class (typical example) of Class II standard parts	Non-standard parts to be approved after qualification test or evaluation test that have the equivalent level of minimum quality class (typical example) of Class III standard parts
		Non-standard parts with upscreening for higher quality class (Note 2)	Class II standard parts to be approved after additional upscreening to Class I-equivalent level in accordance with EEE-INST-002 etc.	Class III standard parts to be approved after additional upscreening to Class II-equivalent level in accordance with EEE-INST-002 etc.	—
	Part Specification		Part specification (such as SCD) equivalent to the official specifications of JAXA, MIL, GSFC and ESCC falling under Class I level	Part specification (such as SCD) equivalent to the official specifications of JAXA, MIL, GSFC and ESCC falling under Class II level	Part specification (such as SCD) equivalent to the official specifications of JAXA, MIL, GSFC and ESCC falling under Class III level
	Parts Qualification		Qualification and evaluation test specified in the Class I-equivalent part specification (such as SCD) (Quality Conformance Inspection (Lot Assurance Test) may be conducted as an alternative)	Qualification and evaluation test specified in the Class II-equivalent part specification (such as SCD) (Quality Conformance Inspection (Lot Assurance Test) may be conducted as an alternative)	Qualification and evaluation test specified in the Class III-equivalent part specification (such as SCD) (Quality Conformance Inspection (Lot Assurance Test) may be conducted as an alternative)
	Traceability		Serial number or lot	Lot	Lot
	Screening		100%	100%	If specified
	Quality Conformance Inspection (Lot Assurance Test)		Applicable	Applicable	Applicable
	Supply source		Supplier capable of manufacturing and assuring the quality of above-mentioned Class I-equivalent parts	Supplier capable of manufacturing and assuring the quality of above-mentioned Class II-equivalent parts	Supplier capable of manufacturing and assuring the quality of above-mentioned Class III-equivalent parts
	Radiation Test or Analysis		Applicable	Applicable	Applicable
	Non-standard Parts Approval Request (NSPAR) (Note 2)		Required	Required	Required

(Note 1) Non-standard parts which usage has been approved based on Non-standard Parts Approval Request (NSPAR) or the parts list and which have good flight heritage.

(Note 2) NSPAR application form shall be submitted to the project in charge and approved in accordance with 5.4.3. When it is difficult to apply NSPAR on certain parts, their usage can be approved as a part of the parts list review specified in 5.4.1 after the discussion with the project in charge.

Table 5-2 Lists of Class I, II, III Standard Parts

Standard Parts	
Quality Assurance Level	Applicable Parts
Class I	1) Qualified parts listed in JAXA QPL / QML 2) Qualified parts listed in Level 1 of NPSL (Note 1) 3) Qualified parts defined as Class 1 components in ECSS-Q-ST-60 (Note 1) 4) Qualified parts listed in part I of EPPL 5) Qualified parts defined as Level 1 parts in EEE-INST-002 (Note 1) 6) Qualified parts listed in MIL QPL / QML (Quality assurance level shall be equal to Level 1 of NPSL and EEE-INST-002) (Note 1)
Class II	1) Class II qualified parts listed in JAXA QPL / QML 2) Qualified parts listed in Level 2 of NPSL (Note 1) 3) Qualified parts defined as Class 2 components in ECSS-Q-ST-60 (Note 1) 4) Qualified parts listed in part II of EPPL 5) Qualified parts defined as Level 2 parts in EEE-INST-002 (Note 1) 6) Qualified parts listed in MIL QPL / QML (Quality assurance level shall be equal to Level 2 of NPSL and EEE-INST-002) (Note 1)
Class III	1) Qualified parts listed in Level 3 of NPSL (Note 1) 2) Qualified parts defined as Level 3 components in EEE-INST-002 (Note 1) 3) Qualified parts defined as Class 3 components of ECSS-Q-ST-60 (Note 1) 4) Qualified parts listed in MIL QPL / QML (Quality assurance level shall be equal to Level 3 of NPSL and EEE-INST-002) (Note 1)

(Note 1) Application instructions stated in Application Note and such of NPSL, EEE-INST-002, and ECSS-Q-ST-60 shall be applied.

5.1.3 Parts Interfacing with Ground Equipment

Any parts used at the interface with ground equipment including test equipment shall not adversely affect the flight hardware.

5.2 Parts Selection

5.2.1 Common Requirements

Parts selection and evaluation shall be performed systematically from the project definition phase to the project readiness review and design review phases. In addition, parts selection and preliminary evaluation shall be performed in consideration of the following general requirements. Candidate parts shall be documented as soon as possible in a candidate parts list.

(1) When selecting parts, minimize the type of candidate parts.
(2) Give priority to JAXA-qualified parts.
(3) Give priority to standard parts listed in Table 5-1.
(4) When selecting non-standard parts, give priority to parts with good flight heritage in the past projects. Verify that the current use conditions are consistent with the previously approved conditions.

(5) A single failure point is prohibited. However, when it cannot be avoided to use EEE parts at the single failure point, the parts of the highest quality level shall be used, to the extent the project can allow.

(6) When selecting parts, investigate the possibilities of becoming obsolete in advance and avoid the parts that have risks to become obsolete.

(7) For any parts that need to be newly developed, examine necessity, development elements and development plan in the initial design phase.

(8) For any parts which the contractor has never evaluated and plans to use for the first time, select them after examining manufacturers, basic performance, reliability, test reproducibility, radiation tolerance, and other relevant factors of the parts.

(9) When MIL-HDBK-217 in 2.1.2 (11) cannot be applied, state the failure rate data of the parts and their sources.

5.2.2 Items to be Considered in Parts Selection

5.2.2.1 Restrictions on Parts Application

The following items shall be considered in parts application.

(1) When any restrictions on application are specified in the part specifications, NPSL and other relevant documents, apply the restrictions.
The restrictions on application of NPSL are stated in "Important! Application Notes" of each part type in NPSL (http://nepp.nasa.gov/npsl/).

(2) When any restrictions on parts application are specified in the equipment design specifications and other relevant documents, apply the restrictions.

(3) Apply the requirements, considering that the function and performance of the equipment will not be impaired by wear and degradation of the parts due to operation, temperature cycle and radiation environment during the required life of the equipment. Properly manage limited life items in JMR-004 in 2.1.1(1).

(4) Do not select and use the following parts due to the reasons such as life limit for space use, confirmed nonconformance, safety problems and reliability risks.
   (a) Hollow core resistors
   (b) Mesa or alloy junction transistors
   (c) Non-metallic bonded (non-metallurgically bonded) diodes
   (d) Semiconductors or integrated circuits with unglassivated active area
   (e) Double seal aluminum electrolytic capacitors and wet slug tantalum capacitors in other than tantalum case (such as wet slug tantalum capacitors in silver case)*
   (f) Parts whose internal structure is metallurgically bonded with melting temperature that does not comply with the end-application mounting conditions
   (g) Wire link fuses less than 5 A
   (h) TO5 relays in which the armature / coil assembly and header are not double-welded or diodes are included
   (i) RNC90-type resistors with resistance of 100 kΩ or more (See "5)" of "Application Notes for MIL-PRF-55182" in NPSL)
   (http://nepp.nasa.gov/npsl/Resistors/55182/55182aps.htm)
   (j) Parts made with germanium (excluding microwave diodes and solar cells)

(5) Do not use variable resistors and potentiometers (excluding mechanical position monitoring type).

(6) Do not use parts using TO3 and DO4 / DO5 package.

(7) Pure tin and tin alloy with lead content of 3 % or less may develop whiskers. Parts with those materials shall not be used unless they are evaluated for whisker resistance or are properly treated for whisker prevention (such as solder coating including "HSD or over-plating")*.

(8) For health and safety, beryllium oxide (unless otherwise specified in the procurement specifications), cadmium, lithium, magnesium, mercury, zinc, radioactive materials and all other materials that may cause safety hazards shall not be used. However, this excludes the cases where materials are contained in an alloy to be used as structural materials or used in hermetically sealed containers including batteries and safety problems will not develop.

(9) Hermetically sealed relays, thermostats and switches shall be used (except for coaxial switches and waveguide switches)*.

(10) Organic materials with low outgassing in a vacuum shall be used when they are not hermetically sealed. Materials with values equal to or smaller than the following shall be used in reference to JERG-0-034 in 2.1.1 (2) and NASA-RP-1124 in 2.1.2 (12). When any materials with values larger than these are used or when outgassing is likely to cause adverse effects, effective protective measures shall be taken. If no outgas data is provided, outgas tests shall be conducted to obtain the necessary outgas data*.
   (a) Total Mass Loss (TML): 1.0 % or less
   (b) Collected Volatile Condensable Materials (CVCM): 0.1 % or less

(11) Non-hermetically sealed materials shall be used with particular attention paid to offgas, flammability and toxicity.

(12) Post programming burn-in (PPBI) shall be implemented on one-time programmable parts (OTP) such as FPGA (PLD) and PROM. Coordinate with JAXA before omitting PPBI based on the flight heritage, sufficient PPBI data or the required quality assurance level. When PPBI is omitted, conduct a burn-in test at the equipment level to confirm that problems do not occur after programming.

(13) Evaluate robustness against stress caused by mounting and assembly technology.

* See Appendix 2 for supplementary requirements regarding launch vehicles.

5.2.2.2 Part Specification

For flight parts, part specifications shall be used as the grounds for the definition and management. New part specifications are not required for standard parts that apply official specifications such as JAXA, ESCC and MIL, and proven non-standard parts that apply existing part specifications.

For new non-standard parts, part specifications shall be developed.

(1) Temperature range for use, environmental conditions, electrical characteristics and other relevant factors shall be defined in the part specifications in consideration of actual application conditions.

(2) Qualification test shall be defined in the part specifications and the result shall be favorable. Data of similar tests or similar parts may be used.

(3) Design, manufacturing process, screening, quality conformance inspection and other relevant items shall be defined in the part specifications and shall conform to the designated quality assurance level. If no corresponding part specification of JAXA is available and no reference quality assurance level is defined, the requirements shall be based on the quality assurance level of the part specification with the closest similarity among MIL, ESCC and other relevant specifications, and the technical rationale shall be described.

(4) The part specifications shall define the management method so that the parts with the same design, structure and manufacturing condition as those used in the qualification test can be procured. When long-term continuous production is necessary, the maintenance management of such production shall also be defined. However, this does not apply when only parts of the same lot as those used in the qualification test are used.

(5) There shall be no reliability problems in design, structure, manufacturing condition and other relevant factors.

(6) To procure a part, a procurement document shall be prepared in accordance with 5.5.2.1.

5.2.2.3 Radiation Hardness

Radiation-sensitive parts shall be selected and applied with due consideration given to malfunction, failure and degradation by the in-orbit radiation environment (cosmic radiation (heavy particles), electromagnetic radiation, trapped radiation (charged particles - electrons and protons in radiation belts) and solar radiation (flare)).

The following shall be particularly considered. However, in detail, individual requirements of the project shall be applied since the radiation environment differs depending on the orbit, mission duration and so forth.

(1) Total Ionizing Dose (TID) and Displacement Damage (DD)

a. Total Ionizing Dose (TID)

TID shall be determined based on the Dose-Depth Curve of the project individual requirements, and the parts that endure the TID (in consideration of Al-equivalent shield thickness) with safety factor of 1.25 as a design margin shall be selected. When selecting parts such as bipolar and BiCMOS devices that may be affected by Enhanced Low Dose Rate Sensitivity (ELDRS), TID tolerance in low dose rate shall be considered.

b. Displacement Damage (DD)

For any parts (including photocouplers) that suffer from DD induced by protons, their influence shall be taken into consideration as needed.

(2) Single Event Effect (SEE)

To prevent SEE, select the parts that will cause no adverse effects on the mission under heavy ion and proton environment with the applied derating.

a. To prevent Single Event Latchup (SEL), select the parts having a threshold Linear Energy Transfer (LET) above the lower limit specified in the project requirements. When using any parts having a lower threshold LET than the lower limit, implement protective measures including a latchup protective circuit*.

b. For parts whose threshold LET for Single Event Upset (SEU) is below the lower limit specified in the project requirements, appropriate protective measures (including no measures) shall be taken according to the result of the mission impact assessment.

For the parts having threshold LET between the lower limit and the upper limit specified in the project requirements, SEU probability shall be calculated before the application of the parts*.

In SEU probability calculation, the solar quiet condition defined in CREME-MC in 2.1.3 (1) shall be used when a solar flare is not occurring while the worst-week model shall be used when a solar flare is occurring. The number of occurrences of solar flare shall be estimated in consideration of the solar activity cycle.

c. For power MOSFETs in which Single Event Burnout (SEB) and / or Single Event Gate Rupture (SEGR) occur(s), parts shall be selected so that no adverse effects are caused on the mission under their operation within the SEE safety operation area and applied derating criteria.

d. For linear integrated circuits where Single Event Transient (SET) and / or Single Event Functional Interruption (SEFI) occur(s), parts shall be selected in consideration of the effects of temporary transient and functional interruption. Or circuit design measures shall be taken.

(3) Identification of Radiation-Sensitive Parts

Prior to parts procurement, the contractor shall collect and evaluate the information regarding radiation-sensitive parts, identify the radiation tolerance data and their source for each part, and use the information for parts procurement, test plan preparation and radiation analysis of equipment.

* See Appendix 2 for supplementary requirements for scientific satellites.

5.2.2.4 Consideration to Space-capable Parts

When using commercial parts (space-capable parts), each project shall prepare an evaluation plan to perform evaluation, selection and quality assurance of the parts in reference to JERG-0-052 in 2.2 (5), JERG-1-010 in 2.2 (6), and JERG-2-023 in 2.2 (7), before applying for NSPAR. When it is difficult to apply for NSPAR, the parts shall be reviewed by the project. See 5.4 for details.

5.2.3 Ensuring Life by Derating

The contractor shall apply necessary derating to the parts to be used to satisfy the reliability, life and so forth required of the equipment.

The derating criteria shall be established in accordance with EEE-INST-002 in 2.1.2 (1) or ECSS-Q-ST-30-11 in 2.1.2 (2).

5.3 Parts Evaluation Prior to Selection

In parts selection, the following shall be confirmed for the newly developed parts listed in the candidate parts list.

(1) Evaluation of part manufacturers

(2) Construction analysis

(3) Evaluation test and qualification test

5.3.1 Evaluation of Part Manufacturers

The contractor shall evaluate the adequacy and capability of each part manufacturer's organization, factories and facilities, and confirm that the parts will be supplied in accordance with proper specifications for space use.

5.3.2 Quality Verification by Analysis (Construction Analysis)

The candidate parts shall be evaluated to confirm the integrity of built-in quality and the structure including the following.

(1) Validity of design and structural technology
(2) Integrity of reliability-related portions
(3) Validity of workmanship

When evaluation equivalent to those mentioned above has been conducted during development and evaluation of newly adopted parts, its results can be used.

5.3.3 Evaluation Test and Qualification Test

It shall be confirmed by the evaluation test that the function, performance and reliability of the parts will not be impaired by the environment encountered during the mission. When the test data of similar parts is available, confirmation may be made using this data.

If the qualification data of non-standard parts is additionally required, a qualification test shall be performed in accordance with 5.3.3.2.

5.3.3.1 Evaluation Test

The following items shall be included in the evaluation test.

(1) Temperature characteristic test (operation with electrical load under high / low temperature)
(2) Mechanical stress test (shock, vibration and constant acceleration)
(3) Thermal stress test (thermal shock, temperature cycling, storage at high / low temperature and humidity)
(4) Life test
(5) Assembly evaluation
(6) Radiation verification test (total ionizing dose, displacement damage and single event effect)

5.3.3.2 Qualification Test

(1) When qualification data of non-standard parts is newly required, the contractor shall, after coordinating with JAXA, plan and implement a qualification test to assure that the applicable parts meet the requirements of the specifications.
(2) The contractor shall re-qualify parts to assure the equivalence of the parts with the initial qualification in the case of changes in the design, material, manufacturing process and quality management of the parts.
(3) The qualification test or re-qualification test may also serve as the quality conformance inspection of the initial lot.

5.4 Parts Application Review

5.4.1 Selection and Review of Parts to Be Used

The contractor shall select parts to be used in the project based on the candidate parts list, and update and maintain the list as the list of the parts to be reviewed (the list of the parts to be used).

The parts used in the project can be a factor to restrict the function, performance and reliability of spacecraft and launch vehicles. Therefore all parts shall be selected in a planned manner from initial phase of the project to the extent possible and a list of the parts to be used shall be created, maintained and updated as follows.

(1) JAXA shall identify critical parts based on the mission requirements and clarify the procurement management policy of such parts in the System Definition Review (SDR) phase. The basic policy regarding the selection and procurement management of other parts shall be established by SDR.

(2) In the preliminary design phase, parts to be used in the applicable equipment shall be selected, and a list of the parts to be used shall be created and properly maintained. It is recommended to register the list in the Project Approved Parts Database (PAPDB).

(3) In the critical design phase, the list of the parts to be used shall be updated with inclusion of additional items. The list of the parts to be used shall be included in the input package of the Critical Design Review (CDR) and submitted to JAXA for review.

(4) When any items are added in the maintenance design phase, the list of the parts to be used shall be updated after the validating their specifications, qualification, application and other relevant factors and obtaining JAXA approval. The result shall be reported in post-test reviews (such as Post Qualification Review (PQR) and Pre-Shipment Review (PSR)).

(5) The parts list to be used for procured equipment shall be submitted to JAXA at the design review of the equipment, by updating the parts list of the subsystem manufacturer.

5.4.2 Application Review

In order to review the validity of the selected parts, an application review shall be conducted at a proper timing between the beginning of the preliminary design and CDR as stated below. Any items arising after CDR shall be reviewed in accordance with (4) below.

(1) An application review shall be performed by comparatively reviewing the design items for parts application and the parts selection result with actual application conditions. This review shall include the following. The review shall be conducted with particular emphasis on newly adopted parts and the parts that will be used in severer conditions / environments than in the past applications. Analysis conditions of temperature, vibration, shock and so forth for the application review shall be based on the conditions used for the qualification test.

a. Parts selection result (in comparison with the Approved Parts List (APL))
b. Conformity with the derating criteria
c. Conformity with the environment (such as vibration, shock and radiation) and the application restrictions (including evaluation of limited life items defined in JMR-004 in 2.1.1(1)).
d. For the examples of mounting method evaluation, see the description for planning and confirmation of applicable mounting method in JERG-0-039 in 2.1.1 (3) and JERG-0-043 in 2.1.1 (4).

e. Evaluation of failure / nonconformance information (including Shinraisei Gijutsu Joho (JAXA alerts))

(2) If any problem is identified in the review, validity of the final application shall be reviewed based on the trade-off result. The review report (a summary at the equipment level) including the verification results of the necessary measures shall be developed.

(3) This review report shall be reviewed at CDR.

(4) When design is changed in the maintenance design phase, validity of the parts application after the design changes shall be reviewed and the result shall be reported in the post-test review (such as PQR and PSR).

5.4.3 Non-Standard Parts Approval Request (NSPAR)

(1) When any parts to be used are "non-standard parts" listed in Table 5-1, the contractor shall fill out NSPAR application form and submit it to the project in charge for approval. If NSPAR is not applied, it shall be reviewed in the review described in 5.4.1.

(2) NSPAR shall be prepared and submitted by using PAPDB. When PAPDB cannot be used, the contractor shall follow the directions of the project in charge.

(3) Non-standard parts approval in the past is valid when the following conditions are met.

a. NSPAR application form on the parts has been submitted and approved in the past and there has been no reliability problem in design, structure, and manufacturing condition, and other relevant factors.

b. The specifications, test data, and other relevant documents / data approved in the past prove that the applicable conditions (such as life and environmental conditions) in the past approval are the same or severer than the conditions to be applied to the applicable rocket or spacecraft.

5.5 Parts Procurement

5.5.1 General

(1) The contractor shall procure the parts selected in accordance with the quality assurance level in 5.1 (See Table 5-1) and the parts selection criteria in 5.2.

(2) Qualified parts shall be confirmed for validity of their qualification. For new parts, particular attention shall be paid to the adequateness of the qualification criteria and validity of the part specifications.

(3) In parts procurement, continuous productivity shall be considered.

(4) It shall be confirmed that there is no quality issue that arose recently.

(5) It shall be confirmed that proper additional tests are required for non-standard parts.

5.5.2 Procurement Requirements

5.5.2.1 Procurement Document

When procuring the selected parts, the contractor shall prepare a procurement document that defines the requirements and procure the parts in accordance with the document.

The following items shall be specified at minimum in the procurement document.

(1) Item, part number, part manufacturer, quantity, and delivery date

(2) Technical requirements*

Design, structure, operating temperature range, environmental conditions, electrical characteristics and other relevant items shall be specified.

(3) Reliability and quality assurance requirements*

a. The design, manufacturing process, screening, qualification test, quality conformance inspection, incoming inspection criteria and other relevant items shall be specified in the procurement document and shall conform to the selected quality assurance level. When specifications of corresponding officially qualified parts are not available and no reference quality assurance level is defined, the requirements shall be based on the quality assurance level of the specifications of other officially qualified parts with the closest similarity, and the technical rationale for its application shall be provided.

b. The parts management method shall be specified so that the parts with the same design, structure and manufacturing conditions as those used for the qualification test can be procured. However, this may not be the case if only the parts from the same lot as those used for the qualification test are used.

(4) Traceability*

(5) Packaging

(6) Documents to be submitted

For the parts that are the reliability control items defined in JMR-004 in 2.1.1 (1), the contractor shall request the supplier to submit the documents that include test records necessary for reliability control or to store such documents for a period specified by the contractor after delivery.

* When the requirements are specified in the part specifications in 5.2.2.2, only the specifications number is requried in the procurement document.

5.5.3 Tests and Inspections

5.5.3.1 Screening

(1) A screening test shall be performed on all parts assembled in flight hardware in order to eliminate initial failures.

(2) In establishing the requirements of a screening test, care shall be taken not to impair the reliability of the parts due to the stress during the test.

(3) All the screening tests shall be implemented in facilities of the part manufacturer or facilities where screening test capability is confirmed.

(4) When 100-percent screening test is conducted on non-standard parts, SCREENING REQUIREMENTS (Table 2) per part type specified in paragraph 6.3 of EEE-INST-002 in 2.1.2 (1) of this document shall be applied as a guideline.

5.5.3.2 Quality Conformance Inspection

Quality conformance inspection shall be performed on each lot in accordance with part specifications for quality assurance of the lot. When a quality conformance inspection is conducted on non-standard parts, the requirements for quality conformance inspection (lot assurance test) in the applicable specifications of equivalent or similar officially qualified parts shall be applied as a guideline.

5.5.3.3 Radiation Verification Test

When the result of the previous radiation test on the parts to be used indicates little margin on radiation tolerance under the radiation environment to be encountered, a radiation verification test shall be performed in accordance with the radiation hardness assurance program defined for each project. Radiation verification tests shall be performed in accordance with internationally recognized standards such as ESCC 22900 in 2.1.2 (4), ESCC 25100 in 2.1.2 (5), JEDEC JESD57 in 2.1.2 (6), MIL-STD-750 in 2.1.2 (8), and MIL-STD-883 in 2.1.2 (9).

5.5.4 Source Inspection

(1) The contractor shall plan and implement a source inspection as needed as a part of a procedure to assure that the parts to be procured meet the requirements of the specifications and procurement documents.
(2) The details of the source inspection such as part type, processes (including precap inspection) and items to be inspected shall be specified in the parts program plan.

5.5.5 Incoming Inspection

The contractor shall document the procedure of an incoming inspection (including the method and pass / fail criteria) including the following items and perform the inspection in accordance with the document.

(1) Confirmation of appearance and marking (part number, lot identification, manufacturer name, etc.)
(2) Confirmation of quantity
(3) Confirmation of packaging
(4) Confirmation of the documents attached by the part manufacturer
(5) Confirmation of results of the tests additionally performed according to part type and criticality (e.g., solderability, electrical test, etc.)

When a source inspection has been implemented by the contractor or its representative, an incoming inspection may only confirm the below.

(1) Packaging condition
(2) Quantity

5.5.6 Destructive Physical Analysis (DPA)

The contractor shall plan and carry out DPA as follows to verify the quality of the parts to be procured for flight hardware (Flight Model (FM) or Proto-Flight Model (PFM)) (including parts to be used in procured equipment and in-house parts). Here, DPA means a series of inspections, tests and analyses that are conducted by disassembling the samples taken from the parts to be procured to confirm that the material, design, workmanship and structure comply with the requirements of the specification and are appropriate for the intended use.

(1) For non-standard parts, the following part types among EEE parts in 3 (1) shall be subjected to DPA.
Sample size shall be three per lot. When this is difficult due to the reasons including cost (expensive parts), it shall be coordinated individually.

a. Integrated circuits
b. Transistors
c. Diodes
d. Capacitors (ceramic, tantalum)
e. Resistors (metal film, wire-wound, network)
f. Crystals and crystal oscillators
g. Filters
h. Relays
i. Switches
j. Thermistors
k. Sensors
l. Fuses
m. RF devices
n. Others (mainly optical parts)

(2) For standard parts, the following part types among the parts specified in 3 (1) shall be subjected to DPA. Samples size shall be three per lot. For expensive parts, it shall be coordinated individually.

a. Integrated circuits
b. Transistors
c. Diodes
d. Crystals and crystal oscillators
e. Relays

(3) DPA may be conducted with samples that represent the family of the parts (e.g. for capacitors and resistors, parts with the maximum and minimum constant values per lot can be the representatives of each part family).

(4) DPA shall be conducted in accordance with the procedure of official standards including MIL-STD-1580 in 2.1.2 (10) and the results shall be documented.

(5) DPA shall be conducted by a procurer or a third party (such as a quality assurance company and test laboratory) that is independent from a part manufacturer. However, DPA may be conducted in the facility of the part manufacturer in the presence of the procurer or its representative.

(6) DPA (disassembly) shall not be conducted if part disassembly causes adverse effect on health and safety (e.g. to prevent toxic dust containing beryllium oxide from scattering).

(7) The omission of DPA may be coordinated based on the detailed information for each part when the parts fall under any of the followings, regardless of the above-mentioned requirements.

a. Flight proven parts that meet all the following conditions.
   - No problem has occurred in the past Construction Analysis (CA) and DPA.
   - No nonconformance or failure has occurred in the past in actual use (including ground test) after being mounted in the equipment.
   - The use of the applicable part poses no problem in risk management.
   - it has been confirmed that the changes in design and manufacturing conditions nor the nonconformances since the past usage have not caused reliability problems.
b. The part has a simple structure and its internal condition can be inspected after sealing.

c. Verification equivalent to DPA is performed during in-process inspection or quality verification test (Quality conformance Inspection (QCI), Lot Acceptance Test (LAT) / Lot Validation Test (LVT)). (e.g. JAXA-qualified parts)

5.5.7 Parts Handling and Storage

The contractor shall establish the in-house requirements for parts storage and handling procedures. The in-house requirements shall include at least the following.

(1) Environment criteria of the facilities where parts are stored and handled.
(2) Packaging criteria for storing parts.
(3) Criteria for identifying and handling the parts that are sensitive to electrostatic discharge (See JERG-0-036 in 2.2 (2)).

5.5.8 Relifing

(1) The contractor shall establish and manage the procedure for parts storage control as an in-house document.
(2) When using unmounted parts that have been stored in excess of the period specified in the storage control procedure and / or the following storage period, a relifing test shall be performed in accordance with the storage control procedure and only the parts that have passed the test shall be supplied for mounting.
(3) For the parts after a lapse of five years from their acceptance, the following tests shall be performed as a relifing test.
    a. Visual inspection
    b. Solderability test
(4) The parts after a lapse of ten years from their acceptance shall be used after re-evaluating their quality by a relifing test which includes the following items.
    a. Visual inspection
    b. Solderability test
    c. Electrical characteristics test (If parts cannot be tested alone, an alternative evaluation method may be adopted after coordinating with JAXA.)

5.5.9 Inspection Data Management

The inspection data in 5.5.3 to 5.5.6 and 5.5.8 shall be documented and stored.

5.6 Traceability and Action against Nonconformance

5.6.1 Traceability

For all parts for flight use, the traceability of the manufacturing and testing quality records shall be confirmed by either the serial number, lot number, date code, or order number, depending on the quality level.

Traceability shall be maintained through all the stages during the manufacturing / testing by the part manufacturer, parts acceptance and mounting, assembly / test, and parts storage.

5.6.2 Failure Analysis

(1) When anomaly / failure occurred in EEE parts after they were mounted, root cause investigation, disposition / corrective action and preventive action shall be implemented in accordance with the applicable reliability program plan.

(2) The impact of the failure on the applicable parts and similar parts as well as the possibility of causing dependent failures shall be assessed. If required, it shall be reported to JAXA.

(3) Anomaly / failure control shall be implemented from the start of manufacturing of the assembly for qualification or flight use.

5.6.3 Making Use of Nonconformance Information

The contractor shall collect information of the following items through the phases of parts selection, procurement and storage, and verify the soundness of the parts.

(1) By investigating the information obtained from the JAXA alert system, JAXA Problem Reporting and Corrective Action System (JAPCAS) and other relevant information sources, it shall be confirmed that no nonconformance information is present.

(2) When nonconformance information is obtained after the parts selection, the nonconformance information shall be analyzed and reported to JAXA after examining the extent affected by the nonconformance.

5.7 Making Use of Parts Information

5.7.1 Parts Database

The contractor may obtain and utilize the following information from the “Database of JAXA Qualified EEE Parts and Materials” operated by JAXA.

a. Parts information
b. Information of parts developed by JAXA
c. Specifications information
d. Qualification management information
e. Application forms
f. Related information

Reference: Database of JAXA Qualified EEE Parts and Materials
(https://eeepitnl.tksc.jaxa.jp/en/)

5.7.2 Parts Application Handbook

JERG-0-035 in 2.2 (1) may be utilized as a reference.

Appendix 1: Terms and Abbreviations

1. Abbreviations

(1)	APL	: Approved Parts List
(2)	BPF	: Band Pass Filter
(3)	CA	: Construction Analysis
(4)	CDR	: Critical Design Review
(5)	CREME-MC	: Cosmic Ray Effects on MicroElectronics - Monte Carlo
(6)	CVCM	: Collected Volatile Condensable Materials
(7)	DD	: Displacement Damage
(8)	DPA	: Destructive Physical Analysis
(9)	ECSS	: European Coordination for Space Standardization
(10)	EEE	: Electrical, Electronic, Electromechanical
(11)	ELDRS	: Enhanced Low Dose Rate Sensitivity
(12)	EMI	: ElectroMagnetic Interference
(13)	EPPL	: European Preferred Parts List
(14)	ESCC	: European Space Components Coordination
(15)	FRL	: Failure Rate Level
(16)	FPGA	: Field-Programmable Gate Array
(17)	GSFC	: Goddard Space Flight Center
(18)	HPF	: High Pass Filter
(19)	HSD	: Hot Solder Dip
(20)	JAXA	: Japan Aerospace Exploration Agency
(21)	JAPCAS	: JAXA Problem Reporting and Corrective Action System
(22)	LAT	: Lot Acceptance Test
(23)	LET	: Linear Energy Transfer
(24)	LPF	: Low Pass Filter
(25)	LVT	: Lot Validation Test
(26)	MIL	: Military
(27)	NASA	: National Aeronautics and Space Administration
(28)	NPSL	: NASA Parts Selection List
(29)	NSPAR	: Non-Standard Parts Approval Request
(30)	PAPDB	: Project Approved Parts DataBase
(31)	OTP	: One-Time Programmable
(32)	PLD	: Programmable Logic Device
(33)	PPBI	: Post Programming Burn-In
(34)	PQR	: Post Qualification Test Review
(35)	PROM	: Programmable Read Only Memory
(36)	PSR	: Pre-Shipment Review
(37)	QCI	: Quality Conformance Inspection
(38)	QML	: Qualified Manufacturers List
(39)	QPL	: Qualified Products List
(40)	RF	: Radio Frequency
(41)	RFI	: Radio Frequency Interference

(42) SAW : Surface Acoustic Wave
(43) SCD : Source Control Drawing
(44) SDR : System Definition Review
(45) TML : Total Mass Loss
(46) SEE : Single Event Effect
(47) SEU : Single Event Upset
(48) SEL : Single Event Latchup
(49) SEB : Single Event Burnout
(50) SEDR : Single Event Dielectric Rupture
(51) SEFI : Single Event Functional Interrupt
(52) SEGR : Single Event Gate Rupture
(53) SET : Single Event Transient
(54) TID : Total Ionizing Dose

2. Definition of Terms (All radiation-related terms are listed after (31).)

(1) Incoming inspection:

Inspection conducted by the contractor to verify that the appearance / shape, function, performance, quantity etc. of the delivered parts meet the requirements of the part specifications. Typically the inspection is performed when the acceptance of the parts delivery takes place at the supplier's office.

(2) Space-capable parts:

A general term for the parts that are used outside space industry; not designed, manufactured and quality-assured in accordance with military standards or space standards; but categorized as high-reliable parts (for submarine cables, nuclear power, aircraft, etc.), automotive parts (for engine control and other parts involving human lives) and industrial parts (for plant equipment / infrastructure communication and other parts which cause significant impact in case of failure).

(3) Database of JAXA Qualified EEE Parts and Materials:

Database created, maintained and operated by JAXA.

(4) Suppliers:

Parties the contractor places an order for products or services. For example, the following agents and companies are included.

a. Part manufacturers
b. Professionals performing screening, DPA, etc.
c. Quality assurance companies that assure the quality of parts by implementing such as a source inspection and failure analysis and deliver them to the contractor
d. Overseas source inspection agents

(5) Counterparty of the contract (Contractor):

A development company responsible for parts selection, procurement and application. Depending on the contract type, JAXA internal organizations, domestic organizations jointly participating in development with JAXA, and overseas organizations participating in development with JAXA shall

implement a part or all of the requirements of this standard. For example, the Institute of Space and Astronautical Science of JAXA, as an institute to promote collaborative researches, often coordinates the requirements with domestic and / or overseas research institutes during system design phase implemented by JAXA. As stated above, for some cases, domestic and / or overseas research institutes could be considered as contractors. JAXA integrates the development requirements in upstream phases and optimizes the system.

(6) Source inspection:

Inspection conducted by the contractor at the facility of the supplier that manufactures products. It is considered part of an incoming inspection in a broad sense.

(7) Construction analysis:

A series of destructive inspection, non-destructive inspection, analysis and tests conducted on selected samples to verify at an early stage that material, design, manufacturing workmanship and structure are appropriate to the specification requirements and intended application.

(8) Obsolete parts:

Parts that are no longer supplied or have a risk of supply termination due to the various reasons including production discontinuation.

(9) Officially qualified parts:

Parts qualified by official organizations. JAXA-qualified parts, ESCC-qualified parts, and MIL-qualified parts are referred to as officially qualified parts in this standard.

(10) System Definition Review (SDR):

It is a review chaired by the head of a Directorate or a person appointed by the head of the Directorate. The followings are reviewed.

- Validity of basic configuration and specifications of the system
- The system specification is sufficiently feasible with consideration of draft specifications of subsystems / equipment including software, based on the result of a system feasibility study (in the project formulation phase)
- Validity of verification plan with respect to system specifications (including software)
- Technical preparation for the preliminary design phase has been completed
- A series of preparations for transition to a project such as developing organizational structure and planning have been completed (judged at the Directorate level)

(11) Critical Design Review (CDR):

A review implemented prior to prototype model production and when critical design is almost completed. In CDR, the results from the critical design such as manufacturing drawings, specifications and test results of the engineering model are evaluated to confirm that they satisfy the requirements specified in the contracts and technical specifications and that the transition to prototype model production is ready.

(12) Screening:

A test or combination of tests to remove or detect nonconformance items or items that may have initial failures.

(13) Single failure point:

A single element that causes failure of the entire hardware if it fails. It is a specific portion that has no backup function or cannot have backup function and its failure leads to the loss of function of the entire system.

(14) Ground equipment:

Equipment that has electrical and / or mechanical interface with launch vehicles or spacecraft and is used to inspect flight hardware / software on the ground.

(15) Tailoring:

An act to revise the requirement document by sorting out or rewriting the requirements to suit the applicable program in consideration of various conditions

(16) Qualification test:

A test to verify whether parts satisfy the required function, performance and reliability under the required environmental conditions in order to qualify that the part design, manufacturing / test process and finished parts meet the required specifications.

(17) Qualified parts:

Parts intended to be used commonly in launch vehicles and spacecraft and whose function, performance and reliability have been validated by a qualification test in advance. They consist of officially qualified parts and other qualified parts. Officially qualified parts include JAXA-qualified parts, MIL-qualified parts and ESCC-qualified parts.

(18) Standard parts:

The officially qualified parts that meet the quality assurance level required in the applicable program.

(19) Non-standard parts:

Parts other than standard parts.

(20) Non-Standard Parts Approval Request (NSPAR):

A request for approval submitted by the contractor to the applicable project in JAXA to use non-standard parts in their subsystems or equipment.

(21) Quality assurance:

A systematic and organized system of all activities necessary to assure that the end items meet all the defined quality requirements.

(22) Quality assurance level:

A category of quality assurance for Class I to Class III parts.

(23) Quality conformance inspection:

A set of inspections performed to verify that the parts manufacturing process has been maintained since the time of the qualification and that the manufactured parts and lots meet the requirements of the part specifications.

(24) Nonconformance:

The condition of an item where one or more characteristics fail to meet the requirements or are abnormal. It includes anomaly, failure, deviation, defect, shortage and malfunction.

(25) Nonconformance information system:

Refers to the JAXA Problem Reporting and Corrective Action System (JAPCAS), maintained and operated by JAXA.

(26) Project Approved Parts Database (PAPDB):

The database maintained and operated by JAXA which integrates information of the parts used in spacecraft and NSPAR approval.

(27) Part:

An item that consists of a single element or a combination of two or more pieces that cannot be disassembled without destroying the intended use of the design.

(28) Quality assurance level of parts:

The term representing the quality level of parts. Depending on their quality level, parts are classified into Class I parts, Class II parts and Class III parts.

(29) Post Qualification Test Review (PQR):

A review implemented after conducting the qualification test for the prototype model manufactured based on the manufacturing drawings, specifications and manufacturing processes. By evaluating the qualification test result, it verifies that the product meets the requirements of the development specifications and that the specified manufacturing drawings, specifications and manufacturing processes are established.

(30) Source Control Drawing (SCD):

A part specification document used for procurement in which technical specifications and quality assurance requirements are specified.

(31) Dose:

A general term that represents the amount of radiation or absorbed energy. The term is also used in various meanings such as absorbed dose and exposure dose.

(32) Total Ionizing Dose (TID):

The sum of the absorbed radiation dose that a semiconductor or material absorbs in a certain time period. One of the typical radiation effects that causes degradation in performance and other characteristics of semiconductor devices.

(33) Displacement Damage (DD):

A kind of damage that occurs in optical devices (such as optocouplers, LEDs, optical sensors and CCDs) and solar cells. High-energy particles including protons displace nuclei in the crystalline lattice and create crystal defects, which degrade the performance of a device.

(34) Enhanced Low Dose Rate Sensitivity (ELDRS):

The state that a device degrades more by the irradiation at low dose rate than at high dose rate, or the degree of the degradation. In MIL-STD-883G METHOD 1019.7, 1.1 g, this term is used for the parts that degrade more by the irradiation at dose rate of 0.5 Gy(Si) / s [50 rad(Si) / s] or less.

(35) Single Event Effect (SEE):

A phenomenon that causes malfunction (soft error) or permanent damage such as latchup in circuit elements by the incidence of a single high-energy particle. There are various kinds of SEEs such as SEU, SEL, SEB, SEGR, SEDR, SET and SEFI.

(36) Single Event Upset (SEU):

A bit flip of the recorded information in devices such as memories and microprocessors. Electric charge generated by the incidence of a charged particle flows into memory circuit and causes malfunction, which results in a bit flip.

(37) Single Event Transient (SET):

A non-destructive phenomenon that occurs in optical devices, linear ICs such as OP-amps and comparators, and logic circuits. Noise pulse generated by the incidence of a charged particle into the input stage of the device is retained in the latch circuit or propagated to the output stage, and causes a malfunction in the circuit.

(38) Single Event Latchup (SEL):

SEL occurs mainly in devices with CMOS structure. CMOS structure includes a parasitic thyristor and it turns on by the noise current induced by the incidence of a charged particle, causing continuous large current flow in the device. Since large current continues to flow until the parasitic thyristor is turned off by shutting down the device, it causes meltdown of an electrode in the device and voltage drop in the same power supply system.

(39) Single Event Burnout (SEB):

SEB occurs mainly in power MOSFETs. A parasitic transistor in the device is turned on by the incidence of a charged particle and that induces a large current, resulting in the burnout of the device.

(40) Single Event Gate Rupture (SEGR):

SEGR occurs in power MOSFETs and is a breakdown of the gate oxide.

(41) Single Event Dielectric Rupture (SEDR):

SEDR is a destructive phenomenon that occurs in devices such as linear ICs and FPGAs. It is an electrical breakdown of the dielectric at the area with high electric field induced by the incidence of a charged particle.

(42) Single Event Functional Interrupt (SEFI):

SEFI is a non-destructive phenomenon that occurs in devices such as linear ICs, memories, AD / DA converters and FPGAs. It is a phenomenon that leads to a temporal transient or malfunction (or interruption of normal operation) of the device by the incidence of a charged particle. The device recovers itself when the power supply is reset.

Appendix 2: Supplementary Notes for Individual Projects

(1) Supplementary Items for Launch Vehicles

Refer to the following items in addition to the main body of this document for launch vehicles.

- Related to 5.2.2.1 (4)(e): Aluminum electrolytic capacitors can be used as long as consideration is given to the use conditions (such as temperature, voltage and orbit altitude) and storage conditions on the ground.
- Related to 5.2.2.1 (7): Tin alloy having a lead content of 3% or less and pure tin may cause whiskers, however they may be used by applying JERG-1-009 "Lead Free Parts Application Standard for Rocket Avionics."
- Related to 5.2.2.1 (9): When non-hermetic type relays, thermostats and switches are used, necessary explosion-proof measures such as potting and pressurization by inert gas shall be taken.
- Related to 5.2.2.1 (10): For launch vehicles, 5.2.2.2 (9) shall be replaced with the following sentence.

  "JERG-0-034 in 2.1.1 (2) and NASA-RP-1124 in 2.1.2 (12) shall be referred for outgassing, and effective protective measures shall be taken in case any adverse effect is expected.

(2) Supplementary Items for Scientific Satellites

Refer to the following items in addition to the main body of this document for scientific satellites.

- Related to 5.2.2.3 (2) (a): The lower limit of SEL threshold LET shall be 75 MeV/(mg/cm^2) in the case of science missions.
- Related to 5.2.2.3 (2) (b): For the parts with SEU threshold LET of less than 25 MeV/(mg/cm^2), protective measures (including no measures) shall be taken depending on the result of the impact assessment to the mission.

  For parts with SEU threshold LET of between 25 MeV/(mg/cm^2) and the upper limit specified by project individual requirements, SEU occurrence rate shall be estimated before selection.