AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE	PAGE OF PAGES
	1 / 97

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. *(If applicable)*
000001	07/24/2015		AEPS

6. ISSUED BY CODE GRC

NASA/Glenn Research Center
Procurement Division, MS 60-1
21000 Brookpark Road
Cleveland OH 44135-3127

7. ADMINISTERED BY *(If other than Item 6)* CODE

8. NAME AND ADDRESS OF CONTRACTOR *(No., street, county, State and ZIP Code)*

CODE FACILITY CODE

(x) 9A. AMENDMENT OF SOLICITATION NO.
NNC15ZCH014R

x 9B. DATED *(SEE ITEM 11)*
07/24/2015

10A. MODIFICATION OF CONTRACT/ORDER NO.

10B. DATED *(SEE ITEM 13)*

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☒ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended. ☒ is not extended.
Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods: (a) By completing Items 8 and 15, and returning 0 copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA *(If required)*

13. THIS ITEM ONLY APPLIES TO MODIFICATION OF CONTRACTS/ORDERS. IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

CHECK ONE

A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: *(Specify authority)* THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.

B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES *(such as changes in paying office, appropriation date, etc.)* SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).

C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:

D. OTHER *(Specify type of modification and authority)*

E. IMPORTANT: Contractor ☐ is not. ☐ is required to sign this document and return _____ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION *(Organized by UCF section headings, including solicitation/contract subject matter where feasible.)*

INCO TERMS 2: DESTINATION

Please see the attached pages for Amendment 1.

Except as provided herein, all terms and conditions of the document referenced in Item 9 A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER *(Type or print)*		16A. NAME AND TITLE OF CONTRACTING OFFICER *(Type or print)*	
		LEAHMARIE Koury	
15B. CONTRACTOR/OFFEROR	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA	16C. DATE SIGNED
(Signature of person authorized to sign)		*(Signature of Contracting Officer)*	12/10/15

Part I.

In accordance with Procurement Class Deviation 15-05 the following clause and provision are removed from the subject RFP in their entirety:

I.138 1852.234-2 Earned Value Management System. (NOV 2006)

L.11 1852.234-1 Notice of Earned Value Management System. (NOV 2006)

and replaced with:

I. 138 EARNED VALUE MANAGEMENT SYSTEM 1852.234-2 (NOV 2015) [(DEVIATION)](ALTERNATE I)(NOV 2006)

(a) In the performance of this contract, the Contractor shall use--

1) An Earned Value Management System (EVMS) that has been determined by the Cognizant Federal Agency to be compliant with the EVMS guidelines specified in the American National Standards Institute (ANSI)/Electronic Industries Alliance (EIA) 748 Standard, Industry Guidelines for Earned Value Management Systems (current version at the time of award) to manage this contract; and

(2) Earned Value Management (EVM) procedures that provide for generation of timely, accurate, reliable, and traceable information for the Contract Performance Report (CPR) and the Integrated Master Schedule (IMS) required by the data requirements descriptions in the contract.

(b) If, at the time of award, the Contractor's EVMS has not been determined by the Cognizant Federal Agency to be compliant with the EVMS guidelines, or the Contractor does not have an existing cost/schedule control system that is compliant with the guidelines in the ANSI/EIA-748 Standard (current version at the time of ward), the Contractor shall apply the system to the contract and shall take timely action to implement its plan to be compliant with the guidelines. The Government will not formally validate/accept the Contractor's EVMS with respect to this contract. The use of the Contractor's EVMS for this contract does not imply Government acceptance of the Contractor's EVMS for application to future contracts. The Government will monitor compliance through routine surveillance.

(c) The Government will conduct Integrated Baseline Reviews (IBRs). Such reviews shall be scheduled and conducted as early as practicable, and if a pre-award IBR has not been conducted, a post-award IBR should be conducted within 180 calendar days after contract award, or the exercise of significant contract options, or within 60 calendar days after distribution of a supplemental agreement that implements a significant funding realignment or effects a significant change in contractual requirements (e.g., incorporation of major modifications). The objective of IBRs is for the Government and the Contractor to jointly assess the Contractor's baseline to be used for performance measurement to ensure complete coverage of the statement of work, logical scheduling of the work activities, adequate resourcing, and identification of inherent risks. See the NASA IBR Handbook (http://evm.nasa.gov/handbooks.html) for guidance.

(d) Unless a waiver is granted by the Cognizant Federal Agency, Contractor proposed EVMS changes require approval of the Cognizant Federal Agency prior to implementation. The Cognizant Federal Agency shall advise the Contractor of the acceptability of such changes within 30 calendar days after receipt of the notice of proposed changes from the Contractor. If the advance approval requirements are waived by the Cognizant Federal Agency, the Contractor shall disclose EVMS changes to the Cognizant Federal Agency at least 14 calendar days prior to the effective date of implementation.

(e) The Contractor agrees to provide access to all pertinent records and data requested by the Contracting Officer or a duly authorized representative. Access is to permit Government surveillance to ensure that the Contractor's EVMS complies, and continues to comply, with the EVMS guidelines referenced in paragraph (a) of this clause, and to demonstrate:

(1) Proper implementation of the procedures generating the cost and schedule information being used to satisfy the contract data requirements;

(2) Continuing application of the accepted company procedures in satisfying the CPR required by the contract through recurring program/project and contract surveillance; and

(3) Implementation of any corrective actions identified during the surveillance process.

(f) The Contractor shall be responsible for ensuring that its subcontractors, identified below, comply with the EVMS requirements of this clause as follows:

(1) For subcontracts with an estimated dollar value of $100 million or more, the following subcontractors shall comply with the requirements of this clause.

(2) For subcontracts with an estimated dollar value of less than $100 million, the following subcontractors shall comply with the requirements of this clause except for the requirement in paragraph (b), if applicable, to obtain compliance/validation.

[TBD]

(g) If the contractor identifies a need to deviate from the agreed baseline by working against an Over Target Baseline (OTB) or Over Target Schedule (OTS), the contractor shall submit to the Contracting Officer a request for approval to begin implementation of an OTB or OTS. This request shall include a top-level projection of cost and/or schedule growth, whether or not performance variances will be retained, and a schedule of implementation for the reprogramming adjustment. The Government will approve or deny the request within 30 calendar days after receipt of the request. Failure of the Government to respond within this 30-day period constitutes approval of the request. Approval of the deviation request does not constitute a change, or the basis for a change, to the negotiated cost or price of this contract, or the estimated cost of any undefinitized contract actions.

(End of clause)

L.11 NOTICE OF EARNED VALUE MANAGEMENT SYSTEM 1852.234-1 (NOV 2015) [(DEVIATION)] (RFP SPECIFIC EDIT)

(a) The offeror shall provide documentation that its proposed Earned Value Management System (EVMS) complies with the EVMS guidelines in the American National Standards Institute (ANSI)/Electronic Industries Alliance (EIA)-748 Standard, Earned Value Management Systems (current version at time of solicitation).

(b) If the offeror proposes to use a system that currently does not meet the requirements of paragraph (a) of this provision, the offeror shall submit its comprehensive plan for compliance with the EVMS guidelines to the Government for approval.

(1) The plan shall:

(i) Describe the EVMS the offeror intends to use in performance of the contract;

(ii) Distinguish between the offeror's existing management system and modifications.

(iii) Provide a matrix that correlates each guideline in ANSI/EIA 748 (current version at time of solicitation) to the corresponding process in the offeror's written management procedures;

(iv) Describe the proposed procedure for application of the EVMS requirements to subcontractors;

(v) Describe how the offeror will ensure EVMS compliance for each subcontractor subject to the flowdown requirement in paragraph (c) whose EVMS has not been recognized by the Cognizant Federal Agency as compliant according to paragraph (a);

(vi) Provide documentation describing the process and results, including Government participation, of any third-party or self-evaluation of the system's compliance with the EVMS guidelines; and

(vii) If the value of the offeror's proposal, including options, is $100 million or more, provide a schedule of events leading up to formal validation and Government acceptance of the Contractor's EVMS. Guidance can be found in the Department of Defense Earned Value Management Implementation Guide (https://acc.dau.mil/CommunityBrowser.aspx?id=19557) as well as in the National Defense Industrial Association (NDIA) Earned Value Management Systems Acceptance Guide (http://www.ndia.org/divisions/divisions/procurement/pages/programsystemcommittee.aspx).

(viii) RFP SPECIFIC: The plan shall be submitted as part of the Cost Proposal, and shall not be counted against the Mission Suitability page count referenced in L.16. All information provided shall be concise be concise and not overly burdensome.

(2) The offeror shall provide information and assistance as required by the Contracting Officer to support review of the plan.

(3) The Government will review the offeror's EVMS implementation plan prior to contract award.

(c) The offeror shall identify in its offer the major subcontractors, or major subcontracted effort if major subcontractors have not been selected, planned for application of the EVMS requirement. Prior to contract award, the offeror and NASA shall agree on the subcontractors, or subcontracted effort, subject to the EVMS requirement.

(d) The offeror shall incorporate its compliance evaluation factors for subcontractors into the plan required by paragraph (b) of this provision.

(End of provision)

PART II.

Spare Part Clarification

Part II (a):

SOW section 2.1 Base Period of Performance Deliverables: “4. Two (2) additional EDU cathodes and one (1) additional EDU discharge channel,” is hereby removed in its entirety.

Part II (b):

The following RFP Section M language is removed in its entirety:

TA1.1 - The Offeror's proposed PPU technical development approach including details of:

- Initial design reference point and selection rationale of that reference design, whether using the Government's PPU electrical design (provided in provisional attachment J.2(16)) or Offeror's own electrical design including:
    - Design advancements and deviations from the Government reference design
    - Level of maturity and heritage on the Offeror's own electrical design, if chosen
- Anticipated design iterations
- Use of models and simulations
- Parts selection including EEE parts
- Spare parts and rationale
- Identified long lead procurement items
- Anticipated residual risks of the PPU design at CDR

And replaced with:

TA1.1 - The Offeror's proposed PPU technical development approach including details of:

- Initial design reference point and selection rationale of that reference design, whether using the Government's PPU electrical design (provided in provisional attachment J.2(16)) or Offeror's own electrical design including:
    - Design advancements and deviations from the Government reference design
    - Level of maturity and heritage on the Offeror's own electrical design, if chosen
- Anticipated design iterations
- Use of models and simulations
- Parts selection including EEE parts
- List of spare parts and rationale
- List of additional development hardware for component testing and rationale
- Identified long lead procurement items
- Anticipated residual risks of the PPU design at CDR

Part III. Modifications to J.1(d) Government-Furnished Property and Information

Table 1 in attachment J.1(d) is removed in its entirety and replaced with the following (please note the highlighted identified changes):

Table 1

#	Name	Description	Serial #	Manu-facturer	NASA Tag #	QTY	Unit Acq. Cost	Furnished as-is?	Any instructions for physical inspection	Location	Any applicable conditions
1	TDU Thruster	As built High-Fidelity Laboratory Model Hall Thruster		NASA		2	$750K (TBR)	Yes	N/A	NASA ~~GRC~~	TBD
2	TDU Spare Parts and Raw Materials	As built laboratory components and sub-assemblies	Various	NASA	N/A	Various	Total $100K (TBR)	Yes	N/A	NASA ~~GRC~~	N/A
3	Lab Cathode Heaters	As built BaO and LaB6 laboratory cathode heaters	N/A	NASA	N/A	>2 (TBR)	$1K	Yes	N/A	Various	N/A
4	Lab Cathodes	As built BaO and LaB6 laboratory cathodes	N/A	NASA	N/A	2 of each	$15K	Yes	N/A	Various	N/A
5	Thruster Shipping Container	A shipping container that protects TDU thruster during shipping	N/A			1	$24K (TBR)	Yes	N/A	NASA ~~GRC~~	N/A
6	15 kW Thruster Power Console	A power console for operating non-flight HERMeS thrusters over the full throttling range. It is made of commercially-available power supplies. (use at GRC or JPL only)		NASA GRC	N/A	1	$75K (TBR)	Yes	N/A	NASA ~~GRC (B301, VF5)~~	N/A
6	Thruster Xenon Feed System	A xenon feed system for operating non-flight HERMeS thrusters over the full throttling range. It is made of commercially-available components. (use at GRC or JPL only)		NASA GRC	N/A	1	$40K (TBR)	Yes	N/A	NASA ~~GRC (B301, VF5)~~	N/A
7	Discharge Channel Magnetic Field Mapping Equipment	This equipment includes the hardware necessary to autonomously create a 2-D map the magnetic field of a HERMeS. (use at GRC or JPL only)	N/A	NASA GRC	N/A	1	$45K	Yes	N/A	NASA ~~GRC (B301, VF5)~~	N/A
8	Diagnostic for Ion Thruster Plume Characterization	Wein filter spectrometer (ExB probe), Retarding Probe Analyzer (RPA), electrostatic probes, laser-induced fluorescence (LIF), and translating/rotary stages for plume	N/A	NASA GRC	N/A	1	$120K	Yes	N/A	NASA ~~GRC (B301, VF5)~~	N/A

		interrogation. (use at GRC or JPL only)									
9	Thruster Thermal Shroud	Includes a 1.2 m diameter by 1.0 m long thermal shroud within which a HERMeS thruster can be mounted. The shroud can either be actively cooled with liquid nitrogen or heated with eight internal heat lamps.	N/A	NASA GRC	N/A	1	$10K	Yes	N/A	NASA ~~JPL~~	N/A
10	Inverted-Pendulum Thrust Stand	Haag-design NASA thrust stand for thrust measurement. (use at GRC or JPL only)	N/A	NASA GRC	N/A	1	$20K	Yes	N/A	NASA	N/A
11	Profilometer	Nanovea inspection tool for component erosion measurements. (use at GRC or JPL only)	N/A	Nanovea	N/A	1	$70k	Yes	N/A	NASA	N/A
12	Brassboard HP-120/800V PPU	As built PPU tested in 1 ATM and Vacuum	N/A	NASA GRC	N/A	1	$100K	Yes	N/A	NASA GRC (B333, RTBD)	N/A
13	Brassboard HP-120/800V PPU harness and cables for 1-ATM	Input and output harness and cables that connects to 1. The High Voltage Bus, 2. Low Voltage Bus, 3. 1553 Communication /control bus. 4. Discharge resistive load 5.Auxiliary supplies resistive load.	N/A	NASA GRC	N/A	8	$5K	Yes	N/A	NASA GRC (B333, RTBD)	
14	Brassboard HP-120/800V PPU Discharge Supply Resistive Load	A resistive load simulator for verifying the functionality of PPU Discharge Supply.	N/A	NASA GRC	N/A	1	$15K	Yes	N/A	NASA GRC (B333, RTBD)	
15	Brassboard HP-120/800V PPU Auxiliary Supplies Resistive Load	A resistive load simulator for verifying the functionality of PPU Auxiliary Supplies	N/A	NASA GRC	N/A	1	$5K	Yes	N/A	NASA GRC (B333, RTBD)	
16	SCB Simulator and Interface Box	Telemetry and command interface (aka Data Command and Interface Unit)	N/A	JPL	N/A	1	$6k (TBR)	Yes		NASA JPL	
17	Brassboard HP-120/800V PPU Coldplate	PPU Coldplate	N/A	NASA	N/A	1	$8k	Yes	N/A	NASA GRC	N/A

PART IV: Attachment J.1(b) Contract Data Requirements

Attachment J.1(b) is hereby removed it its entirety and replaced with the following (attached) J.1(b)v2 (please note the highlighted identified changes.):

To synopsize the substantive changes were made in the following four areas:

1. DRD 01.004.01 Earned Value Management System Description and Contract Data Requirements List (CDRL) Table due dates modified to the following:
    - At contract award plus 15 calendar days. Final due 60 calendar days after contract award. Update if EVMS architecture changes.

2. DRD 01.004.07 Integrated Program Management Report and Contract Data Requirements List (CDRL) Table due dates modified to the following:
    - Preliminary IMS, Format 6, at Contract Award plus 15 calendar days. The first submission (Formats 1-7 and Fee Schedule) is due within 12 working days after the end of the second full accounting period following the contract authority to proceed (ATP).

3. DRD 02.011.06 Critical Component/Subassembly Design Review Package and Contract Data Requirements List (CDRL) Table due dates modified to the following:
    - Plan: Preliminary - NLT 30 calendar days prior to the review; Final – NLT 14 calendar days prior to review.
    - Final review documentation – NLT 7 calendar days prior to review.
    - Review: Can be one review or smaller reviews as early as technically feasible but no later than 30 days prior to PDR.

4. Consistency of time units and language clarification.

Attachment B. Contract Data Requirements

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1.0 Introduction

Subject to the Rights in Data clause, this attachment sets forth the requirements for the data deliverables required by the Contract Statement of Work (SOW). The Contractor shall furnish data identified in the Data Requirements List (DRL) and defined by the Data Requirements Descriptions. In cases of conflict where data requirements are covered by a Federal Acquisition Regulation (FAR) or NASA FAR Supplement (NFS) regulation or clause, the FAR or NFS regulation will take precedence over this document per FAR 52.215-8.

2.0 Applicable and Guidance Documents

Applicable documents (A in table below) are used only where an alternate is not permitted. Guidance documents (G) are used where an alternate can be implemented. NASA acceptance of alternate documents is required.

Table 1. Applicable and Guidance Document List

Document Type	Document No.	Document Title
G	---	NASA IPMR Implementation Guide
G	AIAA S-120-2006	AIAA Standard — Mass Properties Control for Space Systems
G	AIAA S-122-2007	AIAA Standard — Electrical Power Systems for Unmanned Spacecraft
A	ANSI/ASME Y14.24	Types and Applications of Engineering Drawings
A	ANSI/EIA-748	Earned Value Management Systems
A	ANSI/ESD S20.20	Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
A	ASME Y14.100	Engineering Drawing Practices
A	DI-MGMT-81861	Data Item Description, Integrated Program Management Report
A	EEE-INST-002	Instructions for EEE Parts Selection
A	GEIA-STD-0005-1	Performance Standard For Aerospace And High Performance Electronic Systems Containing Lead-Free Solder
A	GEIA-STD-0005-2	Standard for Mitigating the Effects of Tin in Aerospace and High Performance Electronic Systems
G	GLP-QE-8739.1	GRC Electrostatic Discharge Control Procedure
A	GLWI-QE-8720.2	Failure Modes and Effects Analysis (FMES), Critical Items List (CIL), and Fault Tree Analysis (FTA)
G	GLWI-QE-8720.3	Reliability Prediction/Maintainability Assessment/Availability Analyses
G	GLWI-QE-8720.5	Preparation of the Limited-Life Items Plan
A	IEEE 730	Standard for Software Quality Assurance Plans
G	IEST-STD-CC1246E	Product Cleanliness Levels - Applications, Requirements, and Determination
A	JPL-PD-ED-1212	Design And Analysis Of Electronic Circuits For Worst Case Environments and Part Variations

Document Type	Document No.	Document Title
G	NAS 412	Foreign Object Damage / Foreign Object Debris (FOD) Prevention
G	NASA/SP-2010-3403	NASA Schedule Management Handbook
G	NASA/SP-2010-3404	NASA Work Breakdown Structure (WBS) Handbook
A	NASA-HDBK-4008	Programmable Logic Devices (PLD) Handbook
G	NASA-HDBK-8739.23	Complex Electronics Handbook for Assurance Professionals
G	NASA-STD-005	NASA Configuration Management Standard
G	NASA-STD-6008	NASA Fastern Procurement, Receiving Inspection, and Storage Practices for Spaceflight Hardware
A	NASA-STD-6016	Standard Materials and Processes Requirements for Spacecraft
G	NASA-STD-7009	Standards for Models and Simulations
A	NASA-STD-8719.13	Software Safety Standard
A	NASA-STD-8719.9	NASA Standard for Lifting Devices and Equipment
A	NASA-STD-8739.8	Standard for Software Assurance
A	NFS 1852.234-1	Notice of Earned Value Management System
A	NFS 1852.234-2	Earned Value Management System
A	NFS 1852.246-72	Material Inspection and Receiving Report.
G	NIST SP 800-53	Security and Privacy Controls for Federal Information Systems and Organizations
G	NPD 7120.4	Program/Project Management
G	NPD 8730.2	NASA Parts Policy
G	NPD 8730.5	NASA Quality Assurance Program Policy
A	NPR 6000.1H	Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems, Equipment, and Associated Components
G	NPR 7120.5	NASA Space Flight Program and Project Management Requirements
G	NPR 7120.7	NASA Information Technology and Institutional Infrastructure Program and Project Management Requirements
G	NPR 7120.8	NASA Research and Technology Program and Project Management Requirements
G	NPR 7123.1	NASA Systems Engineering Processes and Requirements
A	NPR 7150.2	NASA Software Engineering Requirements
G	NPR 8000.4	Agency Risk Management Procedural Requirements
A	NPR 8621.1	NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping
A	NPR 8715.3	NASA General Safety Program Requirements
A	NPR 8735.2	Management of Government Quality Assurance Functions for NASA Contracts
A	SAE AS9100	Quality Systems - Aerospace - Model for Quality Assurance in Design, Development, Production, Installation and Servicing

3.0 Submission Definition

3.1 Frequency and Delivery Schedule

The frequency for the data submission will be identified by one of the following items: Weekly (W), Monthly (M), Annually (A), As Required (AR), As Generated (AG). Unless otherwise specified, deadlines are in working days.

As Generated (AG), As Required (AR): After each initial edition, revision, addition, etc. Items that are critical to schedule, performance, or interface shall be transmitted to NASA GRC by electronic transfer or express shipment within 48 hours of generation.

3.2 Product Maturity

1. Preliminary: An early submission of an item. To be completed as is practicable at the time of preparation. Preliminary submittals are written with the best available current information and are resubmitted when further information becomes available.
2. Baseline: Formal configuration control of an item begins. Baseline is a fixed reference configuration established by defining, reviewing, and recording the approved configuration documentation for a System or item at a milestone event or at a specified time. Any updates shall require review and approval.
3. Final: The complete, thorough submission of an item for approval, review, or information that, to the best of the Contractor's knowledge and intention, will not require further revision or updates. However, this does not preclude updating if later found to be necessary. Any updates shall require the same review and approval process as was required for the original submissions.
4. Update: The delivery is revised with the best up-to-date information available at the time.

3.3 Data Deliverable Types

The data types and their contractually applicable requirements for approval and delivery are:

Type 1: All versions and interim changes that affect the content or intent of those versions of the deliverable require written approval from NASA before formal release for use or implementation. The Data Requirement Description (DRD) shall be delivered to the NASA identified location.

Type 2: NASA reserves a time-limited right to disapprove in writing any versions and interim changes to those versions. The Data Requirement (DR) shall be delivered to NASA GRC for review not less than 14 calendar days prior to its release for use or implementation. The Contractor shall clearly identify the release target date in the "submitted for review" transmittal. If the Contractor has not been notified of any disapproval prior to the release target date, the data shall be considered approved. To be an acceptable delivery, disapproved data shall be revised to remove causes for the disapproval before its release.

Type 3: These DRs shall be delivered by the Contractor and do not require NASA approval. However, to be a satisfactory delivery, the DR must satisfy all applicable contractual requirements.

3.4 Document Format

All documents may be in Contractor format except when directed otherwise in the DRD, contract clause, or referenced requirement.

All documents, unless otherwise noted within the specific data requirements description (DRD), shall be submitted in electronic format using standard Microsoft Office software (Word, Excel, Powerpoint).

Contractor may consolidate related DRDs, if approved by NASA.

3.5 Document Marking

All documents shall be marked in compliance with Contract Clause D.2 1852.245-74.

3.6 Subcontractor Data Requirements

Where a Subcontractor is performing any part of the work related to a DR, the Contractor shall ensure these DRDs are levied on the applicable Subcontractor. The Contractor shall integrate and provide Subcontractor data into the applicable DR. NASA shall have the right to inspect individual Subcontractor data. Subcontractor integration is the responsibility of the Prime Contractor and is addressed in the Contractor's Project Management Plan.

4.0 Contract Data Requirements List (CDRL)

The CDRL Table is a summary of all the DRDs in this document. The Table identifies the DRD number, Title, Type, Reference to SOW, and Deliverable time-frame. Within the deliverable time-frame section, it identifies the product maturity and the event. If a deliverable is due prior to the identified event, it is denoted with a "T-" or "T+" number of days. E.g. T-30d means the deliverable is due no later than 30 days prior to the event.

Table 2. Contract Data Requirements List (CDRL)

CONTRACT DATA REQUIREMENTS LIST (CDRL)																			
			Mapping to SOW	B = Baseline; F = Final; I = Initial; P = Preliminary; U = Update If Time difference is required, it is denoted as T + or - the number of day(d), months(m)															Notes
				Base Period			Option Period	other	Update as necessary w/approval after				Contract Award	ATP	Monthly	Kick-off	Event	Reviews	
				Project Reviews															
DRD No.	DR Title	Type	Paragraph (s)	RR-SDR	PDR	CDR	SAR		RR-SDR	PDR	CDR	SAR							
01.001	Project Management Plan	1	4.1.1 & 4.1.1.1	B		F		See Note			x		P T+30d						Update Communication section as necessary during project life cycle, such as for project baseline changes.
01.002	Contract Work Breakdown Structure and WBS Dictionary	2	4.1.1.2					See Note					P	F T+30d					Revised pages shall be submitted 10 calendar days after contract WBS changes (following Government approval)
01.004.01	Earned Value Management System Description	2	4.1.1.4.2					See Note					P, See Note F , T+60d						At contract award plus 15 calendar days. Final due 60 calendar days after contract award. Update if EVMS architecture changes.
01.004.05	Integrated Baseline Review Package	2	4.1.1.4.2					See Note										IBR T-30d	
01.004.06	Contractor Monthly Project Management Review Package	3	4.1.1.4.3; 4.1.3.3.1; 4.1.3.3.7												T+12d				
01.004.07	Integrated Program Management Report	3	4.1.1.3; 4.1.1.4.1										P – See Note	See Note	T+12d				Preliminary IMS, Format 6, at Contract Award plus 15 calendar days. The first submission (Formats 1-7 and Fee Schedule) is due within 12 working days after the end of the second full accounting period following the contract authority to proceed (ATP).
01.005.01	Configuration and Data Management Plan	2	4.1.1.5	B	F					x									

CONTRACT DATA REQUIREMENTS LIST (CDRL)																			
			Mapping to SOW	B = Baseline; F = Final; I = Initial; P = Preliminary; U = Update If Time difference is required, it is denoted as T + or - the number of day(d), months(m)															Notes
				Base Period			Option Period	other	Update as necessary w/approval after				Contract Award	ATP	Monthly	Kick-off	Event	Reviews	
				Project Reviews															
DRD No.	DR Title	Type	Paragraph (s)	RR-SDR	PDR	CDR	SAR		RR-SDR	PDR	CDR	SAR							
01.005.03	Configuration Reports	3	4.1.1.5					See Note											Deliver as generated.
01.005.04	Software Design Description	2	4.1.1.5; 4.1.2.11; 4.2.3.2.1; 4.3.3.2.1		P	B					x								
01.005.05	Software Requirements Document	1	4.1.2.11		B		F												Update as necessary during project life cycle, such as for project baseline changes.
01.006.01	Risk Management Plan	2	4.1.1.6.1	P	B					x									
01.006.02	Risk Report/List	3	4.1.1.6.2												T+12d				
01.007	Contractor Kickoff Data Package	3	4.1.1.2													T-5d			
01.008	Contractor Still Photographs, Audio, Video, and Motion Pictures	3	4.1.1.9					See Note											At each documented event after contract start date as required to support schedules, reviews or otherwise required by NASA or the Contractor.
01.009	Contractor Performance Fee Submittal Package	1	Clause H.11					See Note											Per timeline defined in Clause H.11
02.001	System Engineering Management Plan	2	4.1.2.1	B		F		See Note			x		P T+30						Update as necessary during project life cycle, such as for project baseline changes.
02.002	Specifications	1	4.1.2.2.1; 4.2.3.1; 4.2.3.2; 4.3.3.2	B	U	F					x								
02.003.01	Interface Control Document(s) and Drawings	1	4.1.2.2.3		B	F					x								
02.004.01	Verification and Validation Plan	2	4.1.2.3.1	P	B	F					x								
02.004.02	Verification Procedures	2	4.1.2.3.2		P-Flight F-EDU	F-Flight					x								
02.004.03	Verification Reports	2	4.1.2.3.3														P, T+7d F, T+30d		
02.004.04	Verification Closure Notices	2	4.1.2.3.4														F, T+30d		
2.014	Assembly, Integration, and Test Plan	2	4.1.2.4		P	B					x								

CONTRACT DATA REQUIREMENTS LIST (CDRL)																			
			Mapping to SOW	B = Baseline; F = Final; I = Initial; P = Preliminary; U = Update If Time difference is required, it is denoted as T + or - the number of day(d), months(m)															Notes
				Base Period			Option Period	other	Update as necessary w/approval after				Contract Award	ATP	Monthly	Kick-off	Event	Reviews	
				Project Reviews															
DRD No.	DR Title	Type	Paragraph (s)	RR-SDR	PDR	CDR	SAR		RR-SDR	PDR	CDR	SAR							
02.005	Technical Performance Measures	2	4.1.2.5	P	F					x									
02.006	Properties Report	3	4.1.2.6		P	B	F	See Note											Update at each DAC.
02.007	Document Tree	3	4.1.2.7	P	B	U	F					x							
02.008	Drawing Tree	3	4.1.2.8	P	B	U	F					x							
02.009	Hardware Handling and Transportation Plan	2	4.1.2.9	P	B	F					x								
02.010.01	Engineering Review Data Package	2	4.1.1.5; 4.1.2.10.1															See Note	**Packages:** NLT 2 calendar days prior to review; **Final review documentation** – NLT 2 calendar days of review completion.
02.010.02	Test Readiness Review Package	2	4.1.2.10.2; 4.2.3.3.3; 4.2.3.7; 4.3.3.1.3; 4.3.3.7															TRR T-7d	
02.011.01	EP String Requirements Review-Subsystem Definition Review Package	2	4.2.1.2	See Note														See Note	**Plan: Preliminary** - NLT 50 calendar days prior to the review. **Final** – NLT 28 calendar days prior to review; **Final review documentation** – NLT 14 calendar days prior to review.
02.011.06	Critical Component/Subassembly Design Review Package	2	4.2.1.3		T-30d See Note													CCDR T-30d	**Plan: Preliminary -** NLT 30 calendar days prior to the review; **Final** – NLT 14 calendar days prior to review. **Final review documentation** – NLT 7 calendar days prior to review. **Review:** Can be one review or smaller reviews as early as technically feasible but no later than **30 days prior to PDR**

CONTRACT DATA REQUIREMENTS LIST (CDRL)																			
			Mapping to SOW	B = Baseline; F = Final; I = Initial; P = Preliminary; U = Update If Time difference is required, it is denoted as T + or - the number of day(d), months(m)															Notes
				Base Period			Option Period	other	Update as necessary w/approval after				Contract Award	ATP	Monthly	Kick-off	Event	Reviews	
				Project Reviews															
DRD No.	DR Title	Type	Paragraph (s)	RR-SDR	PDR	CDR	SAR		RR-SDR	PDR	CDR	SAR							
02.011.02	EP String Preliminary Design Review Package	2	4.2.1.4		See Note													See Note	**Plan: Preliminary -** NLT 50 calendar days prior to the review; **Final** – NLT 28 calendar days prior to review. **Final review documentation** – NLT 14 calendar days prior to review.
02.011.03	EDU EP String Acceptance Review Package	2	4.2.1.5				See Note												See Note	**Plan: Preliminary -** NLT 50 calendar days prior to the review; **Final** – NLT 28 calendar days prior to review. **Final review documentation** – NLT 14 calendar days prior to review.
02.011.04	EP String Critical Design Review Package	2	4.2.1.6			See Note													See Note	**Plan: Initial -** NLT 50 calendar days prior to the review; **Final** – NLT 28 calendar days prior to review. **Final review documentation** – NLT 14 calendar days prior to review.
02.011.05	Flight EP String Acceptance Review Package	2	4.3.1.1				See Note												See Note	**Plan: Preliminary -** NLT 50 calendar days prior to the review; **Final** – NLT 28 calendar days prior to review. **Final review documentation** – NLT 14 calendar days prior to review.
02.013	Software Development and Management Plan	2	4.1.2.11		B	F					x		P T+30d						
02.015	Software User Guide	2	4.1.2.12			B	F					x							
02.016	Information Technology System Security Plan	2	4.1.2.13										F T+180d						

CONTRACT DATA REQUIREMENTS LIST (CDRL)																			
			Mapping to SOW	B = Baseline; F = Final; I = Initial; P = Preliminary; U = Update If Time difference is required, it is denoted as T + or - the number of day(d), months(m)															Notes
				Base Period			Option Period	other	Update as necessary w/approval after				Contract Award	ATP	Monthly	Kick-off	Event	Reviews	
				Project Reviews															
DRD No.	DR Title	Type	Paragraph (s)	RR-SDR	PDR	CDR	SAR		RR-SDR	PDR	CDR	SAR							
03.001	Safety and Mission Assurance Plan	1	4.1.3.1; 4.1.3.2.1; 4.1.3.3; 4.1.3.3.1; 4.1.3.3.3; 4.1.3.3.4; 4.1.3.4; 4.1.3.7.1; 4.1.3.7.8; 4.1.3.7.9; 4.2.3.1.2; 4.2.3.2.1; 4.3.3.1.2; 4.2.3.2.3; 4.3.3.2.1; 4.3.3.2.3; 4.3.3.3.2;	P	B	F					x								
03.002.02	System Safety Hazard Analysis	2	4.1.3.2.2; 4.1.3.2.3		P See Note	B	F					x							Preliminary at PDR for System-level Safety Analysis
03.002.03	Mishap Report	3	4.1.3.2.4					See Note											Initial notification within 24 hours of occurrence; Final report within 75 calendar days.
03.003.02	Waiver and Deviation Requests	1	4.1.3.3.2					See Note											Within 5 days of identifying need.
03.003.03	Mandatory Inspection Points Data Packages	1	4.1.3.3.3					See Note											In accordance with NASA defined MIPs per IMS.
03.004.01	Materials and Processes Selection, Implementation, and Control Plan	2	4.1.3.5; 4.1.3.7.6	B		F					x								
03.004.02	Materials Identification and Usage List	1	4.1.3.5		B	U	F					x							
03.004.03	Materials Usage Agreements	1	4.1.3.5					See Note											New MUAs at CDR; revised as generated.
03.005.01	Contamination Control Plan	2	4.1.3.6	P	B	F					x								
03.005.02	Contamination Control Report	3	4.1.3.6			B	F					x							
03.006.02	Reliability Analysis	2	4.1.3.7.2		P	B	F	~~See Note~~				x							Due as generated.

CONTRACT DATA REQUIREMENTS LIST (CDRL)																			
			Mapping to SOW	B = Baseline; F = Final; I = Initial; P = Preliminary; U = Update If Time difference is required, it is denoted as T + or - the number of day(d), months(m)															Notes
				Base Period			Option Period	other	Update as necessary w/approval after				Contract Award	ATP	Monthly	Kick-off	Event	Reviews	
				Project Reviews															
DRD No.	DR Title	Type	Paragraph (s)	RR-SDR	PDR	CDR	SAR		RR-SDR	PDR	CDR	SAR							
03.006.03	Failure Modes and Effects Analysis/ Critical Items List	2	4.1.3.3.3; 4.1.3.7.3; 4.1.3.7.4		P	B	F					x							
03.006.05	Electrical / Electronic Worst Case Analysis	2	4.1.3.7.5		P	B	F					x							
03.006.07	Thruster Life Certification Plan	1	4.1.3.7.7		P	B	F					x							
03.007.02	Parts Stress/De-Rating Analysis	2	4.1.3.7.9		P	F					x								
03.007.03	Radiation Tolerance Report	2	4.1.3.7.9		P	F					x								
03.007.04	EEE Parts Identification List	2	4.1.3.7.9		P See Note	F See Note	~~See Note~~					x							As Designed: Preliminary at PDR; Final at CDR; Update with Approval As Built: Part of ADP
03.007.05	Electrostatic Discharge Control Plan	2	4.1.3.7.9	P	B	F		~~See Note~~											
04.001.01	Modeling and Analysis Plan	2	4.2.3.1.1; 4.2.3.2.2; 4.2.3.3.1; 4.3.3.1.1; 4.3.3.2.2; 4.3.3.3.1		B	F		See Note			x								-
04.001.02	Models	3	4.1.3.6; 4.2.3.1.1; 4.2.3.2.2; 4.2.3.3.1; 4.3.3.1.1; 4.3.3.2.2; 4.3.3.3.1					See Note											Due as generated.
04.001.03	Analysis Reports	3	4.2.3.1.1; 4.2.3.2.2; 4.2.3.3.1; 4.3.3.1.1; 4.3.3.2.2; 4.3.3.3.1					See Note											Due as generated.
04.002	Engineering Hardware Development Plan	1	4.2.3	B					x				P						

CONTRACT DATA REQUIREMENTS LIST (CDRL)																			
			Mapping to SOW	B = Baseline; F = Final; I = Initial; P = Preliminary; U = Update If Time difference is required, it is denoted as T + or - the number of day(d), months(m)															Notes
				Base Period			Option Period	other	Update as necessary w/approval after				Contract Award	ATP	Monthly	Kick-off	Event	Reviews	
				Project Reviews															
DRD No.	DR Title	Type	Paragraph (s)	RR-SDR	PDR	CDR	SAR		RR-SDR	PDR	CDR	SAR							
04.003	Test Plans	2	4.1.2.10.2; 4.1.2.10.3; 4.2.3.1.3; 4.2.3.2.4; 4.2.3.3.1; 4.2.3.3.3; 4.2.3.7; 4.3.3.1.3; 4.3.3.2.4; 4.3.3.3.3; 4.3.3.7					See Note										TRR See Note		**Plan: Preliminary -** NLT 30 calendar days prior to the test. **Final** – provided with the TRR data package.
04.004	Test Reports	3	4.2.3.1.3; 4.2.3.2.4; 4.2.3.3.3; 4.2.3.7; 4.3.3.2.4					See Note												**Report: Preliminary -** NLT 5 working days of test completion. **Final** – NLT 15 calendar days of test completion;
04.005	Engineering Drawings	2	4.2.3.1.2; 4.2.3.2.3; 4.2.3.3.2; 4.3.3.1.2; 4.3.3.2.3; 4.3.3.3.2;		60%	90%	F													
04.006	Manufacturing, Assembly, and Production Plan	2	4.2.3.1.2; 4.2.3.2.3; 4.2.3.3.2; 4.3.3.1.2; 4.3.3.2.3; 4.3.3.3.2;		B	F					x								
04.007	Programmable Logic Device Design Data Package	2	4.2.3.2.1; 4.3.3.2.1			B					x								
04.008	Acceptance Data Package	2	4.3.1.1				See Note												**Package: Preliminary -** NLT 10 calendar days prior to the review. **Final** – Delivered with end item;
04.009	Operations Documentation	2	4.2.3.1.4; 4.2.3.2.5; 4.2.3.3.4; 4.3.3.1.4; 4.3.3.2.5; 4.3.3.3.4			B	F					x							
04.010	Spares Plan and Parts List	2	4.2.3.5; 4.3.3.5	P	B	F					x								

CONTRACT DATA REQUIREMENTS LIST (CDRL)																			
			Mapping to SOW	B = Baseline; F = Final; I = Initial; P = Preliminary; U = Update If Time difference is required, it is denoted as T + or - the number of day(d), months(m)															Notes
				Base Period				Option Period	other	Update as necessary w/approval after				Contract Award	ATP	Monthly	Kick-off	Event	Reviews	
				Project Reviews															
DRD No.	DR Title	Type	Paragraph (s)	RR-SDR	PDR	CDR	SAR		RR-SDR	PDR	CDR	SAR							
04.011	Ground Support Equipment Plan	2	4.2.3.6; 4.3.3.6;		B					x			P						

5.0 Data Requirements Descriptions

The Data Requirement Description (DRD) fully defines each Data Requirement (DR) in the Contract Data Requirements List (CDRL) by identifying the use, content, and submittal requirements.

5.1 Project Management

5.1.1 Project Management Plan

DRD No.: 01.001
Title: Project Management Plan (PMP)
Type: 1

Description/Use: The PMP provides an overall description of the processes and methods planned for accomplishing the Contract Statement of Work and for overall coordination of contract management activities. The PMP also describes the structure and environment within which the contract and subcontract management operates.

References/Remarks: NPR 7120.5 (current revision)

Content/Data Preparation: The Project Management Plan shall provide a description of the Contractor's management concepts, practices, approaches, plans, and schedules necessary for accomplishing (managing and controlling) the tasks described in the Statement of Work. The PMP shall present those management systems to be utilized to define and delegate task assignments and shall define the roles and organizational relationships of the Contractor, Subcontractors, and Government. The PMP shall cover all aspects of contract and subcontract management for the contract. The PMP shall provide information giving the Government insight into staffing, organizational structure, approaches and processes used to manage activities across the contract.

The PMP shall identify and describe Control Plans that will be used in executing the SOW tasks. Control plans, even those with a stand-alone Data Requirements Description within this document, can either be a part of the PMP or separate stand-alone documents referenced in the appropriate part of the PMP.

In addition to the information described above, the PMP shall include, at a minimum, the following items:

1. Narrative and graphical descriptions of the management approaches used to accomplish and monitor contractual tasks including the establishment and implementation of the Configuration Control Board process.
2. Narrative description of roles and responsibilities of the contract's key personnel.
3. Management approach for work plan development and execution.
4. Management approach to routinely review and address cost, schedule, technical progress, concerns, and issues including:

   a. Management approach to processes, plans and procedures for cost, schedule, and technical baseline control and systems engineering including a process for change order review, approval and implementation.
   b. Controls applicable to any tasks and activities exceeding established cost or schedule plans including requirements for providing recovery plans.
   c. Description of performance reporting to NASA in preparation for major milestone reviews.
5. Management support system method, tools, and implementation.
6. A Communication Plan, including but not limited to a description of the overall interaction policy and approach, key interaction milestones, flexibility and adaptability of interactions, and the process for continuous improvement and incorporations of lessons learned.
7. Approach to interfaces with the Government, other contractors, and/or other entities that are necessary and pertinent to the accomplishment of contractual tasks, including such things as data, analyses, equipment, software deliverables, schedules, interfaces, and other technical/managerial interactions.
8. Approach to establishing and implementing agreements and/or cooperative relationships with associate contractors or with any other parties necessary for the completion of the work under this contract.
9. Risk methodology and assessment of risks inherent in the management approach, including a process for incorporating lessons learned from previous applicable contracts and continuous improvements.
10. Acquisition strategy including a description of the procurement process and the make/buy decision process.
11. Approach to the establishment and management of subcontracts.
12. Description of the approach for providing regularly scheduled Contract level reviews.
13. Approach to property management of items procured under and in support of the contract that includes bonded storage of flight hardware components.
14. Approach to manage Organizational Conflicts of Interest.
15. Description of facility usage in support of the contract.
16. Approach to periodically assess the contract operations to identify opportunities to streamline the processes, procedures, and organization to provide greater responsiveness and reduced schedule and cost.
17. Definition of performance assessment metrics that will be used to communicate to NASA the progress of the Contractor's efforts against the project baseline plan.
18. Financial baseline plan, which includes cost-sharing approach and project reserves, and financial performance reporting plan.
19. Schedule performance reporting plans which includes schedule reserves.
20. Earned Value Management implementation and reporting plan.

NOTE: It is not intended that this plan duplicate other plans called for in the Data Requirements List. This plan should summarize the overall project and reference or summarize other plans where appropriate and shall reference Contractor's internal procedures where applicable.

Delivery Schedule: Preliminary at Contract Award plus 30 calendar days. Baseline at RR-SDR. Final at CDR. Update communication section as necessary during project life cycle, such as for project baseline changes; all other update as necessary w/approval after CDR.

5.1.2 Contract Work Breakdown Structure (CWBS) and WBS Dictionary

DRD No.: 01.002
Title: Contract Work Breakdown Structure and WBS Dictionary
Type: 2

Description/Use: To establish a product-oriented framework for reporting project cost, schedule, and technical performance. To provide a basis for uniform planning, reporting status, program visibility, and assignment of responsibilities.

Reference/Remarks:

Reference is made to NPR 7120.5E, NASA Space Flight Program and Project Management Requirements, and NASA/SP-2010-3404, NASA Work Breakdown Structure (WBS) Handbook (available here: http://evm.nasa.gov/docs/Handbooks/Sched_Mgmt_Jan_10/Special_Publication_NASA_WBS_Hdbk_%20Jan_2010.docx). These documents shall be used as guides in the preparation of the WBS and the WBS dictionary.

Content/Data Preparation: The Work Breakdown Structure (WBS) establishes a product-oriented logical subdivision of hardware, software, services, facilities, etc., that make up the total project scope of work. The WBS Dictionary provides a narrative description of the tasks and effort to be performed in each WBS element.

The WBS and WBS Dictionary are two distinct project documents used for defining the approved project scope of work. The contents of each document are detailed in the following:

1. WBS - A logical, hierarchical display of the subdivision of all project work to be completed. The WBS shall include the approved element title and element number.
2. WBS Dictionary - The WBS dictionary shall describe and document the work content of every WBS element and relevant efforts associated with each element (e.g., design, development, manufacturing, etc.). The WBS dictionary shall be arranged in the same order as the contract WBS. The WBS dictionary shall include the following for each WBS element:
    a. WBS element title.
    b. WBS element code.
    c. WBS element content description (including quantities, relevant associated work, and contract end items where applicable).
    d. WBS Index.
    e. SOW paragraph number.

f. Specification (number and title) associated with the WBS element (if applicable).
g. Contract line item (CLIN) associated with the WBS element.
h. Date, revision number, revision authorization and approved changes.
i. Contract Identification Number.
j. Budget and reporting number (i.e., Charge Code)

Format: The WBS shall be in a chart format showing element relationships, arranged in the same order as the WBS provided in the Request for Proposal. The WBS Dictionary shall be ordered in consonance with the WBS index and shall reference each WBS element by its identifier and name.

Delivery Schedule: Preliminary submission at Contract Award. Final 30 days after Authority to Proceed (ATP), update as required. Revised pages shall be submitted 10 calendar days after contract WBS changes (following Government approval). Changes shall be incorporated by change page or complete reissue.

5.1.3 Earned Value Management System (EVMS) Description

DRD No.: 01.004.01
Title: Earned Value Management System Description
Type: 2

Description/Use: A fully validated Earned Value Measurement (EVM) system is required as per NPR 7120.5E. It describes the program or project's implementation of its earned value management system.

Scope: The Earned Value Management System Description provides a description of the system and the contractor's comprehensive plan for complying with the requirements of ANSI/EIA Standard 748 and the applicable NASA FAR Supplement Solicitation Provisions and Contract Clauses.

References/Remarks: Reference is made to NPD 7120.4B, Program/Project Management and NPR 7120.5, NASA Program and Project Management Process and Requirements. Changes to the EVMS shall be processed in accordance with NFS 1852.234-2.

Applicable Documents: ANSI/EIA Standard 748 Industry Guidelines for Earned Value Management Systems, NFS 1852.234-1 Notice of Earned Value Management System, NFS 1852.234-2 Earned Value Management System.

Content/Data Preparation: The Earned Value Management System Description shall provide an understanding of each activity required to meet the requirements of ANSI/EIA Standard 748. The document shall briefly, but comprehensively, present the contractor's approach and schedule of internal activities to comply with the requirements and to demonstrate this compliance to a Government/NASA Compliance Review Team. The document shall include the contractor's plan for implementation of and activities leading up to the demonstration review with the Compliance Review

Team. The contractor shall provide a monthly status of progress toward meeting this plan until the contractor's management system is accepted by the Review Team. The plan shall address the requirements of NFS 1852.234-1 and NFS 1852.234-2. NOTE: If the EVMS being proposed has been validated and there is an Advance Agreement (AA) in place, then it is acceptable to include a statement to that effect in the proposal and a copy of the AA in lieu of the EVM System Description document. The Government Project Manager retains the right to require acceptance by a Government Compliance Review Team as specified above.

Contractor format is acceptable. The EVMS Description shall be available in hard copy or electronic media format upon request.

Changes shall be incorporated by change page or complete reissue.

Delivery Schedule: In accordance with NFS 1852.234-1 and NFS 1852.234-2, preliminary submission at contract award plus 15 calendar days ~~after notification of selection, but prior to contract award~~. Final due 60 calendar days after contract award. Update if EVMS architecture changes.

5.1.3.1 Integrated Baseline Review (IBR) Package

DRD No.: 01.004.05
Title: Integrated Baseline Review Package
Type: 2

Description/Use: An IBR is a joint assessment conducted by the Government PM (project Manager) and the Contractor to verify the realism and accuracy of the PMB (Performance Measurement Baseline). This involves verifying the technical content of the baseline and assessing the realism and accuracy of the related resources (performance budget and Spacecraft Master Schedule). The IBR is unlike the VR [Validation Review] that focuses on EVMS compliance with ANSI/EIA-748. Instead the IBR focuses on assessing the realism of the baseline. (DoD EVM Implementation Guide [October 2006], Section 2.4.1, p. 55).

References/Remarks: The following references are given for the Integrated Baseline Review (IBR) Data Package: NPR 7120.5 (current version), NASA Program and Project Management Processes and Requirement, and NFS 1852.234-2, Earned Value Management System.

Content/Data Preparation: An IBR Data Package shall be submitted in accordance with the IBR objectives stated above. The IBR Data Package shall contain the following:

a. Program/Business Management and Control Account Notebooks that incorporates the data products requested by the Project Office (hard copy and electronic copy);
b. A baselined electronic version of the Integrated Master Schedule;
c. Contractor Earned Value Process Documentation (hardcopy and electronic);
d. Two months of EV Performance data.

Typical content of Integrated Baseline Review Notebooks should include the following. Note: Most of these documents are simply ongoing operational documents gathered together into one notebook. Some documents will already reside in the EVMS Plan. The IBR Data Package shall contain the following:

1. Program/Business Management and Control Account Notebooks that incorporates the data products requested by the Project Office (hard copy and electronic copy).
2. A baselined electronic version of the Integrated Master Schedule.
3. Contractor Earned Value Process Documentation (hardcopy and electronic).
4. Two months of EV Performance data.

Typical Content of Integrated Baseline Review Notebooks should include the following (most of these documents are simply ongoing operational documents gathered together into one notebook. Some documents will already reside in the EVMS Plan):

Program Management Data Notebook:

1. Earned Value Management (EVM) Top Level Authority
2. Brief overview of EVM process
3. Organization Charts -flow down as needed including EVM from subcontracts
4. Internal communication and action planning structure
5. Top Level Planning and Baseline assumptions
6. Program Percentages (Level of Effort versus Discrete)
7. Program WBS
8. Program Element of Cost (EOC) Resource Allocation Matrix (RAM)
9. Top Level Program Work Authorization and Control Account Plan (CAP)
10. Program technical scope - flow down from SOW to Managers and Control Account Management (CAM)
11. Estimate at Completion (EAC) assumptions if different from negotiated Budget at Completion (BAC) values
12. Contract Performance Report (CPR) Submittals
13. Program Schedule
    a. Top level with vertical and horizontal traceability
    b. Critical path
14. Risk Management approach
    a. Current Top Risks
    b. Integrated Product Team (IPT) Risk list and Self-Assessment Procedures
15. Management Reserve levels and approach
16. Undistributed budgets, if any, and their work assignments
17. Funding Profile
18. Subcontractor Management Plan, if applicable
    a. Management review or reporting cycle
    b. Technical/Schedule/Cost/Risk Plan and Status
    c. EVM flow-down
    d. IBR results
    e. Any other key programmatics

Control Account Management (CAM) Data Notebook:

1. Data content specific to the Control Account or Integrated Product Team

Technical Scope/Cost

1. Organization chart for the Cost Account (CA)
2. RAM (show location in RAM with budget amounts)
3. Location in Contract Statement of Work
4. Work Authorization Documentation: trace to authorized budget
   a. Show how work gets authorized from high to low levels
5. Time Phased Control Account Plan
   a. Work Packages (WP) and Planning Packages (PP)
   b. Resource loading of tasks: WP and PP
6. Baseline Metrics
   a. Phased dollars by element of cost breakdown
   b. Phased workforce profiles (Full Time Employees)
7. Labor Reports

Schedules

1. Flow-down of intermediate schedule into detailed schedules
2. Including any program critical path
3. Key handoffs
4. Schedule Metrics

Risk List

1. Current or anticipated risks in this CA or IPT

Earned Value Methodology

1. EV techniques and rationale
2. Contract performance report (>= 2 months)
3. Variance analysis reporting if applicable
4. Internal communication and action planning

Delivery Schedule: 30 calendar days prior to the IBR.

5.1.3.2 Contractor Monthly Project Management Review Package

DRD No.: 01.004.06
Title: Contractor Monthly Project Management Review Package
Type: 3

Description/Use: The Contractor Monthly Project Management Review Package provides NASA with insight into the contracted efforts. This data requirement provides activity reporting for the Contractor's progress, accomplishments, performance, and facilities/systems utilization.

Content/Data Preparation: The Contractor Monthly Project Management Review Package shall include quantitative descriptions of overall technical and administrative progress, and status of significant activities relating to the accomplishments of the SOW tasks. Risks to the accomplishment of SOW tasks shall also be identified. Report items covered shall include significant accomplishments, problems encountered, quality assurance results, and corrective actions. The package shall include status of Technical Performance Measures. All Contractor Monthly Project Management Review Packages shall be of sufficient depth and clarity to permit understanding and evaluation of progress made. Supporting data in the form of charts, graphs, etc. may be included as appropriate.

The Contractor Monthly Project Management Review Package shall contain the following at a minimum:

1. A summary of the complete contracted effort, base and option periods of performance, including:
    a. Contractor Project Manager
    b. Contractor Lead Engineer
    c. Key Subcontractors and their Project Manager and Lead Engineer
    d. Total contract value (base + option)
    e. Base period contract value
    f. Base period start and end dates
    g. Anticipated option period award and end dates
    h. Summary description of contracted effort (base and option periods of performance) with focus on base period of performance
    i. Top level life cycle milestones (base and option periods of performance)
2. Current stoplight (green, yellow, red) status, including variance explanations, of the contracted activities as related to technical, cost, schedule, and management. Include previous month's stoplight status (green, yellow, red) for comparison.
3. Key accomplishments
4. Key issues and concerns, including impact, action plan (including any NASA help needed), and projected resolution date.
5. A summary report of all problems, failures or anomalies and corrective actions taken or planned.
6. Software status and issues including results of peer reviews/inspections, estimated number of Source Lines Of Code (SLOC) and % complete, number of software requirements coded, number of software requirements verified, and number of defects: new, open, closed
7. List of all nonconformances
8. Integrated Master Schedule status, focusing on 30, 60, and 90 days out as well as any subsequent milestones that may be in jeopardy of slipping if near-term identified issues are not resolved
9. Tabular list of key milestones that were completed, are past due, or are due within the next 12 months. Including CWBS number, milestone description, baseline completion date, projected completion date, and completed date as applicable.

10. Monthly contract financial status versus baseline spend plan. Include contract cost/fee reported to date versus funds available on contract (from monthly financial report).
11. Financial status variance explanations.
12. Top risks and status from the Contractor Risk Report.
13. Upcoming events (30, 60, and 90 days out), including significant meetings, milestones, and travel

Delivery Schedule: Monthly within 12 business days of calendar month close.

5.1.3.3 Integrated Program Management Report (IPMR)

DRD No.: 01.004.07
Title: Integrated Program Management Report (IPMR)
Type: 3

Description/Use: The IPMR is the primary means of communicating program cost and schedule information between the prime contractor and the Government. It may also be tailored for use on intra-government work agreements. It consists of seven formats that provide program managers information to: (1) integrate cost and schedule performance data with technical performance measures, (2) identify the magnitude and impact of actual and potential problem areas causing significant cost and schedule variances, (3) forecast schedule completions, and (4) provide valid, timely program status information to higher management.

- Format 1 defines cost and schedule performance data by product oriented Work Breakdown Structure (WBS).
- Format 3 defines changes to the Performance Measurement Baseline (PMB).
- Format 5 is a narrative report used to provide the required analysis of data contained in Formats 1, 3 and 6.
- Format 6 defines and contains the Contractor's Integrated Master Schedule (IMS).
- Format 7 defines the time-phased historical & forecast cost submission.
- Fee Schedule details the Fee earned by each CLIN (See Section 15.3).

Scope: The IPMR is the primary means of communicating cost and schedule performance and project health information between the Contractor and NASA.

Applicable Documents: Data Item Description, Integrated Program Management Report, DI-MGMT-81861, available at the following web site: www.acq.osd.mil/evm.

Content/Data Preparation: IPMR Formats 1, 3, 5, 6 and 7 are required. The IPMR shall include the data requested in the instructions below, pertaining to all authorized contract work, including both priced and unpriced effort that has been authorized at a

not-to-exceed amount in accordance with the Contracting Officer's direction. The contractor shall provide monthly IPMRs per DI-MGMT-81861 except as modified in this section.

FORMAT 1 INSTRUCTIONS: Provide reporting at WBS level 3 or at the cost account, whichever is lower, except for high cost or high risk items per the Contract WBS DRD, STD/MA-WBS. For each reporting element, provided elements of cost (direct labor, material, overhead, etc.) and direct labor hours. Include G&A and COM as non-add.

FORMAT 3 INSTRUCTIONS: Significant differences (absolute values exceeding +/-5%) between the PMB at the beginning and end of each specified period shall be explained in Format 5. Use quarterly periods for Block 6, columns (10) through (11), yearly periods for columns (12) through (13), and the remainder of the contract for column (14).

FORMAT 5 INSTRUCTIONS: The reporting level identified above is the level where variance reporting thresholds are applied. Variance analysis shall be required for:

- 3 largest current cost variances exceeding +/- $50K or +/- 5%
- 3 largest current schedule variances exceeding +/- $50K or +/- 5%
- 3 largest cumulative cost variances exceeding +/- $100K and +/- 10%
- 3 largest cumulative schedule variances exceeding +/- $100K and +/- 10%
- 3 largest variances at completion exceeding +/- $250K and other cost and schedule variances or technical performance issues that are causing or are likely to cause significant schedule delays or cost overruns.

The required narrative explanations and variance thresholds will be reviewed periodically, and may be adjusted by contract modification with no change in contract price. All reportable WBS variance narratives shall adequately address the root cause of the variance; adequately discuss any schedule variance in terms of float and impact to the program critical path, if any, and quantitatively explain the causes that account for at least 70% of the variance exceeding the threshold. If there are no changes to the reportable element problem analysis, expected impacts, or corrective action status, then specify “no changes since the last reported analysis” and reference the IPMR date when the narrative was initially reported.

Schedule Analysis (See Format 6 Instructions below). Include the results of the Schedule Risk Assessment (SRA) when performed. Critical and driving path analysis should also include identification and analysis of the primary critical path and all near (secondary) critical paths whose total slack (float) values are within 10 working days or less of the primary critical path. The analysis shall be submitted in a waterfall format and organized in a manner such that the path with the least amount of slack is delineated first and followed by each successive path according to total slack values. When driving

path analysis is desired, the specified project milestones and/or major project events are to be identified for contractor reporting. NOTE: If driving paths are identified through the use of assigned task constraints (limited or fixed start/finish dates) within the IMS, then it should be removed from the IMS after identification/explanation of driving path is complete. Constraints that are left within the IMS unnecessarily will hinder or prevent accurate project critical path identification and analysis. Provide the results of the monthly schedule health analysis as discussed in Format 6 instructions.

In some cases, additional variance analysis is required to cover emerging trends. In this case, the supplier will be required to report additional variances for a time period of 6 months or less.

FORMAT 6 INSTRUCTIONS: The IMS shall include all discrete work at a minimum. Subcontractors with EVMS flowdown shall be included with sufficient detail to develop a realistic critical path. The prime and subcontractor (if any) data shall be consistent, statused monthly and based on the same cutoff date to enable a realistic critical path.

Summary Master Schedule: The schedule shall include a top level Gantt chart summary arranged by WBS and that reflects all contract and controlled milestones, major program/project phases (i.e. design, fabrication, integration, assembly, test, etc.) and all end item deliveries. It shall reflect either by manual creation or by automated summarization, a vertically integrated rollup of intermediate and detailed schedule data.

Detailed Schedules: The detailed schedules shall contain vertical and horizontal integration at the task/milestone level of detail (vice the work package/planning package level) to provide better definition in task sequence and greater accuracy in critical identification.

IMS Fields: Additional IMS fields required in the schedule are WBS, LOE identification, responsible organization, and planning package identification. A field identifying critical path is not required.

Relationships/Dependencies: All discrete tasks/milestones except for the start and end of the contract or for interim receipt and delivery events to/from external entities shall have at least one predecessor and successor.

Level of Effort (LOE) in the Schedule: If LOE tasks are excluded from the schedule, the contractor must clearly document in an appropriate location how the cost and schedule for LOE effort is being planned and performance is being measured.

Schedule Margin: If schedule margin is included in the IMS, it must be as a defined task and clearly labeled as “Schedule Margin” or contingency. The number of schedule margin tasks should be minimal with most of the margin duration placed as the last task

before the ending contract event or the end item delivery. Other acceptable locations for placing smaller amounts of schedule margin are prior to high level project milestones, such as PDR, CDR, System I&T Complete, etc.

In addition to the native IMS file, the contractor will provide the IMS discussion and analysis as required in Format 5 (Section 3.6.7 of the IPMR DID) to include the results of the contractor's internal health analysis. This analysis shall include counts for the following schedule assessment indicators: 1) the total number of tasks, milestones and non-detail (e.g., summary, hammock, rollup, etc.) activities contained in the schedule, 2) the number of completed tasks and milestones, 3) the number of tasks and milestones to be completed, 4) the number of tasks and milestones that have no predecessor and/or no successor relationships, 5) the total number of tasks and milestones that have a total float (slack) value greater than 25% of the remaining duration of the total program/project schedule, 6) the total number of non-detail (e.g., summary, hammock, rollup, etc.) activities that have assigned predecessor or successor logical relationships, 7) the total number of tasks and milestones that have constraint (forced or fixed) dates.

FORMAT 7 INSTRUCTIONS: Format 7 is required at the same level as Format 1 reporting.

FEE SCHEDULE INSTRUCTIONS: Provide a separate schedule for Fee earned each month. The schedule should detail the Fee earned by each CLIN and should provide a total Fee earned for the contract as a whole. Any Fee earned in the CLIN for Long-Lead time Material Purchases and/or Capital Assets should be detailed by each Long-Lead time Material Purchase and/or Capital Asset.

SUBCONTRACTOR REPORTS: All subcontractor IPMR formats must be included with the primes' IPMR or reported directly to NASA.

Format: Contractor formats can be substituted for IPMR formats whenever they contain all the required data elements at the specified reporting levels in a form suitable for NASA management use. The IPMR shall be submitted electronically. IPMR formats shall be completed according to the instructions outlined in DI-MGMT-81861 and submitted electronically using the UN/CEFACT XML schema. A wInsight compatible XML file (WINST.DTD) may be used in lieu of the UN/CEFACT XML for Formats 1, 3 and 7. The Cost XML file must be reported at the control account level. Report Format 1 dollars and direct labor hours. Report Format 3 by dollars. The basis for variance analysis is in dollars. Format 6 shall be submitted in the contractor's native schedule electronic file format and the UN/CEFACT XML. Format 5 shall be also be submitted in contractor native format. Formats 1 and 3 and the Fee Schedule will also be submitted in human readable formats such as word processor, spreadsheet or PDF file. IPMRs required from

subcontractors shall also be provided electronically using the same instructions and electronic formats stated above.

Remarks: The IMS (Format 6) will be baselined after ATP as agreed to by both parties and not to exceed 90 days after ATP. Reference is made to NPR 7120.5E, *NASA Space Flight Program and Project Management Requirements*, NASA/SP-2010-3403, *NASA Schedule Management Handbook* and *NASA IPMR Implementation Guide* available at http://evm.nasa.gov/ . These documents shall be used as guides in preparation of the IPMR.

Interrelationships: To ensure an integrated approach to risk management, the information within the data provided by this IPMR DRD shall be integrated with the following DRDs when required: Work Breakdown Structure (WBS) and Dictionary, Project Management Plan, and the Risk Management Plan.

Delivery Schedule:

INITIAL SUBMISSION: Preliminary IMS, Format 6, ~~with proposal~~ at Contract Award plus 15 calendar days. The first submission (Formats 1-7 and Fee Schedule) is due within 12 working days after the end of the second full accounting period following the contract authority to proceed (ATP).
SUBMISSION FREQUENCY: Monthly for all Formats by the 12th working day after the close of the contractor's accounting month.

5.1.4 Configuration and Data Management

5.1.4.1 Configuration and Data Management Plan

DRD No.: 01.005.01
Title: Configuration and Data Management Plan
Type: 2

Description/Use: To identify and describe the Contractor's configuration and data management processes and system(s) that will be implemented in the performance of this contract. This plan establishes the basis for a uniform and concise CM practice for all Contractor-provided hardware/software elements and selected documentation in a manner that is responsive to appropriate, applicable requirements.

References/Remarks: NASA-STD-005 (current version) NASA Configuration Management (CM) Standard
NPR 7150.2 (current version) NASA Software Engineering Requirements (Section 5.1)

Content/Data Preparation: The Configuration and Data Management Plan (C&DMP) shall be prepared in accordance with the Contractor's practices and shall be consistent

with the SEP Project C&DM Plan. The Plan shall describe in detail all configuration management processes, methods, and procedures. The plan shall specify the Contractor's management policies and identify, by specific reference, standard practices and detailed work instructions to be used in implementing the configuration management process.

The Configuration and Data Management Plan shall describe how hardware and software configuration and data management is accomplished and how consistency between product definition, the product's configuration, and the configuration management records is achieved and maintained throughout the applicable phases of the product's life cycle by the Contractor.

The Plan shall describe the Contractor's approach, methodology and application of configuration management principles and practices and include the following:

1. General product definition and scope
2. Description of configuration management activities and procedures for each of the following configuration management functions:
    a. Configuration Planning and Management
    b. Configuration Identification
    c. Configuration Change Management
    d. Configuration Status Accounting (access to accurate, timely information about the product and its documentation, reports of status to the Government or its auditors, verifiable trace for all deliverable end item configurations)
    e. Configuration Verification and Audit
    f. Configuration Management of digital data
3. Organization, roles, responsibilities and resources (objectives, organizational structure, authorities and responsibilities [individual and organizational])
4. Definition of terms
5. Programmatic and organizational interfaces
6. Deliverables, milestones, and schedules including sequence and coordination for the identified CM activities and for all events affecting the CM plan's implementation
7. Subcontract flow down - CM approach for managing Subcontractor CM activities
8. CM interfaces to the Government CM function, including insight into major Subcontractors
9. CM Tools (software tools, techniques, and equipment necessary for the implementation of the specified software configuration management activities
10. CM maintenance information (identifies the activities and responsibilities necessary to ensure continued CM planning during the lifecycle of the contract)

<u>Delivery Schedule</u>: Baseline at RR; Final at PDR. Update as necessary w/approval after PDR.

5.1.4.2 Configuration Reports

DRD No.: 01.005.03
Title: Configuration Reports
Type: 3

Description/Use: To permit visibility of all changes in configuration items (CI), computer software configuration items (CSCI) and controlling documentation proposed by the Contractor. To identify all configuration items (CI) and computer software configuration items (CSCI) and to correlate those CI/CSCI to their specifications and requirements documents.

References/Remarks:

Content/Data Preparation:
The Contractor shall make available reports that define the baseline of the delivered products capturing the 'as required,' 'as designed,' 'as tested,' 'as built' and 'as delivered' with a record of approved and implemented changes to the baseline. The reports shall contain references to change authorization and implementation documents.

Delivery Schedule: As generated.

5.1.4.3 Software Design Description

DRD No.: 01.005.04
Title: Software Design Description
Type: 2

Description/Use: To define and record the architecture and design of the Computer Software Configuration Items (CSCIs). This document is also used as the basis for implementing the software, and providing visibility into the design and information needed for software support.

References/Remarks:

Content/Data Preparation: The Software Design Description shall include:

1. CSCI-wide design decisions/trade decisions
2. CSCI architectural design
3. CSCI decomposition and interrelationship between components.
    a. CSCI components:
        i. Description of how the software item satisfies the software requirements, including algorithms, data structures, and functional decomposition
        ii. Software item input/output description
        iii. Static/architectural relationship of the software units
        iv. Concept of execution including data flow, control flow, and timing
        v. Bi-directional traceability between software requirements and design
        vi. CSCIs planned use of computer hardware resources

b. Rationale for software item design decisions/trade decisions including assumptions, limitations, safety and reliability related items/concerns or constraints in design documentation
c. Interface design

4. CSCI Implementation Plan

Traceability between the design and the code for safety critical code. This could alternatively be documented in the Traceability Matrix DRD if more convenient.

Delivery Schedule: Preliminary at PDR; Baseline at CDR. Update as necessary w/approval after CDR.

5.1.4.4 Software Requirements Document

DRD No.: 01.005.05
Title: Software Requirements Document (SwRD)
Type: 2

Description/Use: This document is used to define and record the derived requirements to be met by a computer software configuration item (CSCI). This document specifies the requirements for a CSCI and the methods to be used to ensure that each requirement has been met.

References/Remarks: NPR 7150.2 (current version) NASA Software Engineering Requirements

Content/Data Preparation: The Requirements Document shall include:
a. Software summary including: application, inventory, environment, organization and overview of operation, contingencies and alternate states and modes of operation, security and privacy, and assistance and problem reporting
b. Access to the software: first-time user of the software, initiating a session, and stopping and suspending work
c. Processing reference guide: capabilities, conventions, processing procedures, related processing, data backup, recovery from errors, malfunctions, emergencies, and messages
d. Assumptions, limitations, safety related items/concerns or constraints
e. Software requirements including a rationale for each requirement.
f. Verification method for each requirement.
g. Traceability between parent and child requirements.
Note: Traceability information may be documented in a separate spreadsheet if more convenient.

Delivery Schedule: Baseline at PDR. Update as necessary after PDR. Final at SAR.

5.1.5 Risk Management

5.1.5.1 Risk Management Plan

DRD No.: 01.006.01
Title: Risk Management Plan
Type: 2

Description/Use: Provides a baseline document for planning, management, control, and implementation of the Contractor's risk management process that is consistent with the government provided guidelines. The purpose of risk management is to identify risks early in the project so that appropriate abatement plans can be implemented to reduce the consequences of the risk or likelihood that the risk will occur. This document provides the overall approach, coordination, structure, and environment within which risk management processes for the contract reside and also addresses how NASA risk requirements are to be implemented by the Contractor through the contract implementation. This document describes the methodologies and processes used to identify, analyze, control and communicate the risks. The identification, characterization, mitigation plan, and mitigation responsibilities associated with specific risks are described and specific risk abatement strategies or contingency planning processes are discussed.

References/Remarks: NPR 8000.4 (current revision)

Content/Data Preparation: The Risk Management Plan (RMP) addresses how the Contractor will implement risk management requirements throughout the project's life cycle. The Risk Management Report provides a status of risks and risk mitigation plans and activities. The RMP documents the process that the Contractor will follow to manage risk throughout the life cycle of the contract items and provide government insight to risk management. "Risk" refers to anything that can prevent the Contractor from meeting contract objectives. All forms of risk shall be managed. These include technical (hardware and software), programmatic, supportability, cost, and schedule risks.

The Risk Management Plan shall include:

1. Introduction. Specify the program/project risk objectives and policy toward risk. Explain the purpose, scope, assumptions, constraints, key ground rules, and policy pertaining to the project continuous risk management process.
2. Overview of Process. Provide an overview of the continuous risk management process and information flow; describe how the risk management process integrates and relates to other project management and system engineering activities. Include general risk mitigation strategies to be employed throughout project life cycle.
3. Organization. Show the organization, roles, and responsibilities of program, project, customer, and supplier key personnel with regard to risk management. Document how team members will be trained in the application of risk management methodology.

4. Process Details. Provide the risk management process details and related procedures, methods, tools, and metrics. Include here, or in an appendix, the specific methodologies to be used for activities of risk management: identify, analyze, plan, track, control, communicate and document as well as de-scope processes and risk acceptance versus closure criteria. Include the process to be used for continual assessment of the project risk profile. Describe how risk information will be communicated both internally to the project staff and throughout the NASA management chain.
5. Documentation of Risks. Specify the format and data elements that will comprise the project Risk List (and/or Risk Database), how configuration control will be applied, and how the list will be used and updated. Explain how team members will be able to access the current Risk Report/List at any time.
6. Key System Interfaces: Describe the relationship and interfaces of the continuous risk management process to lessons learned reporting, System Safety analyses, reliability/probabilistic risk analyses, schedule, financial and other business reporting systems
7. Appendix. Material that is too detailed or sensitive to be placed in the main body of text may be placed in an appendix or included as reference. Include the appropriate reference in the main body of the text. Appendices may be bound separately, but are considered to be part of the document. Include an alphabetized list of the definitions for abbreviations and acronyms used in this document. Include an alphabetized list of definitions for special terms used in the document, i.e., terms used in a sense that differs from or is more specific than the common usage for such terms. Include a Risk Attributes Scorecard that provides the criteria for establishing likelihood and consequence values of a risk.

Delivery Schedule: Preliminary at RR-SDR; Baseline at PDR; Update as necessary w/approval after PDR.

5.1.5.2 Risk Report/List

DRD No.: 01.006.02
Title: Risk Reports/List
Type: 3

Description/Use: The Risk Report/List provides the details of a risk along with status updates, risk mitigation plans, and activities.

References/Remarks: NPR 8000.4 (current revision)

Content/Data Preparation:
At a minimum the Risk Report shall contain:

1. Risk Focus Charts which include:
   a. Risk identification number
   b. Risk Statement
   c. Risk Context
   d. Initial likelihood of occurrence score and rationales

   e. Initial Consequence of occurrence score with Safety, Cost, Schedule, and Technical rationales
   f. Risk Status
   g. Timeframe
   h. Mitigation plans and metrics with resulting Likelihood and Consequence scores. Risk Likelihood and Risk Consequence shall be scored consistent with the Risk Attribute Scorecard values established in the Risk Management Plan (DRD 01.006.01)
2. Summary of risk mitigation activity and progress including objective evidence of exit criteria accomplishments.
3. Cost estimate, applicable schedule, and allocated resources for mitigation activity.
4. Documentation of contingency planning for risks that could not be successfully mitigated, accepted, or closed.
5. Risk Attribute Scorecard as established in the Risk Management Plan (DRD 01.006.01).
6. List of any closed or accepted risks since the last report and rationale for closure or acceptance.
7. Consequence based 5x5 Risk Matrix.
8. Risk List including risk trending, risk identification number, approach, and risk title.

Delivery Schedule: Monthly within 12 business days after ~~of~~ calendar month close.

5.1.6 Contractor Kickoff Data Package

DRD No.: 01.007
Title: Contractor Kickoff Data Package
Type: 3

Description/Use: The purpose of the kickoff meeting is to provide NASA with a comprehensive overview of the contracted task, and shall include top level requirements, the communications plan, integrated data environment, points of contact, Contract Work Breakdown Structure (WBS), data requirements content, all deliverables, Integrated Master Schedule, and milestone review plans.

References/Remarks: The submittal shall be in the form of Power Point presentations.

Content/Data Preparation: At a minimum, the kickoff data package shall include:

1. A summary of top-level requirements.
2. An outline of the communications plan and how data will be shared.
3. Organizational structure and initial staffing with points of contact and their contact information.
4. The Contract WBS.
5. A summary of top-level data requirements.
6. A list of all deliverables.
7. An updated IMS and associated budget.
8. Proposed format for milestone reviews.

Delivery Schedule: No less than 5 business days prior to the kickoff meeting.

5.1.7 Contractor Still Photographs, Audio, Video, and Motion Pictures

DRD No.: 01.008
Title: Contractor Still Photographs, Audio, Video, and Motion Pictures
Type: 3

Description/Use: To provide NASA with the Contractor's visual/audio, still and motion picture, and video coverage of significant Contractor project events and milestones. These shall include items used to support contractor activities such as management reviews, public affairs, productions, and technical records made during development, assembly, fabrication, integration, and testing. Still photos of assemblies shall be taken prior to final enclosure where applicable, commonly called close-out photos.

References/Remarks: These submittals in the original recording media are independent of their use in preparing other contractual submittals.

Content/Data Preparation: Still Photographs, Video, and Motion Pictures will provide complete visual coverage of all Contractor significant events. The Still Photographs, Audio, Video, and Motion Pictures shall provide photographic, audio, and video data documenting significant progress or milestones as well as of facilities or operations utilized in the design, fabrication, verification, hardware closeouts and data required to support program activities. Each data item submitted shall be distinctly identified and be accompanied by log sheets or similar records which fully describe the item, including the applicable distribution statement, when produced.

Delivery Schedule: At each documented event after contract start date as required to support schedules, reviews, or otherwise required by NASA or the Contractor.

5.1.8 Contractor Performance Fee Submittal Package

DRD No.: 01.009
Title: Contractor Performance Fee Submittal Package
Type: 1 - System Efficiency
1 - Early Delivery of Propulsion String

Description/Use: The Contractor Performance Fee Submittal Package, in accordance with contract clause H.11, Performance Fee Incentives, provides NASA with documentation to determine Performance Fee eligibility. This data requirement provides reporting for System Efficiency Incentive A: Tier I and Tier II, System Efficiency Incentive B: Tier I and Tier II, and Early Delivery of Propulsion String Incentive.

Content/Data Preparation:
System Efficiency: The Contractor Performance Fee Submittal Package shall include

1. Quantitative summaries validating

a. Compliance with the incentive requirements identified in Performance Fee Clause H.11 Table 2. System Efficiency Incentive Criteria
b. Compliance of the collected data to the requirements described under Clause H.11. ~~Test Conditions"~~
c. System efficiency was calculated as defined in ~~the Performance Fee~~ Clause H.11.
d. Quantification of system efficiency measurement uncertainty.

2. All required performance data per DRDs 04.008.

A separate Contractor Performance Fee Submittal Package shall be submitted for each System Efficiency Incentive A: Tier I, System Efficiency Incentive A: Tier II, System Efficiency Incentive B: Tier I, and System Efficiency Incentive B: Tier II.

Early Delivery of Propulsion String Incentive: The Contractor Performance Fee Submittal Package shall include

1. A summary description of all data submitted and the submittal dates.
2. NASA Approved System Acceptance Review information per SOW 4.3.1.1 Qualification and Flight EP String Subsystem Acceptance Review and DRDs 02.011.05 and DRD 04.008.
3. A copy of the signed DD-250 as per NFS 1852.246-72.

Delivery Schedule: Contractor shall comply with the timeline defined in Clause H.11 Performance Incentive Fee Table 1. Incentive Requirements and Clause F.2 FAR 52.242-8 Time of Delivery-Alt I.

5.2 System Engineering

5.2.1 System Engineering Management Plan

DRD No.: 02.001
Title: System Engineering Management Plan (SEMP)
Type: 2

Description/Use: The SEMP defines the technical management approach to be used by the Contractor. It defines the system engineering and integration process and products throughout the project life cycle for accomplishing and ensuring the successful completion of the Contract.

References/Remarks: NPR 7120.5 (current revision) and NPR 7123.1 (current revision)

Content/Data Preparation: The SEMP shall be prepared in accordance with the Contractor's policies and procedures for systems engineering and shall be submitted and approved by the Government. The Plan shall describe in detail the systems engineering policies, procedures and tools used as part of the Contractor's technical management effort.

The SEMP shall describe the Contractor's approach, methodology, and application of the systems engineering model and include a description of the process and tools used for the following:

1. Stakeholder Expectations and Involvement: The Contractor shall describe how it will involve all stakeholders throughout the project's life-cycle in the development of the final product.
2. Requirements Development and Management Processes: The Contractor shall describe their approach to develop, document and manage system, subsystem, and component verifiable design requirements for the contracted effort. This should include the identification, documentation, and management of interface requirements (see DRD No. 02.003). Management of requirements should be consistent with the Contractor's C&DMP (DRD No. 01.005.01).
3. Design Solution Processes and Management of Design: The Contractor shall describe the tools and methodologies used to develop and manage the design solution based on the requirements. This description should include the Contractor's process for performing and documenting design trade studies. Drawings and models that result from the design solution process should be managed in accordance with the Contractor's CDMP (DRD 01.005.01).
4. Configuration and Data Management Processes: This contracted effort requires the development and maintenance of a stand-alone C&DMP (See DRD 01.005.01).
5. Risk Identification and Management Processes: This contracted effort requires the development and maintenance of a stand-alone Risk Management Plan (See DRD 01.006.01).
6. Verification and Validation Processes: This contracted effort requires the development and maintenance of a stand-alone Verification Plan (See DRD 02.004.01) and Verification Procedures (See DRD 02.004.02).

Delivery Schedule: Preliminary at Contract Award plus 30 calendar days. Baseline at RR-SDR. Final at CDR. Update as necessary during project life cycle, such as for project baseline changes.

5.2.2 Requirement Documentation

5.2.2.1 Specifications

DRD No.: 02.002
Title: Specifications
Type: 1

Description/Use: Specifications ensure that the Contractor is developing and delivering the Contract end items in accordance with the NASA requirements.

References/Remarks: NPR 7123.1 (current revision)

Content/Data Preparation: Contractor specifications shall reflect content outlined in the Contract SOW and NASA specifications and shall contain the functional, performance

and general design requirements including a description of how the requirements will be met.

The specifications shall include the detailed verification requirements, which include verification method with corresponding success criteria to be satisfied using the methods of test, analysis, inspection or demonstration for compliance. Contractor specifications shall include derived requirements from NASA requirement documents.

Contractor specifications shall include a Requirements Traceability Matrix, or the Contractor shall provide a Requirements Traceability Matrix separately, that includes:

1. An impacts field identifying all systems and subsystems that may be affected by a proposed change to this requirement.
2. An interface impacts field identifying all systems and subsystems that may be affected by a proposed change to this requirement due to an interface association.
3. Identification of the parent requirement.

Delivery Schedule: Baseline at Requirements Review-SDR; Update at PDR; Final at CDR and as necessary w/approval thereafter.

5.2.2.2 Interface Control Document(s) and Drawing(s)

DRD No.: 02.003.01
Title: Interface Control Document(s) and Drawing(s) (ICDs)
Type: 1

Description/Use: To provide configuration controlled documentation in the form of drawings and/or written records to identify necessary design definitions between one or more systems, elements, subsystems, or computer software configuration items (CSCIs) to provide control of and ensure a compatible interface. The ICDs will be provided to the mission user in support of propulsion module and spacecraft integration.

References/Remarks: NPR 7123.1 (current revision)

Content/Data Preparation: The Contractor shall prepare ICDs for the Flight EP String. The ICD shall document the physical, functional, and procedural interface design. The ICD shall provide the descriptive text and diagrams to fully describe the interface implementation. The ICD shall address all of the engineering disciplines associated with the interface design. The ICD shall identify all applicable workmanship and standards being used as part of the interface design. The ICD shall provide traceability from the requirements specification to document design compliance with the requirements.

The ICD shall address the following class of interfaces:

1. Physical – Interfaces involving physical mating and spatial relationships between interconnecting parts of interfacing end items, including clearance envelopes established to avoid interferences and to permit access.

2. Functional – Interfaces involving the interaction or influence of conditions imposed by one Component End Interface (CEI) or higher level assembly upon another or by external sources such as fluids, thermal, electrical, environmental, data, and loads.
3. Procedural – Interfaces involving critical sequence of events occurring in assembly, disassembly, alignment, service operations, and computer programs.

All ICDs addressing external interfaces to the EP string shall be approved by the Government.

Delivery Schedule: Baseline at PDR; Final at CDR. Update as necessary w/approval after CDR.

5.2.3 Verification Documentation

5.2.3.1 Verification and Validation Plan

DRD No.: 02.004.01
Title: Verification and Validation Plan
Type: 2

Description/Use: The Verification Plan documents the verification methodology and processes to be used by the Contractor. It also documents the detailed verification activities needed in order to prove conformity with the technical specifications and perform design certification and end item acceptance

References/Remarks: NPR 7123.1 (current revision)

Content/Data Preparation: The Verification and Validation Plan, at a minimum, includes the test, demonstration, analysis, and inspection activities required to verify Contract End Item requirements. The Verification and Validation Plan shall include, at a minimum:

1. Overview of the Contractor verification program.
2. Description of the Contractor organizational structure for implementing the verification program.
3. Description of the Verification and Validation Process:
    a. Philosophy
    b. Approach
    c. Incompressible Test List
    d. V&V Process
    e. V&V planning
    f. V&V tracking
    g. Close-out process
    h. Assembly, Integration and Test philosophy and process
4. Description of the V&V Phases.

5. Identification of selected software V&V procedures and criteria across the life cycle.
6. Description of software verification environments and validation environments that are to be established for the project.
7. Definition of verification methods.
8. Verification matrix that clearly documents the verification method or methods employed for each requirement.
9. For each verification activity identified in the verification matrix, a detailed verification task description including: identification of specific hardware and software under test and it's relation to flight configuration, resources (facilities, models, software, simulators, etc.) required to perform the activity, and identification of qualification, proto-flight or acceptance verification activities. This information should incorporate the details from the proposed Testing Strategy.
10. Detailed time-correlated sequence of verification activities.
11. Description of all supporting hardware and resources.

Delivery Schedule: Preliminary at RR-SDR; Baseline at PDR; Final at CDR and as w/approval necessary thereafter.

5.2.3.2 Verification Procedures

DRD No.: 02.004.02
Title: Verification Procedures
Type: 2

Description/Use: Written description of the verification approach for each verification activity identified in the verification matrix. The procedure shall identify the verification specific processes that occur, including testing, analysis and inspection activities.

References/Remarks: NPR 7123.1 (current revision)

Content/Data Preparation: The description shall include, at a minimum, the following information:

1. Unique Verification tracking number
2. Verification method (A,I,T,D)
3. Requirement ID, Title and statement
4. Detailed Verification approach and rationale
    a. Requirement success criteria
    b. Associated event plan (as specified in verification plan, DRD 02.004.001) including planned pre- and post- verification analyses, if applicable
5. Verification closure method (DRD 02.004.03 or DRD 02.004.04)
6. Responsible sign-off authority

Delivery Schedule: Preliminary at PDR. Final at CDR. Update as necessary w/approval after CDR.

5.2.3.3 Verification Reports

DRD No.: 02.004.03
Title: Verification Reports
Type: 2

Description/Use: The Verification Reports document the verification activity results associated with verification closure.

Content/Data Preparation: Verification Reports shall contain, at a minimum:

1. Details of the specific verification activity
2. Any deviations from the flow-down requirements
3. Supporting technical data
4. The verification results (pass/fail)
5. Details of anomalies found and their resolution, including plans to perform the verification activity again if necessary or recommendation to process a deviation/waiver request
6. Summary of the results of the verification activity, tests, demonstrations, inspections, and/or analyses performed with any anomalies noted.
7. A recommendation to certify the requirement as closed, re-verify the requirement, or issue a waiver.
8. Signature by responsible authority verifying requirement closure

Delivery Schedule: Preliminary at ~~one week~~ 7 calendar days after event. Final at ~~1 month~~ 30 calendar days after verification/validation event.

5.2.3.4 Verification Closure Notices

DRD No.: 02.004.04
Title: Verification Closure Notices
Type: 2

Description/Use: Verification closure notices shall be provided for each requirement, including safety hazard requirements, identified in the verification matrix. The VCN contains information identifying the requirement and a brief description of the verification results along with a list of supporting documentation providing objective evidence of the requirement verification.

References/Remarks: NPR 7123.1 (current revision)

Content/Data Preparation: Verification closure notices shall contain, at a minimum:

1. A summary of the rationale for closing the requirements
2. Requirement number
3. Any non-conformances
4. Verification method
5. Supporting documentation
6. Signature by responsible authority verifying requirement closure

Delivery Schedule: Final ~~one month~~ 30 calendar days after completion of the verification activities for that requirement.

5.2.4 Assembly, Integration and Test Documentation

5.2.4.1 Assembly, Integration and Test Plan

DRD No.: 02.014
Title: Assembly, Integration and Test Plan
Type: 2

Description/Use: The Assembly, Integration and Test (AI&T) Plan documents the AI&T methodology and processes to be used by the Contractor. It also documents the detailed AI&T activities needed in order to prove conformity with the technical specifications and perform design certification and end item acceptance.

References/Remarks: NPR 7123.1 (current revision)

Content/Data Preparation: The AI&T Plan, at a minimum, includes the activities associated with AI&T. The AI&T Plan shall include, at a minimum:

1. Overview of the Contractor AI&T program.
2. Description of the Contractor organizational structure for implementing the AI&T program.
3. Description of the Facilities:
    a. Assembly
    b. Integration
    c. Bonded Storage
4. Description of Assembly and integration support elements.
5. Implementation of AI&T.
6. Description of Safety element (i.e. Electrostatic Discharge, Contamination, Work Rules, etc.).
7. Description of support equipment.
8. Description of the AI&T work flow.
9. Description of all supporting hardware and resources.

Delivery Schedule: Preliminary at PDR; Baseline at CDR. Update as necessary w/approval after CDR.

5.2.5 Technical Performance Measures

DRD No.: 02.005
Title: Technical Performance Measures
Type: 2

Description/Use: This document will be used to establish the Technical Performance Measures to be tracked during the project and the recurring update and reporting process.

Content/Data Preparation: At a minimum, this document shall include the following:

1. Description of Technical Performance Measures (TPMs) to be monitored during the design and development of the hardware.
2. Description of method, management systems, and processes used to implement the plan, including developing, maintaining, analyzing, reporting, and providing management review of TPMs
3. The TPM description shall consist of at least the following for each metric/measure:
   a. Definition and description of the metric/measure
   b. Graphical representation
   c. Algorithm (if calculated)
   d. Assessment criteria for expected (standard) performance and excellent performance

Delivery Schedule: Preliminary at RR-SDR; Final at PDR; Update as necessary w/approval after PDR.

5.2.6 Properties Report

DRD No.: 02.006
Title: Properties Report
Type: 3

Description/Use: Properties Reports provide the Mass, Power Equipment List (PEL), and physical volume/dimensions properties of each unit of delivered hardware. This report will support hardware integration into the next level of system.

References/Remarks: AIAA S-120-2006 (current revision), AIAA S–122-2007 (current revision)

Content/Data Preparation:
Introduction Section shall covers the definition of target values, reserve values and growth allocations as well as the reconciliation of value estimates with measured data from as-built hardware for Mass, Power and Physical volume/dimensions.

The Mass Properties Section shall include, as a minimum, mass, center of gravity, moments of inertia, and products of inertia and maturity level (in percent). Values shall be denotes as calculated or actuals.

The Power Equipment List (PEL) Section shall include, as a minimum, average power, transient/peak power, duty cycle, maximum current, switching current, line loss, thermal dissipation, and efficiency, mass, quantity (number of units), and power growth allowance for the EP string and its components (Thruster, XFC, and PPU). This shall also address the different states of the EP string.

The physical volume/dimensions Properties section shall include, as a minimum, physical envelope and dimensions of the EP string components (Thruster, XFC, and PPU).

The Baseline Properties Report shall be based upon calculated values.

The Final Properties Report shall be updated as calculations are revised and actual measured data becomes available.

Delivery Schedule: Preliminary at PDR; Baselined at CDR and Final at SAR. Update at each Design Analysis Cycle (DAC).

5.2.7 Document Tree

DRD No.: 02.007
Title: Document Tree
Type: 3

Description/Use: The Document Tree provides a categorized listing of documents required for development, design, production, verification, validation, qualification, and design evolution of a Configuration Item (CI) or Computer Software Configuration Item (CSCI).

Content/Data Preparation: Document Trees depict the hardware and software configuration items in top down, or hierarchical breakdown form. The document tree shall consist of an indentured or hierarchical breakdown listing of all specifications, plans, reports, or other documents applicable to a configuration item.

Delivery Schedule: Preliminary at RR-SDR; Baseline at PDR; Update at CDR; Final at SAR. Update as necessary w/approval after SAR.

5.2.8 Drawing Tree

DRD No.: 02.008
Title: Drawing Tree
Type: 3

Description/Use: A Drawing Tree provides a categorized listing of drawings required for development, design, production, verification, validation, qualification, and design evolution of a Configuration Item (CI).

Content/Data Preparation: Drawing Trees depict the hardware items in top down, or hierarchical breakdown form. The drawing tree shall consist of an indentured or hierarchical breakdown listing of all drawings applicable to a configuration item.

Delivery Schedule: Preliminary at RR-SDR; Baseline at PDR; Update at CDR; Final at SAR. Update as necessary w/approval after SAR.

5.2.9 Hardware Handling and Transportation Plan

DRD No.: 02.009
Title: Hardware Handling and Transportation Plan
Type: 2

Description/Use: This Hardware Handling and Transportation Plan provides the plans for handling and transporting the flight hardware and associated support equipment. This document includes the plans and stipulations (how, what and when) for all hardware shipping containers, test fixtures, transportation equipment, and any other associated support equipment.

Content/Data Preparation: These plans shall include details for, at minimum, the following activities:

1. Bonded storage locations and plans for use
2. Assembly/processing/storage locations plans for hardware segregation and drop resistant shelving
3. Critical lift plans and identified associated hardware, such as critical lift rated cranes per NASA-STD-8719.9, NASA Standard for Lifting Devices and Equipment
4. The plan for identification and development of shipping containers, lifting fixtures attachment hardware, transportation/holding apparatuses, and test fixtures (for all orientations/configurations)
5. Hardware handling risk mitigation
6. Supporting delivery (shipping containers and transportation) of the flight hardware
7. Monitoring, recording, and documenting the hardware's experienced environment during transit (i.e., temperature, humidity, acceleration)
8. Method of packaging, including folding, protective covers, bags in which to place the equipment, and bag sealing methods
9. Shipping documentation
10. Method of marking in accordance with NPR 6000.1H
11. All necessary special provisions for flight hardware packaging, handling, and transportation as NASA NPR 6000.1H Class 1, 2, or 3
12. Electrostatic Discharge (ESD) packaging considerations

Delivery Schedule: Preliminary at RR-SDR; Baseline at PDR; Final at CDR. Update as required w/approval after CDR.

5.2.10 Contractor Technical Reviews

5.2.10.1 Engineering Review Data Package

DRD No.: 02.010.01
Title: Engineering Review Data package
Type: 2

Description/Use: Engineering Review Data provides NASA with the engineering and programmatic data necessary to evaluate changes in the baseline configuration.

Content/Data Preparation: Engineering review documentation shall be composed of presentations, technical data, meeting minutes, actions, and decisions. At a minimum, the data package will consist of the following:

1. A concise statement of the issue
2. Technical description of the baseline configuration including a statement as to why the baseline is deficient
3. Listing of potential alternatives that were investigated
4. Technical description of the proposed configuration
5. Programmatic considerations to include expected cost, schedule and risk implications of adopting the change
6. Technical recommendation

Delivery Schedule: Engineering Review data packages shall be provided no later than (NLT) 2 calendar days prior to the review. Final engineering review documentation shall be provided within 2 calendar days of review completion.

5.2.10.2 Test Readiness Review Package

DRD No.: 02.010.02
Title: Test Readiness Review (TRR) Package
Type: 2

Description/Use: A TRR for each planned test or series of tests that ensures that the test article (hardware and/or software), test facility, test support equipment, support personnel, and test procedures are ready for testing and data acquisition, reduction, and control. The TRR establishes a decision point to proceed with planned testing.

References/Remarks: The TRR shall meet the intent of NPR 7123.1 (current revision).

Content/Data Preparation: Content shall be sufficient to satisfy the objectives of the TRR. Content shall include, but not be limited to:

1. Entrance and exit criteria.
2. Test hardware description, to include planned instrumentation
3. Test objectives, test plan(s), test procedures, and test schedule.
4. Test matrix identifying test points (e.g. thruster voltage and other key parameters).
5. Test flow charts (e.g. block diagram).
6. Safety permits and safety certifications.

The objectives of a TRR are to:

1. Confirm that in-place test plans meet requirements and specifications.
2. Confirm that sufficient resources are allocated to the test effort.
3. Examine detailed test procedures for completeness and safety during test operations.

4. Determine that critical test personnel are test and safety certified as required.
5. Confirm that test support software is adequate, pertinent, and verified.

Delivery Schedule: Final TRR Package shall be provided no later than 7 calendar days prior to the TRR.

5.2.11 Contractor Major Reviews

5.2.11.1 EP String Requirements Review – Subsystem Definition Review Package

DRD No.: 02.011.01
Title: EP String Requirements Review (RR) – Subsystem Definition Review (SDR) Package
Type: 2 – EP String RR – SDR Plan
2 – EP String RR – SDR Documentation

Description/Use: The EP String RR – SDR plan provides the details of how the review will be conducted to meet the intent of NPR 7120.5 and NPR 7123.1, including identification of roles and responsibilities, entrance and exit criteria and delineation of the data that will be delivered to support the review.

The EP String RR – SDR documentation provides the evidence that the Contractor has met the milestone and is ready to proceed to the next milestone as listed in the SEMP (DRD-02.001).

References/Remarks: The EP String Requirements Review (RR) – Subsystem Definition Review shall meet the intent of a System Requirements Review – System Definition Review as identified in NPR 7120.5 (current revision) and delineated in NPR 7123.1 (current revision) or equivalent, as tailored by the Contractor and approved by NASA. EP String for an Advanced Electric Propulsion System Requirements Document, each requirement and its verification method shall be discussed. Any issues with the verification method shall be identified, and alternate methods of verification, if any, may be proposed.

Content/Data Preparation:

1. The EP String RR – SDR Plan shall include, at a minimum:
   a. Review Objective(s).
   b. Organizational roles and responsibilities (Contractor and NASA).
   c. Tailoring to NPR 7123.1 (current revision) or equivalent entrance and success criteria as agreed to by NASA.
   d. Review schedule.
   e. Review data deliverables listing and description.
   f. Review process, including description of feedback submittal, disposition, and closure process.
2. The EP String RR – SDR documentation shall include all review data deliverables identified in the EP String RR – SDR Plan and agreed to by NASA.

Delivery Schedule:
1. The EP String RR – SDR Plan: Preliminary Review plan shall be delivered no later than 50 calendar days prior to the review. Final Review plan shall be delivered no later than 28 calendar days prior to the review.
2. The EP String RR – SDR documentation: Final Review Documentation shall be delivered no later than 14 calendar days prior to the review.

5.2.11.2 Critical Component/Subassembly Design Review Package

DRD No.: 02.011.06
Title: Critical Component/Subassembly Design Review (DR) Package
Type: 2 – Critical Component/Subassembly DR Plan
2 – Critical Component/Subassembly DR Documentation

Description/Use: The Critical Component/Subassembly DRs are intended to be tabletop reviews that provide evidence that the Contractor making realistic technical progress on a critical subassembly, data required by the Government for independent assessments, and opportunities for Government subject matter experts to participate in design maturation prior to PDR.

The Critical Component/Subassembly DR Plans are viewgraph packages describing the roles and responsibilities for a given component or subassembly, entrance and exit criteria, and delineation of the data that will be delivered to support the review.

The Subassembly DR Documentation consists of viewgraph packages and associated models, drawings, or data.

References/Remarks: The Subassembly DR shall meet the intent of a Peer Review as delineated in NPR 7123.1 (current revision), as tailored by the Contractor and approved by NASA.

Content/Data Preparation:
1. The Critical Component/Subassembly DR Plan shall include, at a minimum:
   a. Review Objective(s).
   b. Organizational roles and responsibilities (Contractor and NASA).
   c. Entrance and success criteria as agreed to by NASA.
   d. Review schedule.
   e. Review data deliverables listing and description.
   f. Review process, including description of feedback submittal, disposition, and closure process.
2. The Critical Component/Subassembly DR documentation shall include all review data deliverables identified in the Critical Component/Subassembly DR Plan and agreed to by NASA, including but not limited to:
   a. A requirements flowdown summary, identifying driving and key requirements.
   b. CAD/Solid models, drawings, block diagrams, and schematics both mechanical and electrical as may be applicable to the thruster, the PPU, the XFC or other key hardware.

c. A parts list for the subassembly, identifying potential suppliers for each part. Any issues based on sourcing shall be identified.
d. A manufacturing process flow plan (high level – preliminary).
e. A test flow plan (high level – preliminary).
f. GSE, both mechanical and electrical, with any issues identified.
g. Specific to the thruster design:
    i. Preliminary magnetic circuit model, including information specified in DRD 04.001.02 Models. The model shall demonstrate that the design will provide for the required life of the discharge chamber walls.
    ii. Preliminary thruster thermal model, including information specified in DRD 04.001.02 Models. At this stage the model is expected to consist of a simplified representation of the preliminary thruster design and shall demonstrate a thermal management approach (such as radiators, coatings, thermal interface materials, coil designs) that maintains component temperatures consistent with the life requirements by rejecting heat inputs from the coils, cathode, and discharge chamber plasma.
    iii. Cathode mechanical design and initial lifetime assessment.
    iv. Preliminary structural model of the thruster and cathode design, including information specified in DRD 04.001.02 Models. At this stage the model is expected to consist of a simplified representation of the preliminary thruster design and shall demonstrate acceptable stresses and deflections under launch loads.
    v. Descriptions of the approach to electrical isolation in the thruster, including auxiliary components such as the propellant isolators, harness, and terminal blocks/connectors.
h. Specific to the PPU Discharge Power Supply and Digital control interface design:
    i. Preliminary Discharge Supply design approach based in all applicable requirements listed in requirements according to the Attachment J.1(c).
    ii. Preliminary Discharge Supply controls and power processing models, including information specified in DRD 04.001.02 Models.
    iii. Preliminary digital control interface design approach based in all applicable requirements listed in requirements according to the Attachment J.1(c).
    iv. Preliminary Digital control interface PLD and Software design.
    v. Preliminary thermal model of both subassemblies, including information specified in DRD 04.001.02 Models.
    vi. Preliminary structural model of both subassemblies, including information specified in DRD 04.001.02 Models and shall demonstrate acceptable stresses and deflections under launch loads.

<u>Delivery Schedule</u>:

1. The Critical Component/Subassembly DR Plan: Preliminary Review plan shall be delivered no later than 30 calendar days prior to the review. Final Review plan shall be delivered no later than 14 calendar days prior to the review.

2. The Critical Component/Subassembly DR Documentation: Final Review package shall be delivered no later than 7 calendar days prior to the review.
3. The Critical Component/Subassembly DR Plan and Documentation review can be either one review or smaller reviews as early as technically feasible but no later than **30 days prior to PDR**. ~~shall be scheduled to start no later than 3 months after contract start date.~~

5.2.11.3 EP String Preliminary Design Review Package

DRD No.: 02.011.02
Title: EP String Preliminary Design Review (PDR) Package
Type: 2 – EP String PDR Plan
2 – EP String PDR Documentation

Description/Use: The EP String PDR plan provides the details of how the review will be conducted to meet the intent of NPR 7120.5 and NPR 7123.1, including identification of roles and responsibilities, entrance and exit criteria and delineation of the data that will be delivered to support the review.

The EP String PDR documentation provides the evidence that the Contractor has met the milestone and is ready to proceed to the next milestone.

References/Remarks: The EP String PDR shall meet the intent of a Preliminary Design Review as identified in NPR 7120.5 (current revision) and delineated in NPR 7123.1 (current revision), as tailored by the Contractor and approved by NASA.

Content/Data Preparation:

1. The EP String PDR Plan shall include, at a minimum:
   a. Review Objective(s).
   b. Organizational roles and responsibilities (Contractor and NASA).
   c. Tailoring to NPR 7123.1 (current revision) entrance and success criteria as agreed to by NASA.
   d. Review schedule.
   e. Review data deliverables listing and description.
   f. Review process, including description of feedback submittal, disposition, and closure process.
2. The EP String PDR documentation shall include all review data deliverables identified in the EP String PDR Plan and agreed to by NASA, including but not limited to:
   a. A requirements summary, identifying driving and key requirements.
   b. CAD models, drawings, block diagrams, and schematics both mechanical and electrical as may be applicable to the thruster the PPU, the Propellant Flow Controller or other key hardware.
   c. A components list for the thruster the PPU, the Propellant Flow Controller or other key hardware, identifying potential suppliers for each component. Any sourcing issues shall be identified.

d. A manufacturing process flow plan (high level – preliminary).
e. A test flow plan (high level – preliminary).
f. GSE, both mechanical and electrical, with any issues identified.

Delivery Schedule:
1. The EP String PDR Plan: Preliminary Review plan shall be delivered no later than 50 calendar days prior to the review. Final Review plan shall be delivered no later than 28 calendar days prior to the review.
2. The EP String PDR documentation: Final Review Documentation shall be delivered no later than 14 calendar days prior to the review.

5.2.11.4 EDU EP String Acceptance Review Package

DRD No.: 02.011.03
Title: EDU EP String Acceptance Review (AR) Package
Type: 2 – EDU EP String AR Plan
2 – EDU EP String AR Documentation

Description/Use: The EDU EP String AR plan provides the details of how the review will be conducted to meet the intent of NPR 7120.5 and NPR 7123.1, including identification of roles and responsibilities, entrance and exit criteria and delineation of the data that will be delivered to support the review.

The EDU EP String AR documentation provides the evidence that the Contractor has met the milestone and is ready to proceed to the next milestone as listed in the SEMP (DRD 02.001).

References/Remarks: The EP String AR shall meet the intent of a System Acceptance Review as identified in NPR 7120.5 (current revision) and delineated in NPR 7123.1 (current revision), as tailored by the Contractor and approved by NASA.

Content/Data Preparation:
1. The EDU EP String AR Plan shall include, at a minimum:
   a. Review Objective(s)
   b. Organizational roles and responsibilities (Contractor and NASA)
   c. Tailoring to NPR 7123.1 (current revision) or equivalent entrance and success criteria as agreed to by NASA
   d. Review schedule
   e. Review data deliverables listing and description
   f. Review process, including description of feedback submittal, disposition, and closure process
2. The EP String AR documentation per DRD 04.008 shall include all review data deliverables identified in the EP String AR Plan and agreed to by NASA.

Delivery Schedule:

1. The EP String AR Plan: Preliminary Review plan shall be delivered no later than 50 calendar days prior to the review. Final Review plan shall be delivered no later than 28 calendar days prior to the review.
2. The EP String AR documentation: Final Review Documentation shall be delivered no later than 14 calendar days prior to the review.

5.2.11.5 EP String Critical Design Review Package

DRD No.: 02.011.04
Title: EP String Critical Design Review (CDR)
Type: 2 – EP String CDR Plan
2 – EP String CDR Documentation

Description/Use: The EP String CDR plan provides the details of how the review will be conducted to meet the intent of NPR 7120.5 and NPR 7123.1, including identification of roles and responsibilities, entrance and exit criteria and delineation of the data that will be delivered to support the review.

The EP String CDR documentation provides the evidence that the Contractor has met the milestone and is ready to proceed to the next milestone as listed in SEMP (DRD 02.001).

References/Remarks: The EP String CDR shall meet the intent of a Critical Design Review as identified in NPR 7120.5 (current revision) and delineated in NPR 7123.1 (current revision) or equivalent, as tailored by the Contractor and approved by NASA.

Content/Data Preparation:

1. The EP String CDR Plan shall include, at a minimum:
   a. Review Objective(s).
   b. Organizational roles and responsibilities (Contractor and NASA).
   c. Tailoring to NPR 7123.1 (current revision) entrance and success criteria as agreed to by NASA.
   d. Review schedule.
   e. Review data deliverables listing and description.
   f. Review process, including description of feedback submittal, disposition, and closure process.
2. The EP String CDR documentation shall include all review data deliverables identified in the EP String PDR Plan and agreed to by NASA, including but not limited to:
   a. A requirements summary, identifying driving and key requirements.
   b. CAD models, drawings, block diagrams, and schematics both mechanical and electrical as may be applicable to the thruster, the PPU, the Propellant Flow Controller or other key hardware.
   c. A components list for the thruster the PPU, the Propellant Flow Controller or other key hardware, identifying suppliers for each component. Any sourcing issues shall be identified, with a plan for resolving the issue.
   d. A manufacturing process flow plan.
   e. A test flow plan.

f. GSE, both mechanical and electrical, with any issues identified.

Delivery Schedule:
1. The EP String CDR Plan: Preliminary Review plan shall be delivered no later than 50 calendar days prior to the review. Final Review plan shall be delivered no later than 28 calendar days prior to the review.
2. The EP String CDR documentation: Final Review Documentation shall be delivered no later than 14 calendar days prior to the review.

5.2.11.6 Flight EP String Acceptance Review Package

DRD No.: 02.011.05
Title: Flight EP String Acceptance Review (AR) Package
Type: 2 – EP String AR Plan
2 – EP String AR Documentation

Description/Use: The Flight EP String AR plan provides the details of how the review will be conducted to meet the intent of NPR 7120.5 and NPR 7123.1, including identification of roles and responsibilities, entrance and exit criteria and delineation of the data that will be delivered to support the review.

The Flight EP String AR documentation provides the evidence that the Contractor has met the milestone and is ready to proceed to the next milestone.

References/Remarks: The Flight EP String AR shall meet the intent of a System Acceptance Review as identified in NPR 7120.5 (current revision) and delineated in NPR 7123.1 (current revision), as tailored by the Contractor and approved by NASA.

Content/Data Preparation:
1. The Flight EP String AR Plan shall include, at a minimum:
   a. Review Objective(s).
   b. Organizational roles and responsibilities (Contractor and NASA).
   c. Tailoring to NPR 7123.1 (current revision) entrance and success criteria as agreed to by NASA.
   d. Review schedule.
   e. Review data deliverables listing and description.
   f. Review process, including description of feedback submittal, disposition, and closure process.
2. The Flight EP String AR documentation per DRD 04.008 shall include all review data deliverables identified in the EP String AR Plan and agreed to by NASA.

Delivery Schedule:
1. The EP String AR Plan: Preliminary Review plan shall be delivered no later than 50 calendar days prior to the review. Final Review plan shall be delivered no later than 28 calendar days prior to the review.
2. The EP String AR documentation: Final Review Documentation shall be delivered no later than 14 calendar days prior to the review.

5.2.13 Software Development and Management Plan

DRD No.: 02.013
Title: Software Development and Management Plan (SDMP)
Type: 2

Description/Use: To define the Contractor's software development and management approach. This includes new development, modification, reuse, re-engineering, procurement, maintenance, and all other activities resulting in software products throughout the product life-cycle.

References/Remarks: NPR 7150.2(current version) NASA Software Engineering Requirements

Content/Data Preparation: The Contractor shall manage all software engineering activities in accordance with NPR 7150.2 (current version), NASA Software Engineering Requirements as specified in J.1(c)(2) NPR 7150.2 (current version) Contractor Compliance Matrix. The Software Development and Management Plan shall contain:

1. Life-cycle processes and activities, including: requirements, design and development, software and hardware integration, testing, verification and validation, delivery and maintenance.
2. Software life cycle model including phase transition criteria for each life cycle phase.
3. Up to date NPR 7150.2 Compliance Matrix showing Compliance Evidence locations for each requirement marked either "FC" or "T". (This matrix may be kept in a spreadsheet separate from the main SDMP document.)
4. Content of software documentation to be developed.
5. Identification and description of each Computer Software Configuration Item (CSCI) and any sub-components.
6. Identification of all open source software to be used. (This information shall be supplied in the SDMP delivered with the proposal and updated as necessary thereafter.)
7. Description of the engineering environment (for development, operation or maintenance, as applicable), including test environment, library, equipment, facilities, standards, procedures, and tools.
8. Management of safety, security, privacy, and other critical requirements of the software products or services.
9. Subcontractor management, including Subcontractor selection and involvement between the Subcontractor and the acquirer, if applicable.
10. Plan for operation and maintenance.

Delivery Schedule: Preliminary at Contract Award plus 30 days; Baseline at PDR; Final at CDR. Update as necessary w/approval after CDR.

5.2.12 Software User Guide

DRD No.: 02.015
Title: Software User Guide
Type: 2

Description/Use: The user guide is used to provide hands-on software users information on installation and use of the software. The guide may also cover a particular aspect of software operation, such as instructions for a particular position or task.

References/Remarks: NPR 7150.2(current version) NASA Software Engineering Requirements

Content/Data Preparation: The Software User Guide shall include:

1. Software summary including: application, inventory, environment, organization and overview of operation, contingencies and alternate states and modes of operation, security and privacy, and assistance and problem reporting
2. Access to the software: first-time user of the software, initiating a session, and stopping and suspending work
3. Processing reference guide: capabilities, conventions, processing procedures, related processing, data backup, recovery from errors, malfunctions, emergencies, and messages
4. Assumptions, limitations, safety related items/concerns or constraints

Delivery Schedule: Baseline at CDR. Final at SAR. Update as necessary with approval after SAR.

5.2.13 Information Technology System Security Plan (SSP)

DRD No.: 02.016
Title: Information Technology System Security Plan (SSP)
Type: 2

Description/Use: The purpose of this Information Technology System Security Plan (SSP) is to define, document and implement the security requirements of the Contractor's Information Technology (IT) system as well as to delineate the responsibilities and expected behavior of all individuals who access the system. The SSP shall be viewed as documentation of the structured process of planning adequate, cost-effective security protection for the system. This should ensure the proper security controls are architected into the overall end product for easier transition to NASA.

References/Remarks: Federal Information Processing Standards (FIPS) 200; NIST SP 800-53 revision 4.

Content/Data Preparation: The System Security Plan (SSP) shall include:

1. System Identifications
    a. System Name
    b. System Unique Identifier
    c. Responsible Organization
    d. Contact Information
        i. Physical Location
        ii. Point of Contacts
2. General System Description
    a. System Environment
    b. System Interconnections
    c. Laws and Regulations
3. Information System Categorization
    a. Data Types and System Categorization
4. Security Control Implementations
    a. Management Controls
    b. Operational Controls
    c. Technical Controls

The Contractor shall have the option to use the NASA provided template, filename: "NASA External Information System Security Plan (Moderate)" or their own plan format.

Delivery Schedule: Within 6 months (180 calendar days) of contract award.

5.3 Safety and Mission Assurance

5.3.1 Safety and Mission Assurance Plan

DRD No.: 03.001
Title: Safety and Mission Assurance Plan (SMAP)
Type: 1

Description/Use: This plan documents the management and implementation of tasks required to meet the Safety and Mission Assurance requirements of the Contract SOW, consistent with the reference program guidelines and requirements. The Contractor's approach to tailoring these requirements, if applicable, shall be identified and justified in the SMAP. This plan also provides the specifics of the system safety, quality assurance, software assurance, reliability and maintainability, and Mechanical and Electrical, Electronic, and Electromechanical (EEE) Parts Management activities and deliverables, the roles and responsibilities including the interaction with the system engineering organizations, the reporting protocol, and the cost and schedule associated with accomplishing these activities in relation to the critical or key milestones during all phases of the life cycle.

References/Remarks: NPD 8730.5 (current revision), NPR 8715.3 (current version), SAE AS9100 Rev. C, NASA-STD-8739.8, NASA-STD-8719.13C, NASA-HDBK-8739.23, IEEE 730, NPR 7150. 2 (current version), EEE-INST-002, NPD 8730.2 (current version)

Content/Data Preparation: The Contractor's SMAP shall include a traceability matrix of requirements to planned processes and verification for all S&MA requirements. The SMAP may incorporate other plans required in this SOW in one document. At a minimum, the following shall be included in the Contractor's SMAP.

The System Safety sections describe the development and implementation of a system safety program that complies with the requirements of NPR 8715.3. The System Safety section shall:

1. Define the roles and responsibilities of personnel.
2. Define the required documentation, applicable requirements documents, and completion schedules for analyses and reviews.
3. Address support for Reviews, Safety Working Group Meetings, and Technical Interchange Meetings (TIMs).
4. Provide for early identification and control of hazards to personnel, facilities, support equipment, and the flight system during product development, including design, fabrication, test, transportation, and ground activities.
5. Address compliance with industrial safety requirements Imposed by NASA and OSHA design and operational needs and contractually imposed mission unique obligations.
6. Address software safety so as to identify and mitigate safety-critical software products in compliance with NASA-STD-8719.13.
7. Define the roles and responsibilities of personnel.
8. Define the required documentation, applicable requirements documents, and completion schedules for analyses and reviews.
9. Address support for Reviews, Safety Working Group Meetings, and Technical Interchange Meetings (TIMs).
10. Provide for early identification and control of hazards to personnel, facilities, support equipment, and the flight system during product development, including design, fabrication, test, transportation, and ground activities.
11. Address compliance with industrial safety requirements Imposed by NASA and OSHA design and operational needs and contractually imposed mission unique obligations.
12. Address software safety so as to identify and mitigate safety-critical software products in compliance with NASA-STD-8719.13.

The Quality Assurance (QA) section shall identify, as applicable, the specific quality activities related to the design and development, procurement of materials/subcomponents, fabrication, verification, and shipping to assure the quality of the items delivered. The QA sections shall reference the Contractor's quality system. Each quality element of SAE AS9100 shall be addressed to describe the implementation approach. This can be satisfied by an existing quality manual and procedures. The

Contractor shall provide access to the Quality System Manual and first-tier procedures for review by NASA, along with evidence of third party certification/registration of the Quality Management System by an accredited registrar, if available. At a minimum, the subparagraphs below shall be addressed in detail, identifying the responsibilities and controls used for the specific quality assurance activities related to hardware being procured by NASA:

1. Show how the current procedures address each element of SAE AS9100, such as by a list, outline, cross-reference matrix, etc.
2. Explain how timely review of technical documents that affect quality and changes thereto is ensured.
3. Describe proposed participation including responsibilities/activities in design reviews.
4. Explain proposed process for including NASA in the review of purchasing documents for delegation determination.
5. Describe monitoring, measurement, and control of the quality of products produced by the Contractor and Subcontractors. Explain how products which do not conform to product requirements are identified and controlled to prevent their unintended use or delivery.
6. Describe methodology for inspection and test planning (economical and effective use of personnel, facilities, and equipment).
7. Describe methodology/criteria for assigning itinerate or resident quality assurance personnel at Subcontractor or supplier facilities.
8. Describe establishment and implementation of inspection or other activities necessary for ensuring that purchased product meets specified purchase requirements.
9. Special Process Controls: describe special process controls implemented for in-house processes and, if applicable, for sub-tier supplier processes.
10. Explain the verification that all personnel performing work affecting product quality are competent as a result of appropriate education, training, skills, and experience. In addition explain the system to be used to monitor and maintain this level of personnel competency required during the duration of the contract.
11. Describe responsibilities and requirements for planning and conducting audits (internal and external), and for reporting results and maintaining records.
12. Explain involvement in waivers and deviations when quality assurance is affected.
13. Explain methods for measuring the achievement of quality objectives.
14. Explain the process for determining appropriate quality indices and measurements and reporting those to designated Quality organization in a timely fashion.
15. Explain the methodology used by the Contractor for Process Failure Modes and Effects Analysis (PFMEA) to reduce cost of quality, reduce product variation, reduce employee safety incidents, and improve processing and manufacturing process efficiency.
16. Describe the non-conformance system and its use including the involvement of the Contractor's quality department.

The Software Assurance (SA) sections describe the activities and tasks for software quality, software configuration management, software testing, software verification and validation, and software safety if applicable. The software portion of firmware and/or complex electronics shall be defined and covered in these sections. In accordance with NASA-STD-8739.8 Appendix B or IEEE-730, the Software Assurance sections shall include:

1. Software Assurance Organization.
2. Software Assurance Classification Assessment.
3. Software Safety Criticality Assessment according to NASA-STD-8719.13C, chapter 5.
4. Software Quality Assurance Activities per IEEE 730.
5. Software Safety Activities per NASA-STD-8719.13C if Software is Safety Critical
6. Software Verification and Validation Activities.
7. Software Independent Verification and Validation Activities if Software is safety critical.
8. Software and Complex Electronics Configuration Management.
9. Problem Reporting and Corrective Action.
10. Risk Management.
11. Software Assurance Program Metrics.
12. Software Assurance Records.
13. Training.

The Reliability and Maintainability (R&M) sections describe how R&M tasks/activities shall be performed in order to assure that the tasks can be completed on schedule and performed to achieve mission success. The plan shall describe the necessary resources in R&M engineering, systems engineering, and the electronics and thruster design teams to support R&M tasks. The R&M sections shall describe the process to assure that the project systems engineering and components engineering groups will provide design information necessary for R&M engineering to perform reliability prediction analysis. In particular, the Contractor shall describe the process for the design engineering participation in and response to: the Failure Modes and Effects Analysis (FMEA), the Critical Items List (CIL), and Reliability Analysis. The R&M sections shall describe the process for how systems engineering shall coordinate and support the system maintainability assessment, and how the project systems engineering, components engineering, and R&M Engineering will collaborate on implementing R&M design requirements for the PPU and thruster system. These design requirements would be both quantitative and qualitative and would be included in the System Design Specifications.

The R&M section shall also describe the overall concept for maintaining the SEP system, including PPU, thruster, and xenon storage and feed systems. The maintenance concept evolves as the concept of the design and operations evolves and this eventually leads to the Corrective and Preventative Maintenance plans. The following elements of the maintainability concept should be described in the document:

1. Definition of Maintenance Phases: Identify the mission phases in which the project plans to perform maintenance (corrective or preventative) and designate

maintenance "infrastructure" locations where maintenance will be performed on the ground, such as the launch site.

2. Repair vs. Replacement Policy: Identify what types of components would have to be sent to a depot for repair and which components would be removed and replaced with a spare.
3. Decision on Spares Philosophy: Specify whether there will be development spares, spares provided at the pre-launch processing phase, and what quantity of each will be kept in stock and whether they be kept in close proximity to launch facility.
4. Tool Requirements, including:
   a. Required tools
   b. Special service tools
   c. Diagnostic equipment
5. Preliminary LRU list: List units that will have to be designed as line replaceable units.
6. Decision on Failure Diagnostics: Describe the approach for conducting diagnostics in the event of a failure. The decision on which subsystems can be diagnosed to isolate failures has to be made. The methodology for diagnostics is described for the various sub-systems. This part of the design for maintenance is a major factor in the efficiency of fault/failure isolation and in determining which units in the system will be LRUs. Some other decisions that fall under this element are:
   a. Manual troubleshooting
   b. Trouble-shooting based on automatic test equipment
   c. Use of BIT (built-in-test)
7. Spares Re-Supply: Describe the plan for re-supplying the spares pool.
8. Software: Describe the provisions for maintaining software: corrective response to software failure and upgrades (preventative software maintenance).
9. Disposal plan for Failed LRUs that have been replaced.
10. Technician Training.

The Contractor shall plan and implement an electrical, electronic, electromechanical (EEE), and mechanical parts control program according to the general guidelines of NPD 8730.2. The parts control sections of the SMAP shall define and document the Contractor's requirements, system, and implementation plan for controlling the selection, acquisition, traceability, testing, handling, packaging, storage, and application of mechanical and EEE parts for flight and critical ground support equipment.
The EEE parts control sections shall address each of the required management and technical elements of EEE Parts Assurance.

1. Parts Selection: Shall describe a concurrent engineering process, integrated with hardware design, in which parts are selected for use on the basis of suitability for the intended application. The sections shall identify parts that are considered standard and how other (nonstandard) parts will be evaluated, approved for flight, and controlled. Parts Selection shall consider the failure mode criticality of hardware based upon its intended function and the consequences of the loss of

that function. Failure mode criticality of hardware components may be determined by Failure Modes and Effects analysis.

2. Controlling Specifications: Describe how parts shall be controlled by specifications that delineate:
   a. Complete identification of the part
   b. Physical, environmental, and performance specifications
   c. Reliability requirements, including inspections, tests and lot sampling for qualification and acceptance
   d. Special handling, packaging, and storage requirements
   e. Documentation, data retention, and submittal requirements
3. Part Qualification:
   a. Parts shall be qualified to the requirements of the controlling specification. Part qualification shall demonstrate that the part meets its ratings, and that the manufacturer is using materials, processes, design, and quality controls that will produce a consistent, reliable, high quality device that is deemed suitable for the intended application.
   b. Where adequate qualification data is not available, the Plan shall describe the process of qualification testing to demonstrate that the part meets its ratings.
   c. Parts shall be re-qualified in the event of manufacturer process changes, or when a new lot of qualified parts are procured and it cannot be documented that the parts manufacturer has not changed the materials, processes, equipment, or facility used to manufacture the part.
   d. The Plan shall address how the Contractor maintains the documentation to support the qualified status of parts and their respective suppliers.
4. Design Configuration Acceptability and Control: Shall address how the selected parts for a design are reviewed for application and environment suitability, how the parts quality and reliability meets the operational performance requirements, and if the parts are being used within the specific device ratings (including the NASA de-rating policy). The selection process, technical acceptability of devices, and application documentation and review results shall be available to NASA to support hardware design reviews, certification, acceptance reviews, problem resolutions, and ground and flight operations. Key elements are as-designed and as-built parts lists, application stress analyses (including radiation effects), and nonstandard parts acceptability assessments.
5. Parts Procurement: Shall address how the Contractor will select, qualify, control, and monitor parts manufacturers, and shall address the Contractor's source inspections, receiving inspection (including destructive physical analysis), and stocking and handling procedures prior to and during assembly. These procedures shall address how the Contractor will mitigate the procurement and any subsequent installation of parts or of part lots subject to conditions identified in GIDEP and other EEE parts problem reporting systems. This section of the Plan shall ensure that the selection and use of the parts will not have an obsolescence issue to the greatest extent possible.
6. Radiation Effects: Shall include the following requirements:
   a. It shall be shown by test or analysis that Single Event Effects (SEE), Total Ionizing Dose (TID), or Displacement Damage (DD) radiation effects will not

cause EEE parts to fail or malfunction in such a manner as to cause a safety hazard or loss of a mission.

b. EEE parts that are used to control a hazard, or are a part of a subsystem that is intended to control a hazard, shall be able to execute their intended functions within the SEE, TID, and DD radiation environment to which they will be exposed.

7. Commercial Off-The-Shelf (COTS) hardware: Shall address the use of COTS hardware for which insufficient parts information is available. In these cases, parts used in COTS hardware may be qualified by environmental and accelerated life testing of a complete COTS assembly.
8. GIDEP (Government-Industry Data Exchange Program): A description of the closed-loop GIDEP Process that will be implemented to prevent the use of non-reliable and non-conforming parts. The plan should include the Contractor's process to perform GIDEP searches, review of GIDEP Alerts, and their implementation within the organization.
9. Counterfeit parts: Shall document the approach that will be used to mitigate the risk of counterfeit parts.
10. Materials Subject to Metal Whisker Growth: Shall document materials whose use for solder or surface finishes is to be avoided due to the risk of metal whisker growth. The Plan shall also document the approach to mitigate this risk when the use of such materials is unavoidable.
11. Documentation: Shall define the Contractor's electronic (preferred) or paper documentation system, data supporting milestone and design reviews, and NASA's access to the parts electronic data base and files.

Delivery Schedule: Preliminary at RR-SDR; Baseline at PDR; Final at CDR. Update as necessary w/approval after CDR.

5.3.2 System Safety

5.3.2.1 System Safety Hazard Analysis

DRD No.: 03.002.02
Title: System Safety Hazard Analysis
Type: 2

Description/Use: The System Safety Hazard Analysis documents the project's compliance with the safety requirements. It describes the hazards that have been identified for the system, the hazard controls, and the hazard control verifications. The analysis will be provided to the mission for development support of the mission-level required safety deliverables (i.e., safety data packages).

References/Remarks: NPR 8715.3C, NASA-STD-8719.13C.

Content/Data Preparation: The system-level analysis is created by:

1. A Preliminary Hazards Analysis (PHA) that identifies potential hazards and controls for flight and high-risk ground support activities.

2. A Hazard Analysis that identifies a detailed listing of hazards unique to each subsystem and/or component and builds on the PHA information (can be done when more detailed design information is available).
3. An Operational Hazard Analysis that identifies hazards that can be caused by operating and support (e.g., maintenance) personnel or conversely, hazards to which operating and support personnel can be exposed.
4. A Software Hazard Analysis that validates specified software behavior satisfies system safety design constraints that checks if specified software behavior satisfies general software system safety design criteria, and is performed on all software including commercial-off-the-shelf (COTS).

Delivery Schedule: Preliminary at PDR for the system-level safety analysis; Baseline at CDR. Final at SAR; Update as necessary w/approval after SAR.

5.3.2.2 Mishap Report

DRD No.: 03.002.03
Title: Mishap Report
Type: 3

Description/Use: The Mishap Report documents the investigation of a mishap, close call, or previously unidentified serious workplace hazards to prevent recurrence of similar accidents. Proper elements of a mishap report include proximate cause(s), root cause(s), failed barrier(s), and observation(s); sufficient facts/data to support the finding(s) and recommendation(s); and a mishap investigation summary.

References/Remarks: NPR 8261.1 (current revision)

Content/Data Preparation: The Contractor shall report mishaps and close calls per the requirements specified in NPR 8621.1. NASA retains the option of providing a Government representative for Contractor-managed mishap investigations. The Contractor shall support all NASA mishap investigations.

The Contractor shall report unplanned events that result in the following:
1. Injury to non-NASA personnel caused by NASA operations.
2. Damage to public or private property caused by NASA operations or NASA funded development or research projects.
3. Occupational injury or illness to NASA personnel.
4. NASA mission failure.
5. Damage or destruction of NASA property.

Test failures involving damage to equipment or property as a result of testing are not considered mishaps if:
1. The test article is not flight hardware.
2. The testing is part of an authorized research / development / qualification / certification program.
3. Damage is limited to the test article and test instrumentation.

4. NASA program/project management explicitly accepted risk of damage to the test article.
5. The test team performs a test failure analysis and generates a technical report instead of treating it as a mishap.

Delivery Schedule: Initial notification of a mishap to NASA project office within 24 hours of occurrence. Mishap Report delivered to NASA project office within 75 calendar days.

5.3.3 Quality Assurance

5.3.3.1 Waivers and Deviations

DRD No.: 03.003.02
Title: Waiver and Deviation Requests
Type: 1

Description/Use: The Contractor shall submit a waiver or deviation request when NASA approval of either is needed. A Deviation is a documented authorization releasing a program or project from meeting a requirement before the requirement is put under configuration control at the level the requirement will be implemented. A waiver is a documented authorization releasing a program or project from meeting a requirement after the requirement is put under configuration control at the level the requirement will be implemented.

References/Remarks: SAE AS9100 Rev. C, Quality Management Systems – Requirements for Aviation, Space and Defense Organizations.

Content/Data Preparation: The developer shall identify the requirements that apply to the product and provide specific information regarding the noncompliance of the product with the requirements. The developer shall identify the effect of the proposed noncompliance on product performance at higher levels of assembly.

Delivery Schedule: Deliver to the Project Office within five (5) working days of identifying the need for a deviation or waiver request for approval.

5.3.3.2 Mandatory Inspection Points Data Packages

DRD No.: 03.003.03
Title: Government Mandatory Inspection Points (GMIPs) Data Packages
Type: 1

Description/Use: The work activities and operations of the Contractor, Subcontractors, and suppliers are subject to evaluation, review, survey, and inspection by NASA representatives.

The Contractor shall provide the NASA representatives with documents, records, equipment, and workings areas within their facilities that are required by the representative to perform their overview activities.

References/Remarks: The Government will develop government mandatory inspection points (GMIPs) in compliance with NPR 8735.2 (current revision). These may include process, product, or record reviews and inspections prior to assembly of critical assemblies.

Content/Data Preparation: S&MA deliverables, such as the FMECA, Hazard Analyses, and Risk List, will be used, in part, to assist is defining MIPs. MIPs shall be noted on Contractor fabrication documentation. MIPs shall be defined per DRD No. 03.001.

Delivery Schedule: In accordance with Government-defined MIPs per baseline schedule.

5.3.4 Materials and Processes

5.3.4.1 Materials and Processes Selection, Implementation, and Control Plan

DRD No.: 03.004.01
Title: Materials and Processes Selection, Implementation, and Control Plan
Type: 2

Description/Use: The Materials and Processes Selection, Implementation, and Control Plan documents the degree of conformance and method of implementation for each requirement in NASA-STD-6016, identifying applicable in-house specifications used to comply with the requirement. It also describes the methods used to control compliance with these requirements by Subcontractors and vendors. The Materials and Processes Selection, Control, and Implementation Plan will become the Materials and Processes implementation document used for verification. The plan shall also identify and control limited shelf life items and ensure that shelf life for stored items shall not fall below required storage time.

References/Remarks: NASA-STD-6008, NASA-STD-6016

Content/Data Preparation: The Plan shall address each requirement paragraph of NASA-STD-6016 and describe the method of implementation and degree of conformance for each applicable requirement. If tailoring of the requirements is planned or necessary, alternate approaches to NASA-STD-6016 may be submitted in this plan, which meet or exceed the stated requirements. This tailoring approach will allow for NASA approval of alternate requirements.

The plan shall address, at a minimum, the following:

1. Conformance to the requirements of NASA-STD-6016 with the changes prescribed below and a description of the method of implementation.
2. Organizational authority and responsibility for review and approval of M&P specified prior to release of engineering documentation.
3. Identification and documentation of Materials and Processes. All materials processes used in manufacturing shall be documented in process specifications and all applicable process specifications shall be identified on the engineering

drawing. Each processing step in the process specification shall be identified in a level of detail that ensures the process is repeatable.
4. Procedures and data documentation for proposed test programs to support materials screening and verification testing. Any material/process testing to be performed by the hardware developer shall require prior NASA approval.
5. Materials Usage Agreement (MUA) Procedures
6. Determination of material design properties, including statistical approaches to be employed.
7. Document the process for controlling limited storage life items (LSLI), where LSLI are items that have a specified storage time limit. Examples of possible limited storage life items are solid chemicals, chemical mixtures and/or solutions, solvents, lubricants, epoxies, or specific hardware devices such as batteries.
8. Prepare worksheets for all limited storage life items. (Consult GLWI-QE-8720.5 for guidance.) Develop a planned action for each, and document the LSLI Plan. A rationale must be provided for each planned action. The plan shall include a listing of all limited storage life items.

Prescribed changes to NASA-STD-6016:

- The developer may use the GSFC outgassing database (URL http://outgassing.nasa.gov) in addition to MAPTIS.
- Paragraph 4.2.3.8 does not apply.
- In the event that the alloying requirement of paragraph 4.2.2.11 cannot be met, the developer shall meet the requirements of GEIA-STD-0005-1 and GEIA-STD-0005-2 for solders and surface finishes that are less than 3% Lead by weight.

Delivery Schedule: Baseline at RR-SDR; Final at CDR. Update as necessary w/approval after CDR.

5.3.4.2 Materials Identification and Usage List

DRD No.: 03.004.02
Title: Materials Identification and Usage List (MIUL)
Type: 1

Description/Use: The MIUL is an electronic searchable parts list or separate electronic searchable materials identification and usage list. The MIUL identifies all Materials and Processes (M&P) usages contained in the end item, excluding piece part electronics, for evaluation of the acceptability of M&P selected and utilized.

References/Remarks: NASA-STD-6016, GLWI-QE-8720.5, GEIA-STD-0005-1, GEIA-STD-0005-2

Content/Data Preparation: Materials and processes usage shall be documented in an electronic searchable parts list or separate electronic searchable Materials Identification and Usage List (MIUL). The procedures and formats for documentation of materials and processes usage will depend upon specific hardware but shall cover the final design. The system used shall be an integral part of the engineering configuration control/release

system. A copy of the stored data shall be provided to NASA in a form compatible with the Materials and Processes Technical Information System (MAPTIS).

Delivery Schedule: Baseline at PDR; Update at CDR; Final at SAR; Update as necessary w/approval after SAR.

5.3.4.3 Materials Usage Agreements

DRD No.: 03.004.03
Title: Materials Usage Agreements (MUAs)
Type: 1

Description/Use: MUAs shall be submitted for all materials and processes that are technically acceptable but do not meet the technical requirements of NASA-STD-6016, as implemented by the approved Materials and Processes Selection, Control, and Implementation Plan. [The use of materials and processes that do not comply with the technical requirements of NASA-STD-6016 may be technically acceptable if hardware reliability and vehicle safety are not affected.]

References/Remarks: NASA-STD-6016

Content/Data Preparation: MUAs shall be submitted as described below.
Category I MUAs – Category I MUAs are those that involve material/processes usage that could affect the safety of the mission, crew, or vehicle or affect the mission success, but must be used for functional reasons. Approval by the responsible NASA Materials and Processes organization and the NASA Program/Project Office shall be required.

Category II MUAs - Category II MUAs are those that involve material/processes usage that fails a screening of Material and Processes requirements and is not considered a hazard in its use application but for which no Category III rationale code exists. Approval by the responsible NASA Materials and Processes organization shall be required.

Category III MUAs - Category III MUAs are those that involve materials or processes that have not been shown to meet these requirements but have an approved rationale code listed in Appendix B of NASA-STD- 6016. They are evaluated and determined to be acceptable at the configuration/part level. Category III MUAs shall be reported in the Materials Identification and Usage List (MIUL) system or electronic data system utilizing the approved rationale codes in Appendix B. A key may be provided to correlate Contractor Category III MUA database codes to the codes in Appendix B. No MUA form is submitted. [Category III MUAs are identified for completeness, but are not required until after PDR.]

Delivery Schedule: New MUAs at CDR, revised MUAs delivered as generated.

Format: A sample MUA form is provided in NASA-STD-6016; however, Contractor format is acceptable. The complete MUA package shall be provided in Adobe® PDF

format. The MUA form shall also be provided in a format that is compatible with the NASA Materials and Processes Technical Information System (MAPTIS) database.

5.3.5 Contamination Control

5.3.5.1 Contamination Control Plan

DRD No.: 03.005.01
Title: Contamination Control Plan
Type: 2

Description/Use: The Contamination Control Plan establishes contamination allowances, methods for controlling contamination and recording test results, and defines implementation measures to control contamination of flight hardware/GSE during manufacturing, assembly, test and transportation.

References/Remarks: NASA-STD-6016, Standard Materials and Processes Requirements for Spacecraft; NAS 412, Foreign Object Damage/Foreign Object Debris (FOD) Prevention; Reference to Contractor's applicable institutional policies, procedures, specifications, and instructions.

Content/Data Preparation: The items below, at a minimum, shall be addressed in the plan:

1. The Contractor governing engineering documentation (drawing) shall define cleanliness level acceptance limits and verification methods for fluid systems, and all internal and external contamination-sensitive surfaces.
2. Beginning of life and end of life requirements for contamination sensitive surfaces or subsystems.
3. A description of fabrication, testing, storage, and shipment environments to be encountered by the deliverable hardware.
4. Methods and procedures used to measure and maintain the levels of cleanliness required during each of the various phases of the item's fabrication, test, storage and transportation (e.g., protective covers, environmental constraints, purges, cleaning/monitoring procedures).
5. Cleaning requirements and procedures by which the requirements will be met.
6. A description of training to be implemented to maintain contamination control.
7. A description of how the Contractor will implement all requirements by appropriate documents on all Subcontractors and suppliers.

Delivery Schedule: Preliminary at RR-SDR; Baseline at PDR; Final at CDR. Update as necessary w/approval after CDR.

5.3.5.2 Contamination Control Report

DRD No.: 03.005.02
Title: Contamination Control Report
Type: 3

Description/Use: The Contamination Control Plan establishes contamination allowances, methods for controlling contamination and recording test results, and defines implementation measures to control contamination of flight hardware/GSE during manufacturing, assembly, test and transportation.

The Contamination Control Report is provided to the mission-user to support contamination control planning at the spacecraft/mission level.

References/Remarks: NASA-STD-6016, Standard Materials and Processes Requirements for Spacecraft; NAS 412, Foreign Object Damage/Foreign Object Debris (FOD) Prevention; Reference to Contractor's applicable institutional policies, procedures, specifications, and instructions. IEST-STD-CC1246E recommended for contamination control levels.

Content/Data Preparation: The Contamination Control Report shall provide definition of possible contamination sources from, and contamination sensitivity of, the deliverable hardware. The report shall also define appropriate contamination control approaches during spacecraft integration, test, transportation, ground processing and launch. The items below, at a minimum, shall be addressed in the report:

1. Characterization of potential contamination sources from the deliverable hardware, including: materials, locations and view factors, outgassing characteristics and chemistry, particulate material, quantity and size distribution, and plume characteristics (i.e. beam ion, neutral xenon, and sputter-eroded product characteristics).
2. Characterization of contamination sensitive areas of the deliverable hardware, including: identification of all internal and external contamination-sensitive surfaces, specification of performance parameters affected by contamination, description of susceptibility (organics, particulates, etc.).
3. Reference to contamination control requirements captured in specifications and interface control documentation.
4. Description of contamination control approaches to be implemented after hardware delivery to the mission customer, including: use of protective covers, use of purges, cleaning techniques and materials.

Delivery Schedule: Baseline at CDR; Final at SAR. Update as necessary w/approval after SAR.

5.3.6 Reliability and Maintainability

5.3.6.1 Reliability Analysis

DRD No.: 03.006.02
Title: Reliability Analysis
Type: 2

Description/Use: A reliability analysis is performed to estimate the reliability of system designs, and to identify components and/or sub-systems for reliability improvements in order to meet the numerical reliability design requirement.

References/Remarks: Guidance on the basic approach for the reliability modeling can be found in GLWI-QE-8720.3 (Current Revision).

Content/Data Preparation: A reliability model of the hardware design shall be constructed utilizing sound, well-established reliability analysis techniques and tools such as reliability block diagram (RBD) or Fault Tree Analysis. Evaluation of the model should provide a calculation of the integrated thruster and power processing unit reliability. The input reliability data should be chosen by considering the intended application environment. The reliability of the integrated system should be calculated for the planned mission time or for a selected set of possible mission times of interest if no specific mission time is specified. The recommended practice for using reliability data is to follow the priority list below.

Reliability data may be selected from:

1. Actual experience data from very similar equipment in the same environment.
2. Experience data for similar equipment with a compensating factor for differences in environment.
3. Life test or wear-out test data.
4. Commercial, NASA, or military reliability databases.
5. Reliability handbook data.
6. Engineering judgment.
7. Expert elicitation.

Due to the complexity that can occur in reliability modeling and prediction it is recommended that reliability block diagrams or fault trees be constructed in a tool for modeling, such as Raptor or SAPHIRE. In the choice of a tool, consideration should be given to the ability to apply failure distributions other than the exponential distribution if needed.

Reports shall contain the following:

1. Executive Summary – A one page summary of results.
2. Table of Contents.
3. Purpose and Scope of the analysis.
4. Description of the System Analyzed.
5. Ground Rules and Assumptions.
6. Summary of Techniques and Tools used in the analysis.
7. Important Equations used (if relevant).
8. Major Components List showing reliability input data such as failure rates or other parameters as applicable if a distribution other that exponential is used. The sources of the data must be indicated.
9. The Reliability Block Diagram constructed for the system. For extremely large models, screen shots can be used.

10. Results of Reliability Calculations.
11. List of Components sorted from lowest to highest reliability.
12. Conclusions, Observations, and Recommendations indicating the results of 'weak-link' analysis to identify areas for reliability improvement.

Delivery Schedule: Preliminary at PDR; Baseline at CDR; Final at SAR; Update as necessary w/approval after SAR. ~~Due as generated~~

5.3.6.2 Failure Modes and Effects Analysis/Critical Items List

DRD No.: 03.006.03
Title: Failure Modes and Effects Analysis (FMEA)/Critical Items (CIL)
Type: 2

Description/Use: The purpose of the FMEA is to identify the possible failure modes associated with the design and their system effects during the preliminary and detailed design phases. The FMEA serves as a systematic method to discover what can go wrong with the system design and to drive hardware corrective actions and mitigations. The Critical Items List (CIL) will list critical hardware components (such as single-point failures) that cannot be designed out of the system and the actions that were taken to reduce the likelihood of failure.

References/Remarks: GLWI-QE-8720.2 (Current Revision)

Content/Data Preparation: FMEA shall be performed on the flight hardware design and on Support Equipment (SE) that interfaces with the flight hardware and has the capability to propagate energy or signals to flight hardware. Credible failure modes of mechanical and electrical SE should be assessed for capability to damage flight hardware. SE includes any Ground Support Equipment (GSE), Bench Test Equipment (BTE), or other Test Equipment (TE) that connects to or interfaces with flight hardware. The FMEA should be performed to a level that will identify all single point failures and provides sufficient detail to determine failure causes and the ability to construct a Critical Items List (CIL). The scope, mission environment, and timeline must be defined. After the system is characterized per GLWI-QE-8720.2, a functional flow diagram is developed to describe system operation. The analysts will identify the different ways in which each component may fail. They will consider premature operation, failure to operate at a prescribed time, failure during operation and failure to cease operation at a prescribed time. For each failure mode identified, the analysis will indicate the hardware item, function, mission phase, failure causes, effect on system, effect on vehicle or personnel, criticality, failure detection method, corrective action and/or mitigation.

Failure mode criticality shall be assigned according to the definitions in Table 3 below.

Table 3. FMEA Criticality Categories and Definitions

Category	Definition
1	Single point failure resulting in loss of life or vehicle.
1R	Redundant hardware elements, which if all failed, could cause loss of life or vehicle.
1S	Single failure point rendering inoperative a system designed to monitor hazards or a system used to react to hazards; such hazards being sufficient to cause potential loss of life or vehicle.
1SR	Redundant hardware elements, the failure of which renders inoperative a redundant system designed to monitor hazards or a system used to react to hazards; such hazards being sufficient to cause potential loss of life or vehicle.
2	Single point failure resulting in loss of vehicle mission.
2R	Redundant hardware elements, the failure of which could cause loss of vehicle mission.
3	All others.

The FMEA shall identify all failure modes and effects that could possibly damage other hardware. The FMEA report shall contain the following and be delivered as two electronic folders:

Folder 1

1. Executive Summary – A one page summary of results
2. Table of Contents
3. Purpose and Scope of the analysis
4. Description of the System Analyzed
5. The Functional Block Diagram
6. Ground Rules and Assumptions
7. Summary of Technique used
8. Subsystem Summary pages (A section for Flight Hardware, GSE/TSE, and Built-in Test Equipment [BTE]). A summary page for each subsystem shall contain:
   a. A description of the function of the subsystem
   b. Observations about the failure modes of the sub-system
   c. A brief table of failure modes, effects, and causes for the most severe failure modes associated with the sub-system
9. Conclusions, Observations, and Recommendations

Folder 2: FMEA Worksheets

Sub-folders: 1: Flight Hardware, Sub-folder 2: GSE/TSE, and Sub-folder 3: BTE

1. Worksheet files within sub-folders designated by sub-systems
2. Sub-System FMEA worksheets arranged by assemblies and containing line items for components
3. FMEA worksheets shall contain columns for the FMEA data elements: Item name, identifier, function, failure mode, failure mode criticality, failure causes, relevant

mission phase, sub-system effect, effect on vehicle or personnel, and failure detection method.

4. FMEA line items on the worksheet shall be sorted into sections according to failure mode criticality (starting with criticality category 1 and in descending order of criticality down to criticality 3.)

An item is defined as a specific component associated to a specific failure mode. An item from the FMEA is deemed critical if it is a criticality 1, 1R, 1S, or 2 item as defined in Table 3 above.

The CIL is derived from the FMEA and shall be derived for the flight hardware design. The FMEA should be performed to a level that will identify all single point failures and provides sufficient detail to determine failure causes and the ability to construct a CIL. The guidance document for the CIL is GLWI-QE-8720.2 in the NASA Glenn Research Center Business Management System (BMS) Library.

Definition of the Retention Rationale Prepared for the CIL: If the failure mode cannot be designed out of the system, then a rationale for retaining the hardware item in the design shall be prepared. This rationale shall indicate those measures taken to reduce the risk of failure. These may include specific design features, operational workarounds that could be implemented in the event of failure, test results, planned inspections or tests, and preventative maintenance plans.

The CIL report shall contain the following and be delivered as two folders:

Folder 1

1. Executive Summary – A one page summary of results
2. Table of Contents
3. Purpose and Scope of the CIL
4. Description of the System Analyzed
5. The Functional Block Diagram
6. Ground Rules and Assumptions
7. Conclusions, Observations, and Recommendations

Folder 2 CIL Worksheets

Sub-folder 1: Flight Hardware, Sub-folder 2: GSE/TSE, and Sub-folder 3: BTE

1. Worksheet files within sub-folders designated by sub-systems
2. Sub-System CIL worksheets arranged by assemblies and containing line items for components
3. CIL worksheets shall contain columns for the CIL data elements: Item name, identifier, function, failure mode, failure mode criticality, and retention rationale.
4. A cross-reference to the FMEA for each item in the CIL shall be included.
5. CIL line items on the worksheet shall be sorted into sections according to failure mode criticality (starting with criticality category 1 and in descending order of criticality down to criticality 1S.)

Delivery Schedule: FMEA/CIL Preliminary at PDR; Baseline at CDR; Final at SAR. Update as necessary w/approval after SAR.

5.3.6.3 Electrical/Electronic Worst Case Analysis

DRD No.: 03.006.05
Title: Electrical/Electronic Worst Case Analysis
Type: 2

Description/Use: Demonstrate design margins in electronic and electrical circuits and electromechanical items. This analysis assesses the effect of environment stresses and component variability on system performance requirements.

References/Remarks: JPL-PD-ED-1212, Design and Analysis of Electronic Circuits for Worst Case Environments and Part Variation.

Content/Data Preparation: The analysis shall include the following tasks:

1. Derive part parameter variations for the intended environments and planned duration of the specified mission.
2. Combine part parameter variations with the initial tolerances of the parts as procured to produce a worst case part variation database for the specified mission. Typical part parameters would be voltage, current, resistance, impedance, inductance, and temperature.
3. Apply classical circuit analysis techniques to determine if each circuit and each assembly meets its specified performance outputs over the most extreme but realizable combinations of part performance variations.
4. Reduce complex circuits into smaller functional blocks. By using this approach the analysis becomes more manageable, aiding analysts and reviewers. When a circuit is reduced to these functional blocks, performance requirements for each block need to be established.
5. State all assumptions (clearly identified) including boundary conditions. These may include conservative simplifying assumptions that make the analysis tractable and/or more cost effective. Boundary conditions may include physical or functional interfaces with other elements or hardware or may involve a limitation on the number of functions analyzed. Where functions are not analyzed, the rationale for that decision must be documented.

The WCA Report shall:

1. Show compliance with all performance requirements, both on the functional block level and at the circuit level.
2. Note explicitly any deviations from the performance requirements.
3. Explain any proposed solutions to deviations.

Delivery Schedule: Preliminary at PDR; Baseline at CDR; Final at SAR. Update as necessary w/approval after SAR.

5.3.6.4 Thruster Life Certification Plan

DRD No.: 03.006.07

Title: Thruster Life Certification Plan
Type: 1

Description/Use: This plan will detail and explain the approach to verify the service life of the thruster design for SEP space missions such that the thruster will meet performance requirements over a range of anticipated mission times. The problem of life verification for the thruster is complex due to intrinsic variability in failure behavior and uncertainty in the drivers and models of failure mechanisms. The life qualification approach must accommodate sensitivity of wear rates to variable engine operating parameters, a variability in thruster environment (ground test vs. operation in space), and variability introduced from different throttling profiles. Due to potentially long life requirements it is not feasible to verify the thruster operational life by conducting a single long duration life test. The document will be used to evaluate the Contractor's plan to validate thruster life and guide experimental and modeling activities.

Content/Data Preparation: A plan shall be developed to identify the sources of data that must be obtained from the thruster design and development for the SEP Project. An approach will be developed to utilize these sources of data to demonstrate reliability and life of the thruster. These data can be extracted from (but not limited to) analyses, simulations, materials and component tests, thruster wear tests, FMEA, inspections, and extended operational tests. The results of these evaluations when combined will be compared to success criteria for verification.

The Plan shall contain the following items:

1. Executive Summary – A one page summary of results
2. Table of Contents
3. Purpose and Scope of the Plan
4. Roles and Responsibilities
5. Life Requirements and References
6. Overall Approach for Life Certification
7. Approach to Identifying Failure Modes, including a list of those currently known
8. Summary of Risk Assessment Approach for each failure mode
9. Summary of Analyses Selected
10. Summary of Required Materials Data
11. Summary of Component and Thruster Tests and the types of data to be obtained
12. Risk Reduction Efforts for thruster wear-out failure modes
13. Success Criteria for Certification
14. Process of Certification Approval

Appendix A- Acronyms
Appendix B- Definitions

Delivery Schedule: Preliminary at PDR. Baseline at CDR; Final at SAR. Update as necessary w/approval after SAR.

5.3.7 Electrical, Electronic, and Electromechanical (EEE) Parts

5.3.7.1 Parts Stress/De-Rating Analysis

DRD No.: 03.007.02
Title: Parts Stress/De-Rating Analysis
Type: 2

Description/Use: The de-rating of EEE parts improves the reliability of space flight systems by stressing the parts at a significant margin below their maximum ratings. The Contractor shall analyze the expected stresses for each EEE part that is proposed for use in flight hardware as compared to the maximum stress values derived from the de-rating criteria for the part.

References/Remarks: EEE-INST-002

Content/Data Preparation: The report shall contain the following:

1. Table of Contents, Purpose, Scope
2. Applicable Documents, including list of schematic diagrams
3. Tabulated Stress/De-Rating Analysis
4. Conclusions, including justification for use of parts not meeting de-rating criteria

The tabulated Stress/De-Rating Analysis in the report shall contain the following data:

1. Flight component identity to the circuit board level
2. Part type
3. Circuit reference designator
4. Maximum rating for each parameter to be de-rated for the part type
5. De-rating factor
6. De-rated parameter rating
7. Maximum stress
8. Margin between maximum stress and de-rated rating
9. Whether part meets or fails to meet de-rating criteria

Delivery Schedule: Preliminary report at PDR; Final report at CDR. Updated as necessary after CDR.

5.3.7.2 Radiation Tolerance Report

DRD No.: 03.007.03
Title: Radiation Tolerance Report
Type: 2

Description/Use: This report contains the expected radiation environment for the planned mission (or missions) and sets the minimum radiation parameters that the EEE parts/components must be able to survive. This report lists the EEE parts/components selected for the design with information to substantiate that components/parts were selected to survive the expected radiation environment of the mission (or missions). The assessment of the radiation environment for missions will be accomplished by the

radiation engineer with support from the design engineering team. This Radiation tolerance report will be reviewed by EEE Parts Assurance engineering.

Definitions:

1. Radiation Hardened parts: designed, controlled, and manufactured to function for a particular level of radiation.
2. Radiation Tolerant parts: have been demonstrated to function in a particular radiation environment (such as through user or third party testing) but were not expressly designed, controlled, and manufactured for that radiation environment.

Content/Data Preparation:

1. Development of the mission radiation environment assessment.
2. The radiation tolerance requirement for EEE parts defined in terms of Total Ionizing Dose (TID), Single Event Effects (SEEs), and displacement damage.
3. Listing of EEE Parts sorted by sub-system and function showing the part description, part number, manufacturer, manufacturer's part number, and lot date code. For each part, the information shall be included to substantiate that the part was selected to be radiation hardened or radiation tolerant. Additional report items are:
    a. Report for EEE parts susceptible to Single-Event Latchup (SEL) that demonstrates recovery without damage at worst-case rated voltages and temperatures.
    b. Report for power FETs operated in the off mode that demonstrate not to be susceptible to permanent failure from particle-induced Single-Event Burnout (SEB) and Single-Event Gate Rupture (SEGR).
    c. Report for fault traceability that shall be provided in the telemetry stream for all anomalies involving Single-Event Effects (SEE).
4. In those cases where a part cannot be selected to be at least radiation tolerant, but the functional output of the part cannot be provided by any substitute, then the mitigation (protection from SEEs and TID degradation) must be provided in the report.

Reports shall contain the following:

1. Executive Summary – A one page summary of results
2. Table of contents
3. Purpose and Scope of the assessment
4. Description of the Missions and their environment
5. Ground Rules and Assumptions
6. Summary of technique used and tools selected
7. Important equations used
8. Parts List showing results and deviations from requirements
9. Explanation of any Proposed solutions
10. Conclusion, Observations, and Recommendations

Delivery Schedule: Preliminary assessment at PDR; Final assessment at CDR. Update as necessary w/approval after CDR.

5.3.7.3 EEE Parts Identification List

DRD No.: 03.007.04
Title: EEE Parts Identification List
Type: 2

Description/Use: The EEE Parts Identification List identifies the EEE parts that are proposed for use (As-Designed Parts List) or used (As-Built Parts List) in flight hardware and approved by the Parts Control Board.

Content/Data Preparation: The EEE Parts Identification List shall contain the following information:

1. Flight component identity to the circuit board level.
2. Complete part number (i.e. DLA military specification/drawing part number, SCD part number, with all suffixes).
3. Manufacturer's Generic Part number.
4. Manufacturer (not distributor).
5. Part Description (please include meaningful detail).
6. Federal Source Code or Federal Stock Class (FSC).
7. Procurement Specification.
8. Comments and clarifications, as appropriate.
9. Estimated quantity required (for procurement forecasting).
10. Lot date code/serial number (As-Built list only).

Delivery Schedule: As-Designed Parts List: Preliminary at PDR; Final ~~Baseline~~ at CDR; updates delivered As Generated. As-Built Parts List: As part of Acceptance Data Package (DRD-04.008).

5.3.7.4 Electrostatic Discharge Control Plan

DRD No.: 03.007.05
Title: Electrostatic Discharge (ESD) Control Plan
Type: 2

Description/Use: The ESD Control Plan addresses the requirements necessary to design, establish, implement, and maintain an ESD control program to protect electrical or electronic parts, assemblies and equipment susceptible to ESD damage.

References/Remarks: ANSI/ESD S20.20 Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices). GLP-QE-8739.1 GRC Electrostatic Discharge Control Procedure.

Content/Data Preparation: The plan shall address technical requirements of the ANSI.ESD S20.20 standard or Contractor equivalent covering areas such as grounding, personal grounding, protected areas, packaging, labeling, equipment, and handling.

Delivery Schedule: Preliminary at RR; Baseline at PDR; Final at SAR. Update as necessary w/approval after SAR.

5.4 Product Development

5.4.1 Modeling and Analysis

5.4.1.1 Modeling and Analysis Plan

DRD No.: 04.001.01
Title: Modeling and Analysis Plan
Type: 2

Description/Use: The Modeling and Analysis Plan describes the overall modeling and analysis process supporting the project. This includes but is not limited to identification and schedule of analysis cycles, modeling tools used and roles and responsibilities in managing and supporting this process.

References/Remarks: NASA-STD-7009, Standard for Models and Simulations

Content/Data Preparation:
All Modeling and Analysis Plans shall address, at a minimum, the following topics:

1. Introduction that includes the purpose and scope of the plan
2. Key personnel/organizations responsible for the modeling and analyses
3. Overview, that includes modeling and analysis objectives, summary of approach, and success criteria (for requirements verification)
4. Methodology and software for analysis
5. Documentation (such as data, final report, etc.)
6. Schedule
7. Reference documents

Delivery Schedule: Baseline at PDR; Final at CDR; Update as necessary w/approval after CDR.

5.4.1.2 Models

DRD No.: 04.001.02
Title: Models
Type: 3

Description/Use: Models are required to ensure adequate design, to support independent validation and verification by NASA, and to support integration of the delivered hardware and software into the mission spacecraft.

Content/Data Preparation:
For all tools, models, and simulations that are used in the development of hardware and data products, the following information, at a minimum, shall be delivered along with the system tools (as applicable):

1. All documented assumptions and abstractions underlying the conceptual model, including their rationales and/or reference documents.
2. Source code and build files for all models. Model in native format (m-files, Excel spreadsheet, NASTRAN bulk data, SINDA/Fluint files, and mesh). Software version number, including patch level, and compiler, if applicable.
3. Basic structure and mathematics of the model/tool (e.g. reality modeled, equations solved, behaviors modeled, conceptual models).
4. Required units and vector coordinate system/frames (where applicable) for all input/output variables.
5. Limits of operations of models/tools.
6. Methods of uncertainty quantification and the uncertainty in any data used to develop the model/tool or incorporated into the model/tool.
7. Guidance on proper use of the model/tool.
8. Any parameter calibrations and the domain of calibration.
9. Updates of models/tools (e.g. solution adjustment, change of parameters, calibration, and test cases) and assign unique version identifier, description, and the justification for the updates.
10. Obsolescence criteria and obsolescence date of the model/tools (obsolescence refers to situations where changes to the real system invalidate the model).
11. Compiled versions that run under one of Windows, Macintosh, Linux and UNIX variants.
12. Source code for tools used to create lookup tables within the models, unless they were created with COTS software.
13. Lookup tables used within the models.

Delivery Schedule: Due As generated.

5.4.1.3 Analysis Reports

DRD No.: 04.001.03
Title: Analysis Reports
Type: 3

Description/Use: Analysis Reports document the results of analyses performed in support of all phases of hardware development and use, and requirement verification.

Content/Data Preparation:
All analysis reports shall address, at a minimum, all topics listed below. The Contractor shall standardize an analysis report format.

1. Cover page with title, document number for traceability, relevant part and serial numbers (if applicable), analysis cycle, indication of purpose
2. Executive Summary
3. Objectives/Motivation for the analysis
4. Study Requirements and Constraints
5. Assumptions and ground rules
6. Initializing Data
7. Figures of merit

8. Analysis tools, tests, and Models used
9. Modeling technique
10. Internal Verification and Validation of the results (if applicable)
11. Uncertainty of the results
12. Description of sensitivities
13. Detailed results
14. Key findings/recommendations

Delivery Schedule: Due as generated.

5.4.2 Engineering Hardware Development Plan

DRD No.: 04.002
Title: Engineering Hardware Development Plan
Type: 1

Description/Use: Formalizes the Contractor's plan for fabricating development hardware.

Content/Data Preparation: The Engineering Hardware Development Plan shall describe the Contractor's plan for fabricating development hardware towards gaining confidence and reducing risk in progressing to flight hardware. Hardware can be at the component, sub-assembly, assembly or unit level. The Plan shall describe any use of NASA GFP described in Attachment D to the contract. The Plan shall describe rationale, the hardware being fabricated, use of the hardware, the associated schedule, and resulting benefit in risk reduction or design confidence. The Plan shall define disposition of the hardware at the end of use (Contractor-retained, deliverable, return to NASA GRC or other).

Delivery Schedule: Preliminary at contract award. Baseline at RR-SDR. Update as necessary w/approval after RR-SDR.

5.4.3 Test Plans

DRD No.: 04.003
Title: Test Plans
Type: 2 for development testing
2 for flight hardware/software testing

Description/Use: The test plan documents the testing purpose, approach, methodology, and strategy used to perform a test.

Content/Data Preparation: All test plans either initiated by the Contractor or requested by NASA shall address, at a minimum:

1. Introduction that includes the purpose and scope of the plan
2. Key personnel/organizations responsible for the test

3. Test overview, that includes test objectives, test summary, and success criteria (for requirements verification)
4. Test setup that includes the test article(s), facility (-ies), equipment, software versions, and diagnostics
5. Test operations overview (such as tests conducted, data collected, etc.)
6. Description of post-test break-of-configuration process for flight hardware
7. Test reviews and documentation (such as test readiness reviews, test event reports, final report, etc.)
8. Test schedule
9. Reference documents

Delivery Schedule: Preliminary Test Plans shall be delivered no later than 30 calendar days prior to the subject test. Final Test Plans shall be provided with the TRR data package.

5.4.4 Test Reports

DRD No.: 04.004
Title: Test Reports
Type: 3

Description/Use: To provide the documentation of test results for all tests conducted by the Contractor.

Content/Data Preparation: The Contractor shall provide the following types of reports for project tests:

1. Quick Look Test Reports
2. Final Development Test Reports
3. Final Test Reports for Flight Hardware

Quick Look Test Reports shall include:

1. Description of the test item and configuration
2. Description of the test performed
3. Dates and time performed
4. Data collected (available data)
5. All test anomalies and their impact to the test (tested hardware and software, facilities, personnel, GSE, whether resolved during the test or not)
6. Summary of test results including test objectives met and test objectives not met
7. For development test Quick Look reports, initial assessment of impact on requirements or design, and recommendations for further testing

Final Development Test Reports are the formal documentation to be used for basing requirements or requirement changes, and justification for alteration of hardware and software design. These reports shall include:

1. Description of the test item
2. Description of the test performed

3. Description of the test equipment and facility
4. Test set-up/configuration/version information
5. Dates and time performed
6. Data collected (databases, photos, video)
7. All test anomalies and their impact to the test (tested hardware, software, facilities, personnel, GSE, whether resolved during the test or not) including failure analysis
8. Test results including:
   a. Test conditions as experienced
   b. Timeline of events as tested
   c. Specific results with supporting data
9. Initial test conclusions including:
   a. Requirements or designs proposed to be changed including supporting rationale

Final Test Reports for Flight Hardware report shall include:

1. Description of the test item
2. Description of the test performed
3. Description of the test equipment and facility
4. Test witnesses
5. Test set-up/configuration/version information
6. Dates and time performed
7. Data collected (databases, photos, video)
8. All test anomalies and their impact to the test (tested hardware, software, facilities, personnel, GSE, whether resolved during the test or not) including failure analysis
9. Test results including:
   a. Test conditions as experienced
   b. Timeline of events as tested
   c. Specific results with supporting data
10. Test conclusions including comparing the test results against the detailed verification objective requirements

Delivery Schedule: As generated. ~~Quick Look~~ Preliminary reports shall be provided within 5 working days of test completion. Final Reports shall be provided within 15 calendar days of test completion.

5.4.5 Engineering Drawings

DRD No.: 04.005
Title: Engineering Drawings
Type: 2

Description/Use: To provide engineering data defining the design to the extent required to support system design, manufacturing, test, and logistics support of the hardware and required spare parts. Engineering drawings and associated lists shall be sufficient to depict the detailed configuration of all system, subsystem, and component levels and to

include ground support equipment (GSE). This DRD applies to released manufacturing, layout, assembly and installation drawings and schematics for all hardware. All drawings used by the Contractor and their sub-tiers shall be delivered to NASA. The aggregate set of drawings shall define every dimension of the hardware.

Reference/Remarks: ANSI/ASME Y14.24, ASME Y14.100

Content/Data Preparation: Engineering drawings disclose (directly or by reference) the physical and functional requirements of an item by means of graphics or textual presentation or combinations of both, as supplemented by 3D models.

Part I – Engineering drawings and associated lists of CEIs, elements and/or all components and assemblies shall be provided to define the details necessary for the manufacture, test, inspection, operations, and logistic support of the system. This definition shall:

1. Reflect the end-product at its current level of design maturity
2. Provide the engineering data for logistics support products
3. Provide the necessary data to permit manufacture and/or acquisition of items identical to the original item(s)
4. Provide the necessary data to permit integration of the delivered hardware into the next level of system
5. Document directly or by reference the following:
    a. Details of unique processes (i.e., not published or generally available to industry) when essential to design and manufacture
    b. Performance ratings
    c. Dimensional and tolerance data (Geometric Dimensioning and Tolerancing (GDT) shall be required between all external and major internal interfaces)
    d. Critical manufacturing processes and assembly sequences, and rigging procedures
    e. Diagrams
    f. Mechanical and electrical connections
    g. Physical characteristics, including form and finish
    h. Details of material identification, including heat treatment and protective coatings
    i. Inspection, test, and evaluation criteria
    j. Equipment calibration requirements
    k. Quality assurance requirements
    l. Hardware marking requirements
    m. Requirements for reliability, maintainability, environmental conditions, shock, and vibration testing and other operational or functional tests, as necessary
    n. Cleanliness levels
6. Associated solid models shall be provided in native format

Part II – Cable interconnect diagrams (CIDs), electrical system schematics and wiring lists. Cable interconnect diagrams, electrical system schematics and wiring lists shall be

prepared in accordance with ASME Y14.100. Part I drawings shall be used to the maximum extent possible in providing the design definition. The drawings shall include the following:

1. Cable interconnect diagrams shall show graphically the arrangement of external electrical cabling which interconnects electrical assemblies and/or equipment.
2. Electrical system schematics shall illustrate and describe circuit items with symbols placed such that a circuit may be traced from item to item in the sequence of its function. The placement and arrangement of these circuits shall follow a logical sequence of presentation to provide a clear description of the distribution.
3. Component Level Documentation – Schematics and/or wiring lists for components, including interconnecting cable harnesses, shall be provided.
4. Overall Grounding Documentation – The grounding schematic shall show the details of all grounds and power returns from source to loads. All connections shall be shown. It shall also show details of all Electrical Ground Support Equipment interconnections to facility and safety grounds.

Delivery Schedule: 60% complete at PDR; 90% complete at CDR; Final at SAR.

Format: Native and neutral files of both the models and drawings shall be supplied. Neutral files for solid models shall be STEP and for the drawings shall be PDF and DXF or DWG.

5.4.6 Manufacturing, Assembly, and Production Plan

DRD No.: 04.006
Title: Manufacturing, Assembly, and Production Plan
Type: 2

Description/Use: The Manufacturing, Assembly and Production Plan documents the plans for the manufacturing and assembly of the flight articles, associated unique tooling, fixtures, support, and test equipment for producing an integrated and tested product.

Content/Data Preparation: The Manufacturing, Assembly and Production Plan applies to all flight hardware designed, built, and assembled to create and support the development of the product. The Plan also includes guidance on handling re-work that may result from product rejections at Test Readiness Reviews (TRR) and System Acceptance Reviews (SAR).

The Plan shall address all configuration-controlled hardware. At a minimum, the following shall also be included:

1. Long lead item identification
2. Lifting fixtures and attachment hardware (for all required orientations/configurations)
3. Transportation/holding apparatuses (for all pieces)

4. Test fixtures (for all test verification orientations)
5. Required hardware list
6. Preferred standard manufacturing processes
7. Identification of unique manufacturing processes and the approach to qualification of those processes
8. Soft vs. hard tooling
9. Design for manufacturability

Delivery Schedule: Baseline at PDR; Final at CDR; Update as necessary w/approval after CDR.

5.4.7 Programmable Logic Device Design Data Package

DRD No.: 04.007
Title: Programmable Logic Device Design Data Package
Type: 2

Description/Use: The purpose of the Programmable Logic Device Design Data Package is to provide documentation of the complex electronics design. The package provides the set of files that enables other designers to recreate and troubleshoot the design, as defined in NASA-HDBK-4008, Section 10.b.

References/Remarks: NASA-HDBK-4008

Content/Data Preparation:
1. Design Specification: Describes the as-built design.
2. As-Built Design Files: The set of files (inclusive of source files) that enables other designers to recreate the design, defined in NASA-HDBK-4008, Section 10.b.
3. Verification Plan, Test Procedures, Test Reports.
4. Other Documentation: This includes additional drawings and/or readme files.

Delivery Schedule: Baseline at CDR; Update as necessary w/approval after CDR.

5.4.8 Acceptance Data Package

DRD No.: 04.008
Title: Acceptance Data Package (ADP)
Type: 2

Description/Use: The purpose of the ADP is to provide the documentation needed by NASA to establish the acceptability of the hardware and software for its intended use. All flight hardware provided under contract to NASA shall have an Acceptance Data Package (ADP) upon final delivery. The ADP will be reviewed by NASA and discussed at the System Acceptance Review. The acceptance of any equipment item will be contingent upon NASA's approval of the ADP for that item.

Content/Data Preparation: The data may be provided in separate documents in the Contractor's format. The ADP shall be provided in electronic format. The contents of the

package shall include, as a minimum, the following information, as applicable to the item being delivered:

1. Delivery Document (DD250 or DD1149)
2. Title Page with summary of deliverable item
3. Index of Data
4. Certificate of Conformance
5. As-Built Configuration and Serialization
6. Waivers / Deviations
7. Manufacturing and Quality History Log
8. Operating Time/Cycle Numbers
9. Non-Conformance Reports
10. Problem/failure reports with root cause and corrective actions
11. Shortages
12. Open or Deferred Work
13. As-Built Engineering Drawings, in native file formats, including but not limited to: schematics, layout files, gerber files, and drawings
14. As-Built Final Assembly Drawings
15. As-Built EEE Parts and Materials Lists
16. Limited Life Items / Age Sensitive Items, including data for life used and remaining
17. Nonstandard Calibration Data
18. Temporary Installations
19. Qualification, Proto-flight or Acceptance As-Run Test Procedures and Test Reports
20. Photographic documentation of hardware (pre and post-conformal coating for printed wiring assemblies, box or unit, subsystem, harness, structure)
21. Mass Properties Report
22. Software Version Description and Certification
23. Requirement Compliance Matrix and Supporting Verification Reports/ Verification Closure Notices
24. Packaging, Handling, Storage, Transportation Data
25. Contamination Conformance documentation
26. Notes/Comments

Delivery Schedule: Preliminary data package shall be delivered 10 calendar days prior to the AR for the end item. Final data package shall be delivered with the end item.

Format: Delivery in electronic format on CD/DVD, with files in native (Microsoft Office or other NASA-agreed) format.

5.4.9 Operations Documentation

DRD No.: 04.009
Title: Operations Documentation
Type: 2

Description/Use: This documentation is the single authoritative source of properly validated data which most accurately and completely describes the end item's operational performance capabilities and limitations. This document will be used by the project, engineering, ground operations, flight operations, systems analysis, procedures development and stowage planning.

Content/Data Preparation: The operations document shall detail the commands, command responses, modes, sequences, and expected telemetry response for all operations. Documentation shall allow identification and classification of anomalous operations consistent with hardware design. The operations document shall identify off-nominal telemetry readings that can be tolerated without loss of hardware functionality. Supporting FMEA and other design information shall be referenced as appropriate to allow mission operations to develop mission operation scenarios for training and flight usage.

Delivery Schedule: Baseline at CDR. Final at SAR. Update as necessary w/approval after SAR.

5.4.10 Spares Plan and Parts List

DRD No.: 04.010
Title: Spares Plan and Parts List (SPPL)
Type: 2

Description/Use: The Spares Plan and parts List (SPPL) provides the program/project with contingency for unplanned component/subsystem anomalies or failures.

Content/Data Preparation: The SPPL shall address the Contractor's approach to sparing philosophy. The SPPL shall address to what configuration level the Contractor plans to spare, the schedule for spares procurements, and guidelines for utilizing spares including all GSE and simulators.

Delivery Schedule: Preliminary at RR-SDR; Baseline at PDR; Final at CDR. Update as necessary w/approval after CDR.

5.4.11 Ground Support Equipment Plan

DRD No.: 04.011
Title: Ground Support Equipment (GSE) Plan
Type: 2

Description/Use: The GSE plan is used to formalize the contractual plan for development and use of support equipment, including use of Government Furnished Property.

Content/Data Preparation: The GSE Plan shall describe the Contractor's plan for use of existing Contractor GSE, fabrication of new GSE, and use of Government-Furnished GSE

(as described in Attachment J.1(d) to the contract). The Plan shall describe such for both the development and flight hardware phases of the contract. The Plan shall describe rationale, the specific equipment being used or fabricated, description of quality standards being used in developing new equipment, the use of the equipment, and the associated schedule. The Plan shall define disposition of the equipment at the end of use (Contractor-retained, deliverable, return to NASA GRC or other).

Delivery Schedule: Preliminary at contract award; Baseline at PDR; Update as necessary w/approval after PDR.