CA01C

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CONTRACT/RFP

TBD
EXHIBIT NUMBER

TBD
ATTACHMENT NUMBER

Actuator Assembly for the Thrust Vector Control System for the Ares I Upper Stage
PROJECT/SYSTEM

DATA PROCUREMENT DOCUMENT

TBD
CONTRACTOR

November 15, 2006
DATE

National Aeronautics and Space Administration

National Aeronautics and Space Administration **DOCUMENT** **CHANGE LOG**					DATA PROCUREMENT DOC. NO. ISSUE: CA01C	
INCORPORATED REVISIONS OUTSTANDING REVISIONS					AS OF: 09-07-06	SUPERSEDING: PAGE:
AUTHORITY	PORTION AFFECTED - PAGE NO./NO.				REMARKS	
	INTRO	SGR	DRL	DRD		

National Aeronautics and Space Administration **PAGE**

REVISION LOG

NOTE: The current revision is denoted by a vertical line in the outer margin adjacent to the affected text.	AS OF: 11-07-06	SUPERSEDING:	PAGE:

INSERT LATEST REVISED PAGES. DISCARD SUPERSEDED PAGES.

ITEM PAGE STATUS	ITEM PAGE STATUS

GENERIC DPD INTRODUCTION/STATEMENT OF GENERAL REQUIREMENTS

1.0 INTRODUCTION

1.1 Scope: Subject to the Rights in Data clause, this Data Procurement Document (DPD) sets forth the data requirements in each Data Requirements Description (DRD) and shall govern that data required by the DPD for the contract. The contractor shall furnish data defined by the DRD's listed on the Data Requirements List (DRL) by category of data, attached hereto, and made a part of this DPD. Such data shall be prepared, maintained, and delivered to NASA in accordance with the requirements set forth within this DPD. In cases where data requirements are covered by a Federal Acquisition Regulation (FAR) or NASA FAR Supplement (NFS) clause, that clause shall take precedence over the DPD, consistent with clause FAR 52.215-8.

1.2 DPD Description: This DPD consists of a Document Change Log, a Page Revision Log, an Introduction, a Statement of General Requirements, DPD maintenance procedures, a DRL, and the DRD's.

1.2.1 General Requirements: The general requirements, as specified in paragraph 2.0 of this DPD, prescribe those requirements applicable to the preparation, maintenance, and delivery of data that are better defined in aggregate than in the individual DRD's.

1.2.2 Data Requirements List (DRL): Throughout the performance of the contract, the DRL provides a listing by data category of the data requirements of the DPD.

1.2.3 Data Requirements Descriptions (DRD's)

1.2.3.1 Each data requirement listed on the DRL is given complete definition by a DRD. The DRD prescribes content, format, maintenance instructions, and submittal requirements.

1.2.3.2 For the purpose of classification and control, DRD's of this DPD are grouped into the following broad functional data categories:

CATEGORY SYMBOL DESCRIPTION
CD Contractual Data
CM Configuration Management
DE Design and Development Engineering
LS Logistics/Support
MA Management
MP Materials and Processes
QE Quality Engineering
RM Reliability and Maintainability
SA Safety
SE Systems Engineering
VR Verification

1.2.3.3 The symbols representing these data categories form part of the prefix of the DRD identification number. The first numerical characters reflect the DPD number.

1.2.3.4 To facilitate the usage and maintenance of the DPD, the DRD's have been sectionalized in accordance with the above data categories.

1.2.3.5 The DRD's are filed by data category and are in alpha-numeric sequence as listed on the DRL page (or pages) that precedes the DRD's.

1.2.4   Document Change Log (DCL) and Page Revision Log (PRL): The Document Change Log chronologically records all revision actions that pertain to the DPD. The Page Revision Log describes the current revision status of each page of the DPD and thus, at all times, provides its exact configuration.

1.2.5   DPD Maintenance Procedures: Maintenance procedures define the detailed methods to be employed in maintaining the DPD. Detailed maintenance procedures are specified in paragraph 3.0 of this DPD.

1.3   Data Types for Contractual Efforts: The types of data and their contractually applicable requirements for approval and delivery are:

TYPE	DESCRIPTION

1. *Type 1 – Approval: NASA Approval required. The Contractor shall not implement the document until NASA approval is granted.

2. *Type 2 – Reviews: NASA Review required. The Contractor may implement the document if not notified of corrective actions within 20 business days after receipt by NASA. All NASA identified corrective actions must be resolved before continuing with document implementation.

3. Type 3 – Information: No NASA action required.

* Note: Type 1 and Type 2 data may be placed under NASA configuration management control when designated by NASA. CM control requires the Contractor to submit Type 1 and Type 2 data updates through Engineering Change Proposals (ECPs).

2.0   STATEMENT OF GENERAL REQUIREMENTS

2.1   Applicable/Reference Documents: Documents included as applicable documents in this DPD are the issue specified in the Statement of Work, and form a part of the DPD to the extent specified herein. Applicable documents listed in Item 15.2 of a DRD are applicable only to the preparation of the deliverable documentation described by that DRD.

References to documents other than applicable documents in the data requirements of this DPD may sometimes be utilized, and shall be indicated in 13. Remarks of the DRD. These do not constitute a contractual obligation on the Contractor. They are to be used only as a possible example or to provide related information to assist the Contractor in developing a response to that particular data requirement.

2.2   Subcontractor Data Requirements

2.2.1   The Contractor shall specify to subcontractors and vendors, if any, the availability source of all data required for the satisfactory accomplishment of their contracts. The Contractor shall validate these requirements for documents when appropriate; where the requirement concerns other Contractor data, the Contractor shall provide his subcontractor or vendor with the necessary documents. All such requests shall be accomplished under the auspices of the Contractor.

2.2.2   Reference to subcontractor data in the Contractor's responses is permissible, providing the references are adequate and include such identification elements as title, number, revision, etc., and a copy of the referenced data is supplied with the response document at time of delivery to NASA.

2.3   Data Distribution, Format, Data Restriction Marking, and Transmittal

2.3.1   Distribution: Distribution of required documentation shall be in quantities determined by the Contracting Officer. Recipient names and email (if applicable) addresses shall be noted on a separate distribution list to be furnished by the Contracting Officer. The Contracting Officer's letter may include other information

pertinent to delivery of data, as required.

2.3.2 Format

2.3.2.1 Electronic Format: All documents, unless otherwise noted, will be submitted electronically on the Collaboration and Project Management System (ICE) as described in the Statement of Work.

2.3.3 Data Restriction Marking

2.3.3.1 The Contractor shall determine the data deliverable and mark the data restriction on the data coversheet, or indicate the data restriction in the data transmittal package if the data format precludes identification of data restriction directly in the data. The Contractor shall make a determination for each individual data deliverable item, and shall not apply a default or blanket data restriction marking to all data deliverables (e.g., "data may be export restricted"). If NASA does not agree with the contractor applied data restriction, the NASA Contracting Officer shall return the data to the contractor, cancel the markings, or ignore the markings consistent with the procedures set forth in the "data rights" clause(s) contained in the contract.

2.3.3.2 Data Restriction Categories and Marking Statements: The contractor shall consider the following data restriction categories, as a minimum, and utilize specified marking statements.

If data delivered under this contract is subject to the International Traffic in Arms Regulations (ITAR), the data shall contain an "ITAR Notice" as follows:

International Traffic in Arms Regulations (ITAR) Notice

This document contains information which falls under the purview of the U.S. Munitions List (USML), as defined in the International Traffic in Arms Regulations (ITAR), 22 CFR 120-130, and is export controlled. It shall not be transferred to foreign nationals, in the U.S. or abroad, without specific approval of a knowledgeable NASA export control official, and/or unless an export license/license exemption is obtained/available from the United States Department of State. Violations of these regulations are punishable by fine, imprisonment, or both.

If data delivered under this contract is subject to the Export Administration Regulations (EAR), the data shall contain the "EAR Notice" as follows:

Export Administration Regulations (EAR) Notice

This document contains information within the purview of the Export Administration Regulations (EAR), 15 CFR 730-774, and is export controlled. It may not be transferred to foreign nationals in the U.S. or abroad without specific approval of a knowledgeable NASA export control official, and/or unless an export license/license exception is obtained/available from the Bureau of Industry and Security, United States Department of Commerce. Violations of these regulations are punishable by fine, imprisonment, or both.

If the contract contains FAR 52.227-14 *Alternate II*, the "Limited Rights Notice" may be applicable to data (other than computer software) delivered under this contract.

If the contract contains FAR 52.227-14 *Alternate III*, the "Restricted Rights Notice" may be applicable to computer software delivered under this contract.

If the contract contains FAR 52.227-20, the "SBIR Rights Notice" may be applicable to SBIR data delivered under this contract.

In accordance with the applicable data clause (e.g., FAR 52.227-14(c) or FAR 52.227-20(c)), the contractor may be able to assert a copyright claim in data delivered under this contract. When claim to copyright is made, the Contractor shall affix the applicable copyright notices of 17 U.S.C. 401 or 402 and acknowledgment of Government sponsorship (including contract number) to the data when such data are delivered to the Government.

2.3.4 <u>Transmittal</u>

2.3.4.1 Data shall be transmitted to NASA by electronic format using the ICE system as described in the Statement of Work.

2.4 <u>Contractor's Internal Documents</u>: The contractor's internal documents shall be used to meet the data requirements of this DPD unless a specific format is required by the applicable DRD.

2.5 <u>Document Identification</u>: Type 1 and 2 documents published by the contractor and submitted in response to the data requirements of this DPD shall be identified within an organized identification numbering system prescribed to NASA by the contractor and, if applicable, as approved by NASA. For all data types, the document number, change legend, date, and title constitute the minimum identification of the specific document and shall appear on the cover and title page. The contract number shall also appear on the cover and title page as separate markings. The originator and organization shall be included on the title page. The document number, change legend, and date shall appear on each page of the document. In the front matter of each document, identify the DPD number and applicable DRD number(s) required for document preparation. Successive issues or revisions of documents shall be identified in the same manner as the basic issue and shall have appropriate change identification. Drawings and ECP's are excluded from the marking provisions of this paragraph. All Type 1 documentation, excluding configuration management requirements, shall be marked "PRELIMINARY PENDING NASA APPROVAL," and once approved shall be reissued with "APPROVED BY NASA" and the date and approval authority annotated on the cover.

2.6 <u>Reference to Other Documents and Data Deliverables in Data Submittals</u>: All referenced documents shall be made readily available to the cognizant NASA organization upon request. The contractor should make sure that the references are available to NASA in a manner which does not incur delays in the use of the response document. Reference may be made, within one data submittal, to other data submittals delivered in response to this DPD in those cases where the data required by one DRD may have been delivered by the contractor in response to another DRD. The reference to previously-submitted data shall include the applicable DRD number, data submittal version date, and location within the referenced document.

2.7 <u>Maintenance of Type 1 Document Submittals</u>

2.7.1 Revisions of Type 1 documentation may be accomplished either by individual page revision or by a complete reissue of the document identified in accordance with requirements of 2.7 above, with the exception of drawings (which shall be revised in accordance with contract configuration management requirements).

2.7.2 Individual page revisions shall be made as deemed necessary by the contractor or as directed by the Contracting Officer.

2.7.3 A Type 1 document shall be completely reissued when, in the opinion of the contractor and/or NASA, the document has been revised to the extent that it is unusable in its present state, or when directed by the Contracting Officer. When complete reissues are made, the entire contents of the document shall be brought up to date and shall incorporate revised pages. All revisions shall be recorded. A revision log shall identify complete reissues except for periodic reports and documents which are complete within themselves as final.

2.7.4 Changes of a minor nature to correct obvious typing errors, misspelled words, etc., shall only be made when a technical change is made, unless the accuracy of the document is affected.

2.7.5 All revised pages shall be identified by a revision symbol and a new date. Each document shall contain a log of revised pages that identify the revision status of each page with the revision symbol. This list shall follow the table of contents in each document. The line or lines revised on a given page shall be designated by the use of vertical line in the margin of the page, and the change authority shall be indicated adjacent to the change.

3. DPD MAINTENANCE PROCEDURES

3.1   <u>NASA-Initiated Change</u>: New and/or revised data requirements shall be incorporated by contract modification to which the new or revised portion of the DPD shall be appended. The contractor shall notify the Contracting Officer in the event a deliverable data requirement is imposed and is not covered by a DRD, or when a DRD is changed by a contract modification and for which no revision to DPD is appended. In such cases, the contractor shall submit the requested changes to NASA for approval. See paragraph 3.3.1 for change procedures.

3.2   <u>Contractor-Initiated Change</u>: Contractor-proposed data requirements, or proposed changes to existing requirements shall be submitted to NASA for approval.

3.3   <u>DPD Change Procedures</u>

3.3.1   Changes to a contractual issue of this DPD shall be identified by NASA on the Document Change Log and Page Revision Log. The actual revised material on the DPD page shall be identified by placing a heavy vertical line in the right-hand margin extending the entire length of the change. In addition, the numerical control number of the contractual direction authorizing the change shall be placed adjacent to the vertical revision line. These revision identifiers shall be used to reflect the current revision only; any previous symbols on a page shall be deleted by the current revision.

3.3.2   The date of the contractual direction paper, e.g., Change Order, Supplemental Agreement, or Contracting Officer's letter shall be entered under the "Status " column of the Page Revision Log adjacent to the affected page or DRD number, and in the "as of" block. The date that was in the "as of" block shall be entered in the "Superseding" block.

3.3.3   The Document Change Log entitled "Incorporated Revisions" shall be changed to indicate the number, portions affected, and associated Supplemental Agreement number, if applicable.

3.3.4   The Document Change Log entitled "Outstanding Revisions" is changed periodically to indicate outstanding Change Orders and Contracting Officer notification letters.

3.4   <u>DPD Reissues</u>

3.4.1   When conditions warrant, the DPD shall be reissued by NASA and shall supersede the existing DPD in its entirety. Reissues shall be issued by contractual direction.

3.4.2   All revision symbols (vertical lines and contractual direction control numbers) shall be removed from all pages; revision dates shall remain in the Date Revised block on DRD's that have been revised. The issue symbol, which shall commence with "A" and progress through "Z," shall be entered in the DPD identification block of each DRD page of the DPD.

Actuator Assembly for the Thrust Vector Control System for the Crew Launch Vehicle Upper Stage
DATA REQUIREMENTS LIST

DRD DATA TYPE	TITLE	OPR
CM – Configuration Management		
TVC1-CM-CMP	Configuration Management Plan	TBD
TVC1-CM-EDAL	Engineering Drawings and Associated Lists	TBD
DE – Design and Development Engineering		
TVC1-DE-EEEPL	EEE Parts List	TBD
TVC1-DE-NPAR	EEE Nonstandard Parts Approval List	TBD
TVC1-DE-PCP	Electrical, Electronic, and Electromechanical (EEE) Parts Control Plan	TBD
MA - Management		
TVC1-MA-CRM	Continuous Risk Management	TBD
TVC1-MA-DRP	Design Review Presentation/Package	TBD
TVC1-MA-PS	Program/Project Schedules	TBD
TVC1-MA-TRR	Test Readiness Review	TBD
MP – Materials and Processes		
TVC1-MP-CCP	Contamination Control Plan	TBD
TVC1-MP-MIUL	Material Identification and Usage List	TBD
TVC1-MP-MP	Manufacturing and Assembly Plan	TBD
TVC1-MP-MPCP	Materials & Processes Selection, Implementation, and Control Plan	TBD
TVC1-MP-MUA	Material Usage Agreements	TBD
TVC1-MP-NDE	Nondestructive Evaluation Plan	TBD
QE – Quality Engineering		
TVC1-QE-QP	Quality Plan	TBD
TVC1-QE-SAP	Software Assurance Plan	TBD
RM – Reliability and Maintainability		
TVC1-RM-FMEA	Failure Modes and Effects Analysis and Critical Items List	TBD
TVC1-RM-LLIL	Limited Life Items List	TBD
TVC1-RM-MPAR	Maintainability Allocation/Prediction and Analysis Report	TBD
TVC1-RM-PAP	Product Assurance Plan	TBD
TVC1-RM-RPAR	Reliability Allocation, Predictions and Analysis Report	TBD
SA – Safety		
TVC1-SA-FTA	Fault Tree Analysis	TBD
TVC1-SA-HA	System Safety/Hazard analysis	TBD
TVC1-SA-MSR	Mishap and Safety Statistics Report	TBD
TVC1-SA-SHEWA	Safety, Health, and Environment (SHE) Work Agreement	TBD
TVC1-SA-SHP	Safety, Health, and Environment Plan	TBD
TVC1-SA-SSP	System Safety Plan (SSP)	TBD

SE – Systems Engineering

TVC1-SE-MPR	Mass Properties Report	TBD
TVC1-SE-OPS	Operations Plan	TBD
TVC1-SE-SPEC	Specifications	TBD

SW - Software

TVC1-SW-IDD	Interface Design Description	TBD
TVC1-SW-SCMP	Software Configuration Management Plan	TBD
TVC1-SW-SCR	Software Change Request/Problem Report	TBD
TVC1-SW-SDD	Software Design Description	TBD
TVC1-SW-SDP	Software Development Plan	TBD
TVC1-SW-SMP	Software Maintenance Plan	TBD
TVC1-SW-SRS	Software Requirements Specification	TBD
TVC1-SW-STP	Software Test Plan	TBD
TVC1-SW-STPR	Software Test Procedure	TBD
TVC1-SW-STR	Software Test Report	TBD
TVC1-SW-SUM	Software User Manual	TBD
TVC1-SW-SVD	Software Version Description	TBD
TVC1-SW-SWDD	Software Data Dictionary	TBD
TVC1-SW-SWR	Software Review	TBD

VR - Verification

TVC1-VR-ATP	Acceptance Test Plan	TBD
TVC1-VR-DTP	Development Test Plan	TBD
TVC1-VR-REQ	Verification/Validation Requirements	TBD
TVC1-VR-TR	Hardware Test Report	TBD
TVC1-VR-VC	Verification/Validation Compliance	TBD
TVC1-VR-VP	Verification/Validation Planning	TBD

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.: TVC1-CM-CMP**
4. **DATA TYPE:** 1
5. **DATE REVISED:**
6. **PAGE:** 1/1
7. **TITLE:** Configuration Management Plan
8. **DESCRIPTION/USE:** To describe the contractor's method for accomplishing the configuration management requirements of the contract.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** 60 days after Authority to Proceed (ATP)
13. **SUBMISSION FREQUENCY:** Revise as required
14. **REMARKS:**
15. **INTERRELATIONSHIP:** SOW paragraph 3.3.1
16. **DATA PREPARATION INFORMATION:**

16.1 <u>SCOPE</u>: The Configuration Management Plan (CMP) provides the contractor's proposed management approach for implementation of configuration management.

16.2 <u>APPLICABLE DOCUMENTS</u>: *National Consensus Standard for Configuration Management, EIA-649 A*

16.3 <u>CONTENTS</u>: The CMP shall provide the information defined in MSFC-STD-3394, Appendix A.

16.4 <u>FORMAT</u>: Contractor format is acceptable with NASA approval.

16.5 <u>MAINTENANCE</u>: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.: TVC1-CM-EDAL**
4. **DATA TYPE:** 3
5. **DATE REVISED:**
6. **PAGE:** 1/3
7. **TITLE:** Engineering Drawings and Associated Lists
8. **DESCRIPTION/USE:** To provide engineering data defining the design to the extent required to support manufacturing, test, and logistics support of the vehicle and payload systems 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) and airborne support equipment (ASE). 2D and 3D CAD models shall be submitted as supplemental information.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** 10 days prior to Engineering Model Final Design Review (EMFDR, for Engineering Model)
13. **SUBMISSION FREQUENCY:** Update 10 days prior to Engineering Model Pre-Ship Review for engineering model. 10 days prior to Preliminary Design Review (PDR) and 10 days prior to Critical Design Review (CDR) for flight design, and as requested. In addition, 3D CAD Models shall be submitted between milestones as requested by the procuring activity.
14. **REMARKS:** 00
15. **INTERRELATIONSHIP:** SOW paragraph 3.3.7
16. **DATA PREPARATION INFORMATION:**

16.1 <u>SCOPE</u>: 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.

16.2 <u>APPLICABLE DOCUMENTS:</u> ASME Y14.100 *Engineering Drawing Practices* ASME Y14.41 *Digital Product Definition Data Practices* ASME Y14.5M *Dimensioning and Tolerancing* MIL-STD-961 E *Department of Defense Standard Practices, Defense Specifications*

16.3 <u>CONTENTS</u>: Requirements:

    a. Part I - Engineering drawings and associated lists shall meet the requirements of ASME Y14.100. Geometric Dimensioning and Tolerancing shall be implemented in accordance with ASME Y14.5M. Supplemental 2D/3D CAD shall meet the requirements of ASME Y14.41. Engineering drawings and associated lists of end items, 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).

16. DATA PREPARATION INFORMATION (CONTINUED):

4. 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.

5. Limited rights-in-data items - Engineering drawings for items which the Government does not have unlimited rights in data shall specify the form, fit, and function requirements of the item and conform to the requirements for a control drawing as defined in ASME Y14.100 or a specification prepared in accordance with the requirements of MIL-STD-961.

   b. Part II - Cable interconnect diagrams (CID's), electrical system schematics, and wiring lists. Cable interconnect diagrams, electrical system schematics, wiring lists, and fluid system schematics shall be prepared in accordance with ASME Y14.100. Part I drawings shall be utilized 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. The CID shall show all cable runs and terminations; each cable shall be identified by reference designation number. The connector short sign shall be identified.
   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.

16. DATA PREPARATION INFORMATION (CONTINUED):

5   The Fluid system schematic shall illustrate and describe all components with symbols and flow designators such that the fluid system may be traced from component to component (such as pumps, valves, meters, regulators, and filters). The schematics shall document the range requirements (flow, temperature, and pressure) for all component external interfaces and line sizes. The placement and arrangement of these components shall follow a logical sequence of presentation to provide a clear description of the flow of fluids in the system. The schematics shall reference engineering drawings and associated lists for configuration details.

16.4   **FORMAT**: Format of engineering drawings shall be in accordance with ASME Y14.100. Drawings shall be delivered in PDF format. 2D/3D CAD shall be in accordance with ASME Y14.41, in the current version of native developed CAD, fully parametric and associative. The contractor shall deliver ProEngineer compatible 3D models of the components. Alternate formats may be acceptable upon negotiation. All documentation/data shall include the contractor's CAGE code and document numbers. The Contractor may

submit electronic files of drawings and CAD models via CD, DVD, or direct electronic transfer (Product Data Management (PDM) Tool, FTP, etc.) as specified by the Government [Requisitioner: specify preferred electronic delivery method if known].

For all binary deliveries the contractor shall include a listing of the creating environment to include:
a. CAD product name/version/patches
b. Subordinate (plug-in) software/version/patches
c. Description of hardware
d. Operating system/version/patches

16.5   **MAINTENANCE**: All documents produced under this DRD must be maintained current. Changes to and/or updating of engineering drawings and associated lists shall be in accordance with the contractor's approved drawing system and the provisions herein. Changes to engineering drawings under the Government's Class I change control shall be submitted by Engineering Change Proposal. The contractor shall maintain the capability to restore and modify any engineering data used in the design through the project lifecycle.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.: TVC1-DE-EEEPL**
4. **DATA TYPE:** 3
5. **DATE REVISED:**
6. **PAGE:** 1/1
7. **TITLE:** EEE Parts List
8. **DESCRIPTION/USE:** To provide a summary of as-designed electrical, electronic, and electromechanical (EEE) parts usage with "where-used" and qualification information of designs released for production (As designed EEE parts list). Also to provide the traceability record for the electrical, electronic, and electromechanical (EEE) parts installed in delivered equipment (As built EEE parts list)
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** As-designed EEE parts list: 10 days prior to Engineering Model Final Design Review for Engineering Model, As built EEE parts list 10 days prior to Engineering Model Pre-Ship Review for Engineering Model
13. **SUBMISSION FREQUENCY:** As-designed EEE parts list: 10 days prior to Preliminary Design Review (PDR) and 10 days prior to Critical Design Review (CDR) for Flight design
14. **REMARKS:**
15. **INTERRELATIONSHIP:** SOW Paragraph 2.5.8
16. **DATA PREPARATION INFORMATION:**

16.1 **SCOPE:** The As-Designed EEE Parts List identifies electrical, electronic, and electromechanical parts used in contractor, subcontractor, supplier, and in-house equipment designs. The As-Built EEE Parts List identifies actual electrical, electronic and electromechanical parts used in the assembly of contractor, subcontractor, supplier, and in-house equipment.

16.2 **APPLICABLE DOCUMENTS**
MSFC-STD-3012 *EEE Parts Management and Control for MSFC Space Flight Hardware*

16.3 **CONTENTS:** The As-Built EEE Parts List shall use MSFC-STD-3012 as a guide and include the following for each part:
    a. Delivered end item or equipment identification (part number and serial number).
    b. EEE part's next higher assembly identification (part number and serial number).
    c. EEE part type.
    d. EEE part number.
    e. Generic EEE part number.
    f. EEE part's circuit locating reference designation.
    g. EEE part manufacturer's identification [Commercial and Government Entity (CAGE) code or equivalent].
    h. EEE part's lot identification (Lot Date Code or equivalent).
    i. EEE part's serial number, if applicable.
    j. Identification that an item has been changed from a previous submission.

The As-Designed EEE Parts List shall use MSFC-STD-3012 as a guide and include the following for each EEE part number used:
    a. Deliverable end item or equipment identification (part number).
    b. EEE part type.
    c. EEE part number.
    d. EEE part specification.
    e. Generic EEE part number.
    f. EEE part qualification method and status.
    g. Nonstandard EEE part approval status.
    h. Identification of EEE part manufacturer [QML, QPL, name, or CAGE code (preferred)].
    i. Quantity of EEE part used in equipment (estimated).
    j. Indication that item is a change from the previous submission.

TITLE: EEE Parts List

DATA TYPE: 1

DRD NO.: TVC1-DE-EEEPL

PAGE: 2/2

16. DATA PREPARATION INFORMATION (CONTINUED):

16.4   **FORMAT**: Contractor format is acceptable. Data shall be delivered by hard copy and electronic media.

16.5   **MAINTENANCE**: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.: TVC1-DE-NPAR**
4. **DATA TYPE:** 1
5. **DATE REVISED:**
6. **PAGE:** 1/2
7. **TITLE:** Electrical, Electronic, and Electromechanical Nonstandard Parts Approval Request
8. **DESCRIPTION/USE:** To identify and provide rationale for joint Government and contractor approval of nonstandard electrical, electronic, and electromechanical (EEE) parts as defined in MSFC-STD-3012.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** 10 days prior to Preliminary Design Review, if needed.
13. **SUBMISSION FREQUENCY:** As required to support initial submission. Final submittal, if needed, 10 days prior to Critical Design Review (CDR).
14. **REMARKS:**
15. **INTERRELATIONSHIP:** SOW paragraph 2.5.8
16. **DATA PREPARATION INFORMATION:**

16.1 **SCOPE:** The EEE Nonstandard Parts Approval Request provides the means for requesting approval to use nonstandard electrical, electronic, and electromechanical parts in the system design.

16.2 **APPLICABLE DOCUMENTS**
MSFC-STD-3012 *EEE Parts Management and Control for MSFC Space Flight Hardware*

16.3 **CONTENTS:** The EEE Nonstandard Parts Approval Request shall use MSFC-STD-3012 as a guide and shall conform to the following:

Part 1: Initial Nonstandard Part Usage Request
The purpose of Part 1 is to coordinate approval to use nonstandard EEE parts. The nonstandard parts usage request shall contain the following information:
   a. Unique document control number.
   b. Equipment identification including name, serial number, and part number. The part number shall include configuration information.
   c. Equipment function and criticality.
   d. Supplier, subcontractor, and effectivity.
   e. Subassembly nomenclature, part number, and serial number, if applicable.
   f. Nonstandard EEE part number, part manufacturer and specification number, part name, part type, and common designation.
   g. Salient differences including source control documentation, traceability, quality requirements, and screening and burn-in between design baseline and nonstandard parts.
   h. Qualification status and test plan.
   i. Details of limited life item parts.
   j. Justification for use of the nonstandard part including technical inadequacies.
   k. Details of extended life item parts.
   l. Vendor approval plan.

Part 2: EEE Drawings and Specifications
The purpose of Part 2 is to describe performance, design, qualification, and quality assurance requirements for EEE parts specified in the end item design. The drawings and specifications shall delineate the following:
   a. Complete identification of the part including generic equivalent, physical, environmental, and performance requirements including inspections and tests for qualification, acceptance, and lot samplings where required and packaging, storage, and handling requirements.
   b. Detailed cross-reference to all other applicable specifications for those part types where a combination of specifications is used to provide all of the requirements for a single part type.

TITLE: Electrical, Electronic, and Electromechanical
Nonstandard Parts Approval Request

DRD NO.: **TVC1-DE-NPAR**

DATA TYPE: 1

PAGE: 2/2

16. DATA PREPARATION INFORMATION (CONTINUED):

    c. Unique number to identify each EEE part drawing/specification which is subject to formal change control.

    d. Seller-originated requirements documents which are incorporated into the part specification. (These shall be submitted along with the part specification.)

    e. Applicable military specifications and appropriate paragraphs. (These shall be available on request.)

    f. Exceptions to referenced military specifications.

Part 3: EEE Part Qualification Test Report

To document each nonstandard part qualified by test to its specification, the EEE Part Qualification Test Report shall contain the following:

    a. Reference to related qualification test plan and description of test.

    b. Sample size, measurements taken, test procedures, sequence, equipment used, and acceptance criteria.

    c. Identification of measurements outside acceptable criteria, identification of all failures, and failure analysis.

    d. Statement as to successfulness of test and qualification is applicable.

    e. Reference to the controlling specification to which the qualification is applicable.

    f. Comparison of worst-case application requirements to qualification requirements including the basis of parametric drift over extended life, where applicable.

16.4   **FORMAT**: Use of MSFC Form 4346 (February 1998) or contractor format is acceptable. Nonstandard part approval requests shall include all information specified on MSFC Form 4346 (February 1998). Data shall be delivered by hard copy and electronic media.

16.5   **MAINTENANCE**: Changes shall be incorporated by change page or complete reissue. Not applicable to Part 3.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.: TVC1-DE-PCP**
4. **DATA TYPE:** 2
5. **DATE REVISED:**
6. **PAGE:** 1/1
7. **TITLE:** Electrical, Electronic, and Electromechanical (EEE) Parts Control Plan
8. **DESCRIPTION/USE:** The plan shall define the contractor's planned methods of accomplishing the tasks required to satisfy the EEE parts program requirements.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** 10 days prior to Preliminary Design Review (PDR).
13. **SUBMISSION FREQUENCY:** Update 10 days prior to Critical Design Review (CDR).
14. **REMARKS:**
15. **INTERRELATIONSHIP:** SOW paragraph 2.5.8
16. **DATA PREPARATION INFORMATION:**

16.1   <u>SCOPE:</u> The EEE Parts Control Plan describes the contractor's approach to accomplishing the electrical, electronic, and electromechanical parts control program requirements and tasks.

16.2   **APPLICABLE DOCUMENTS:**
EEE Parts Management and Control for the Crew Launch Vehicle (Draft)
MSFC-STD-3012 EEE Parts Management and Control for MSFC Space Flight Hardware

16.3   <u>CONTENTS:</u> The EEE Parts Control Plan shall use The EEE Parts Management and Control for the Crew Launch Vehicle (Draft), and MSFC-STD-3012 as a guide and include the
following:
     a.   Description of tasks to be accomplished including programmatic tasks, special studies, and support tasks.
     b.   Task matrix defining primary and support organization responsibilities.
     c.   Identification of formats and ground rules to be used in analysis tasks.
     d.   Methods of implementation of tasks.

16.4   <u>FORMAT:</u> Contractor format is acceptable. Data shall be delivered by hard copy and electronic media.

16.5   <u>MAINTENANCE:</u> Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.: TVC1-MA-CRM**
4. **DATA TYPE:** 1 plan, 2 reports
5. **DATE REVISED:**
6. **PAGE:** 1/2
7. **TITLE:** Continuous Risk Management
8. **DESCRIPTION/USE:** To provide a baseline document for planning, management, control, and implementation of the contractor's risk management program.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** Risk Management Plan, Risk List, Analysis, and Tracking Report - 60 days after Authority to Proceed (ATP). Lessons Learned Search Reports and Lessons Learned Submittals – 10 days prior to Preliminary Design Review (PDR).
13. **SUBMISSION FREQUENCY:** Shall update and submit Risk List, Analysis, and Tracking Report, every 30 days (monthly). Shall update Plan as required. Lessons Learned Search Reports and Lessons Learned Submittals shall be updated 10 days prior to Critical Design Review (CDR) and as appropriate throughout the project lifecycle.
14. **REMARKS:** Reference is made to the following documents: NPD 8700.1 NASA Policy for Safety and Mission Success Notice 97-58 NASA Procurement Notice for Risk-Based Acquisition Management (R-BAM) MWI 7120.6 Program and Project Continuous Risk Management
15. **INTERRELATIONSHIP:** SOW paragraph 1.1.2
16. **DATA PREPARATION INFORMATION:**

16.1   **SCOPE:** Continuous Risk Management addresses how NASA risk management requirements are to be implemented throughout the program's life cycle.

16.2   **APPLICABLE DOCUMENTS:** NPR 7120.5 NASA Program and Project Management Processes and Requirements; NPR 8000.4 Risk Management Procedural Requirements

16.3   **CONTENTS:** The Risk Management Plan shall specify how the contractor will satisfy the risk management requirements of NPR 7120.5 by using the risk management procedures and guidelines specified in NPR 8000.4 in a manner that is compatible with the Project Office's Risk Management Plan. The plan shall specify how the contractor will document risk management activities and how the contractor will communicate risk issues and concerns to the Government.

The Risk List shall identify program risks with regards to budget, cost, safety, schedule, and technical risks.

The Risk Analysis shall contain the following data: 1) References to source data for identified risk areas such as test data, lessons learned, Failure Modes Effects Analysis (FMEA), hazard analysis and technical analysis; 2) Catalog of all program/project risks; 3) Risk evaluation data that identifies the impact, probability and time frame for each risk; 4) Risk classification and prioritization data.

The Risk Tracking Report shall contain the following data: 1) Status of all risks and risk metrics; 2) Risk mitigation plans and verification of completed mitigation plans; 3) Risk decision summaries that will document re-planning of unsuccessful mitigation plans and risk acceptance/closures.

Lessons Learned Search Reports shall specify how the contractor has satisfied the requirements of NPR 7120.5

16.   **DATA PREPARATION INFORMATION (CONTINUED):**

by incorporating lessons learned. They shall contain the following data: 1.) Guidelines used to determine relevant searches; 2.) Details of searches that were performed, together with accompanying rationale; 3.) A list of relevant articles returned, source, and relevance to the project; and 4.) How the project plans to incorporate relevant lessons learned.

Lessons Learned Submittals shall include: 1.) Description of the driving event; 2.) Description of the lessons learned and any corrective action that may have resulted; 3.) Recommended changes to specifications or procedures.

16.4   **FORMAT:** Contractor format is acceptable unless specified by the Program Risk Management Plan.

16.5   **MAINTENANCE:** Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.**: CA01C
2. **ISSUE**: Standard
3. **DRD NO.**: **TVC1-MA-DRP**
4. **DATA TYPE**: 1
5. **DATE REVISED**:
6. **PAGE**: 1/2
7. **TITLE**: Design Review Presentation/Package
8. **DESCRIPTION/USE**: The design review shall be a formal technical review that is used to evaluate the design for satisfaction of design and performance requirements, analytical methods, test procedures, as well as to review action items generated previously.
9. **OPR**:
10. **DM**:
11. **DISTRIBUTION**: Per Contracting Officer's letter
12. **INITIAL SUBMISSION**: 10 days prior to Engineering Model Final Design Review (Engineering Model). 10 days prior to Preliminary Design Review (PDR) and 10 days prior to Critical Design Review (CDR) (Flight Design)
13. **SUBMISSION FREQUENCY**: Update as required.
14. **REMARKS**:
15. **INTERRELATIONSHIP**: SOW Paragraphs 1.4.5, 1.4.6
16. **DATA PREPARATION INFORMATION**:

16.1 <u>SCOPE</u>: A Design Review package shall provide the NASA COTR with the design information required for evaluating the technical merit and programmatic impact of a proposed design.

16.2 <u>APPLICABLE DOCUMENTS</u>:

16.3 <u>CONTENTS</u>: A design review package shall include as a minimum:
   a. Review Agenda
   b. Responses to status open action items/recommendations and RID's generated at prior reviews
   c. Any analyses, reports and supportive material (e.g., results from prior test which support the proposed design, etc.), as appropriate
   d. Discussion of Risk Assessment/Mitigation status and plans

   1. The Engineering Model Review (EMR) shall contain the following:
      (a) An overview of the engineering model design to show that the design adequately satisfies the hardware and performance requirements
      (b) Predicted operating characteristics
      (c) Engineering 3D CAD models to show hardware configuration
      (d) Specification of system interfaces and interactions
      (e) System safety hazards assessment
      (f) Structural analysis reports
      (g) Thermal/fluid mechanics analysis reports
      (h) Dynamic analysis reports
      (i) Parts Identification and Materials Lists
      (j) Requested deviations and waivers
      (k) Cost status versus plan and cost projections (through fabrication, test, and analysis)
      (l) Schedule status versus plan and schedule projections
      (m) Test plans for design verification, and other methods of performance verification
      (n) All engineering model level detailed and assembly engineering drawings
      (o) Fracture Control analysis report

TITLE: Design Review Presentation/Package   DRD NO.: **TVC1-MA-DRP**

DATA TYPE: 1   PAGE: 2/2

16.   **DATA PREPARATION INFORMATION (CONTINUED):**

  2   The Preliminary Design Review (PDR) shall contain the following:

  (a) An overview of the preliminary design to show that the design adequately satisfies the hardware and performance requirements
  (b) Predicted operating characteristics
  (c) Engineering 3D CAD models to show preliminary hardware configuration
  (d) Specification of system interfaces and interactions
  (e) System safety hazards assessment
  (f) Structural analysis reports
  (g) Thermal/fluid mechanics analysis reports
  (h) Dynamic analysis reports
  (i) Parts Identification and Materials Lists
  (j) Requested deviations and waivers
  (k) Cost status versus plan and cost projections (through fabrication, test, and analysis)
  (l) Schedule status versus plan and schedule projections
  (m) Test plans for design verification, and other methods of performance verification
  (n) Draft version of the Design Specification
  (o) Fracture Control analysis report

  3   The Critical Design Review (CDR) shall contain the following:

  (a) Updates to all of the PDR required items
  (b) An overview of follow-on testing including preliminary test and instrumentation plans
  (c) Reliability Analysis
  (d) Safety and Hazard Analysis
  (e) Final version of the Design Specification
  (f) All flight hardware level detailed and assembly engineering drawings

16.4   **FORMAT:** Briefing format, contractor format is acceptable.

16.5   **MAINTENANCE:** As required to correct errors and to maintain RID closure status.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.: TVC1-MA-PS**
4. **DATA TYPE:** 2
5. **DATE REVISED:**
6. **PAGE:** 1/2
7. **TITLE:** Program/Project Schedules
8. **DESCRIPTION/USE:** To provide the contractor's time-phased plan, current status, key milestones, task interdependencies, and major development phases necessary to accomplish the total scope of work. This schedule will be used to provide management insight into contractor status, potential problem areas, and critical path identification, which will serve as the basis for evaluating contractor performance.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** Preliminary with proposal. Initial - first calendar month following the end of the first full month after Authority to Proceed (ATP).
13. **SUBMISSION FREQUENCY:** Monthly, no later than the 10th day of the calendar month following the end of the contractor's accounting month.
14. **REMARKS:** The schedule will be baselined at some point after ATP as agreed to by both parties and not to exceed 90 days after ATP. Reference is made to NPR 7120.5 (Current Revision), *NASA Program and Project Management Processes and Requirements*. This document shall be used as a guide in preparation of the schedules.
15. **INTERRELATIONSHIP:** SOW paragraph 1.1.3
16. **DATA PREPARATION INFORMATION:**

16.1 **SCOPE:** The Program/Project Schedule provides data for the assessment of contract schedule and logic network of the tasks to be performed.

16.2 **APPLICABLE DOCUMENTS:** NPD 9501.3 A *Earned Value Management*

16.3 **CONTENTS:** The program/project schedule shall include tasks necessary to accomplish the total scope of work as defined in the work breakdown structure (WBS). The schedule shall also include all logical relationships (interdependencies) between tasks. Schedules shall contain the approved baseline schedule as well as current forecasted dates and shall be traceable to the approved Work Breakdown Structure (WBS). All key milestones shall be clearly identified and logically linked to related tasks. The program/project schedule shall be created and maintained in management software that supports automated time phasing of tasks, a logic driven critical path, schedule assessment, and trend analysis capabilities. Program/Project Schedules and the Logic Network shall be reported in four sections. The following deliverables shall be extractions from the automated logic network database. All data contained in the sections shall be consistent, statused monthly and based on the same cutoff date.

   a. Summary Schedule – One page, top level, Gantt-type summary document arranged by WBS that reflects all contract and controlled milestones, major program/project phases (i.e., design, fabrication, integration, assembly, etc.) and all end item deliveries.
   b. Logic Network Database – an automated logic network database consisting of schedule data for all WBS elements. The entire scope of work shall be broken into schedule tasks and milestones at a consistent level of detail to allow discrete progress measurement and visibility into the overall development, fabrication, integration, assembly, test, and delivery phase of each end item deliverable. Additionally, all schedule tasks/milestones shall be integrated with the appropriate sequence relationships to provide a total end-to

DRD Continuation Sheet

TITLE: Project Schedules
DATA TYPE: 2
DATA PREPARATION INFORMATION (CONTINUED):

DRD NO.: **TVC1-MA-PS**
PAGE: 2/2

end logic network leading to each end-item delivery. This database shall contain all contract and controlled milestones, key subcontractor milestones, end item delivery dates, key data delivery dates, and key Government Furnished Property (GFP) need dates. The database shall contain the appropriate task coding attributes necessary to provide sort, select, and summarization capabilities for, but not limited to, WBS element, program/project phase, and level-of-effort tasks. The logic network database serves as the basis for identification of program/project critical paths as well as critical schedule analysis.

c. Critical Path Report – This report shall be an extract from the Logic Network Database and include all tasks and milestones with 10 workdays or less of total slack (float). The report shall be submitted in a waterfall format and organized in 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.

d. Contractor Schedule Assessment Report – This report shall contain a count of the total number of tasks, milestones and non-detail (e.g., summary, hammock, rollup, etc.) activities contained in the schedule, a count of the number of completed tasks and milestones, a count of the number of tasks and milestones to be completed, a count of the number of tasks and milestones that have no predecessor and/or no successor relationships, a count of 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, a count of the total number of non-detail (e.g., summary, hammock, rollup, etc.) activities that have any predecessor or successor logical relationships, a count of the total number of tasks and milestones that have forced or fixed dates. The report shall contain critical path narratives explaining changes and impacts to the critical paths listed in section c above. The report shall contain narrative explanations for contract milestones and significant project milestones that have moved more that 45 calendar days into the future from their baseline dates. Program/Project milestones shall be identified and negotiated with the project office. These narratives shall include a proposed work-around schedule detailing how the contractor plans to recover the lost schedule time.

16.4 **FORMAT**: Submission of the deliverables in 15.3 shall be by standard hardcopy and electronic media. Electronic media submittals shall be in native file format utilizing schedule management software approved by NASA. A legend identifying the contractor's schedule symbols used and their meaning shall be provided.

16.5 **MAINTENANCE**: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Draft
3. **DRD NO.: TVC1-MA-TRR**
4. **DATA TYPE:** 2
5. **DATE REVISED:**
6. **PAGE:** 1/1
7. **TITLE:** Test Readiness Review
8. **DESCRIPTION/USE:** A Test Readiness Review (TRR) Package shall provide to the NASA COTR information required for evaluating the Contractor's preparedness for the planned test and test series.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** 10 days prior to Engineering Model Test Readiness Review
13. **SUBMISSION FREQUENCY:** Revise as required
14. **REMARKS:**
15. **INTERRELATIONSHIP:** SOW Paragraph 1.4.9
16. **DATA PREPARATION INFORMATION:**

16.1   **SCOPE:** The TRR shall be a formal technical review to be held prior to a test or test series that evaluates the test procedures, processes, and methodology.

16.2   **APPLICABLE DOCUMENTS:**

16.3   **CONTENTS:** The Test Readiness Review shall contain as a minimum the following:
   a. Review Agenda
   b. Responses to status of open action items/recommendations generated at prior reviews
      i. Summary of Test and Instrumentation Plans
      ii. Status of preparation for the tests
      iii. Safety and Hazard Analysis for test
      iv. Evidence that corrective action resulting from analyses was incorporated into the articles involved
      v. Supporting material, (e.g., relevant model test results, etc.).
      vi. Test procedure (outline of)

16.4   **FORMAT:** Contractor format is acceptable.

16.5   **MAINTENANCE:** Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard

3. **DRD NO.:** **TVC1-MP-CCP**
4. **DATA TYPE:** 2
5. **DATE REVISED:**
6. **PAGE:** 1/2
7. **TITLE:** Contamination Control Plan (CCP)
8. **DESCRIPTION/USE:**
   The contamination control plan defines implementation measures to control contamination of flight hardware and fluid systems during manufacturing, assembly, test, transportation, launch site processing, and post-flight refurbishment.
9. **OPR**
10. **DM**
11. **DISTRIBUTION:** As determined by the Contracting Officer.
12. **INITIAL SUBMISSION:** 10 days prior to Preliminary Design Review (PDR).
13. **SUBMISSION FREQUENCY:** The contractor may submit updates/revisions at any time. Final submission at 10 days prior to Critical Design Review (CDR).
14. **REMARKS:**
15. **INTERRELATIONSHIP:** Parent SOW Paragraph: 2.5.6
16. **DATA PREPARATION INFORMATION:**

16.1 **SCOPE:**
The contamination control plan shall be generated in accordance with the guidelines of ASTM E1548, Standard Practice for Preparation of Aerospace Contamination Control Plans (as specified by NASA-STD(I)-6016) and shall include:

   a. A FOD control plan to prevent damage to flight hardware and injury to the flight crew by foreign object debris (FOD) during manufacture, assembly, test, transportation, launch site processing, operation, repair, modification, refurbishment and maintenance. The FOD prevention program shall conform to NAS 412, Foreign Object Damage/ Foreign Object Debris (FOD) Prevention, as specified by NASA-STD(I)-6016.

   b. Definition of cleanliness level acceptance limits and verification methods for fluid systems, and for general flight hardware internal and external surfaces.   The plan shall also contain a list identifying all system fluids, together with the fluid specifications (for procurement or custom mixing) and the required cleanliness levels for the fluid system.

16.2 **APPLICABLE DOCUMENTS:**
NASA-STD(I)-6016, Standard Materials and Processes Requirements for Spacecraft
NAS 412 rev 1, Foreign Object Damage/ Foreign Object Debris (FOD) Prevention

16.3 **CONTENTS:**
The FOD control plan shall address the following elements:

   a. Identification of probable FOD sources
   b. Early design considerations for FOD prevention, resistance to damage, foreign object entrapment, etc
   c. Manufacturing planning for minimizing FOD generation and cleaning up whatever FOD is generated
   d. FOD control methods
   e. FOD Awareness and Prevention Training.
   f. Metrics - Measuring techniques for analysis, trending, and feedback.
   g. Incident investigation/reporting, "lessons learned."
   h. Awareness/Employee Feedback.

The contractor shall define cleanliness level acceptance limits and verification methods for fluid systems, and for general flight hardware internal and external surfaces.   The contractor shall also provide a list identifying all system fluids, together with the fluid specifications (for procurement or custom mixing) and the required cleanliness levels for the fluid system.

16.4 **FORMAT:** Electronic, Word-compatible document or Adobe PDF.

TITLE: Contamination Control Plan (CCP)
DATA TYPE: 2
DRD NO.: TVC1-MP-CCP
PAGE: 2/2

16. DATA PREPARATION INFORMATION (CONTINUED):

16.5   **MAINTENANCE**: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **DRD NO.: TVC1-MP-MIUL**
3. **DATA TYPE:** 2
4. **DATE REVISED:**
5. **PAGE:** 1
6. **TITLE:** Materials Identification and Usage List (MIUL)
7. **DESCRIPTION/USE:**
8. The MIUL is an electronic searchable parts list or separate electronic searchable materials identification and usage list. The MIUL identifies all Material 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.
9. **DISTRIBUTION:** As determined by the Contracting Officer.
10. **INITIAL SUBMISSION:** 10 days prior to Engineering Model Final Design Review
11. **SUBMISSION FREQUENCY:** Update 10 days prior to Preliminary Design Review (PDR) and 10 days prior to Critical Design Review (CDR).
12. **REMARKS:**
13. **INTERRELATIONSHIP:** Parent SOW Paragraph: 2.5.3
14. **DATA PREPARATION INFORMATION:**

14.1 **SCOPE:**
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).

14.2 **APPLICABLE DOCUMENTS:**
NASA-STD(I)-6016, Standard Materials and Processes Requirements for Spacecraft

14.3 **CONTENTS:**
The MIUL shall identify the information as outlined in NASA-STD(I)-6016:

14.4 **FORMAT:** Contractor format is acceptable. However, Contractor format for electronic submittal of MIUL data shall be compatible with the NASA Materials and Processes Technical Information System (MAPTIS) database.

14.5 **MAINTENANCE:** Changes shall be incorporated by change page or complete reissue

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.**: CA01C
2. **ISSUE**: Standard
3. **DRD NO.**: **TVC1-MP-MP**
4. **DATA TYPE**: 2
5. **DATE REVISED**:
6. **PAGE**: 1/2
7. **TITLE**: Manufacturing and Assembly Plan
8. **DESCRIPTION/USE**: To establish the requirements for the Manufacturing and Assembly Plan so that the program can scope the entire magnitude of the task to be accomplished and provide technically sound, efficient, and cost effective plan of action to ensure projected schedules can be maintained. The plan shall define the make-or-buy process, including objectives, criteria, management, logic, and results.
9. **OPR**:
10. **DM**:
11. **DISTRIBUTION**: Per Contracting Officer's letter
12. **INITIAL SUBMISSION**: Summary with contract proposal, then 10 days prior to Preliminary Design Review (PDR)
13. **SUBMISSION FREQUENCY**: Update 10 days prior to Critical Design Review (CDR).
14. **REMARKS**:
15. **INTERRELATIONSHIP**: DRD's TVC1-MP-MPCP, Materials and Processes Selection, Implementation, and Control Plan; TVC1-CM-EDAL, Engineering Drawings and Associated Lists. SOW paragraph 5.4
16. **DATA PREPARATION INFORMATION**:

16.1   <u>SCOPE</u>: The Manufacturing and Assembly Plan is applicable to hardware developer(s), subcontractor(s), and vendor(s).

16.2   <u>APPLICABLE DOCUMENTS</u>: MSFC-STD-506 C *Standard, Materials and Processes Control*

16.3   <u>CONTENTS</u>: This plan shall define the objective, methods and procedures to be used in the manufacture and assembly of the deliverable hardware. Specifically the plan shall contain:

    a. Organization - A description of the manufacturing and assembly organizations and policies, as well as the organizational relationships between these and the other key organizations supporting the deliverable hardware manufacturing effort.

    b. Systems and Controls - The systems and controls to be used by the fabrication and assembly organization for procurements, inspection and testing, nonconformance reporting, material control, configuration control, manufacturing and assembly documentation shall be defined.

       i. Procurements - Major components and assemblies to be procured rather than manufactured and/or assembled in-house, long lead time procurements, and risks associated with sole or proprietary sources shall be identified.

       ii. Inspection and Test - Requirements for inspection and test stations, as well as procedures shall be provided for each control point in the manufacturing and assembly sequence.

    c. Producibility Plan - The plan shall define the producibility analysis process to be used in the development of deliverable hardware. Flight hardware design documentation shall be reviewed to assure the ability to fabricate, inspect, and assemble hardware as depicted by the engineering design drawings.

    d. Manufacturing and Assembly Flow - The methods, procedures, and operations of control points used to plan, manufacture, and monitor the fabrication and assembly of the deliverable hardware shall be defined.

       i. Critical Processes - All processes, methods, facilities, tooling, or skills critical to success shall be identified. The schedule shall fully reflect required availability milestone dates of all project critical items. New, unique, or unfamiliar processes shall be identified with rationale explaining why these processes are to be used.

TITLE: Manufacturing and Assembly Plan

DATA TYPE: 2

DRD NO.: TVC1-MP-MP

PAGE: 2/2

16.   DATA PREPARATION INFORMATION (CONTINUED):

        ii.   Tooling -A listing and planned usage of tooling and support equipment required to fabricate and assemble deliverable hardware shall be described.

        iii.   Assembly Sequence - A time correlated sequence of operations necessary to assemble the hardware, including assembly requirements, constraints, and operations to be performed shall be described.

    e.   Schedules -The detailed development and maintenance of manufacturing and assembly schedules showing milestones and completion dates necessary to ensure that deliverable end items shall be met.

    f.   Capabilities and Facilities - The facilities and capabilities required for fabrication, manufacturing, and assembly shall be described.

    g.   Major Subsystems - The major subsystems of deliverable hardware to be manufactured and assembled by the fabrication organization shall be identified.

16.4   **FORMAT**: Contractor format is acceptable and shall be consistent with contents of paragraph 15.3 of this DRD.

16.5   **MAINTENANCE**: Changes shall be incorporatedby change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **DRD NO.: TVC1-MP-MPCP**
3. **DATA TYPE:** 2
4. **DATE REVISED:**
5. **PAGE:** 1/2
6. **TITLE:** Materials & Processes Selection, Control, and Implementation Plan (MPCP)
7. **DESCRIPTION/USE:**
8. This plan shall document the degree of conformance and method of implementation for each requirement in this standard, identifying applicable in-house specifications used to comply with the requirement. It shall also describe the methods used to control compliance with these requirements by subcontractors and vendors. The Materials and Processes Selection, Control, and Implementation Plan , upon approval by the procuring activity shall become the Materials and Processes implementation document used for verification.
9. **DISTRIBUTION:** As determined by the Contracting Officer.
10. **INITIAL SUBMISSION:** 10 days prior to Preliminary Design Review (PDR)
11. **SUBMISSION FREQUENCY:** Update 10 days prior to Critical Design Review (CDR).
12. **REMARKS:**
13. **INTERRELATIONSHIP:** Parent SOW Paragraph: 2.5.4
14. **DATA PREPARATION INFORMATION:**

14.1 **SCOPE:**
The Materials and Processes Selection, Control, and Implementation Plan shall describe the hardware developer's activities involved in the identification, evaluation, documentation, and reporting of materials and processes usage in space flight hardware, support hardware and ground support equipment.

14.2 **APPLICABLE DOCUMENTS:**
NASA-STD(I)-6016, Standard Materials and Processes Requirements for Spacecraft

14.3 **CONTENTS:**
The necessary interfaces with procuring activity in the operation of this plan shall be defined. The method for materials control and verification of subcontractors and vendors shall be included in the hardware developer's plan. As a minimum and as applicable, the plan shall address the following:

Conformance – The Plan shall address each applicable paragraph of NASA-STD(I)-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(I)-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.

Hardware Developer's Organization - Authority shall be assigned to an individual or group who shall be responsible for review and approval of all M&P specified prior to release of engineering documentation.

Materials and Processes Identification - Identification and documentation of the M&P used, both in the original design and in any changes shall be contained in the Material and Process Identification and Usage List DRD.

Testing - Logic, procedures and data documentation for any proposed test program to support materials screening and verification testing.

TITLE: Materials & Processes Selection, Control,
    and Implementation Plan (MPCP)

DRD NO.: **TVC1-MP-MPCP**

DATA TYPE: 2

PAGE: 2/2

14. DATA PREPARATION INFORMATION (CONTINUED):

Materials Usage Agreement (MUA) Procedures - Logic, procedures and documentation involved in documenting and approving materials/processes as indicated in NASA-STD(I)-6016 shall be defined, including those that do not meet the established requirements, but are proposed for use due to lack of replacement materials/processes or other considerations and shall be contained in the Materials Usage Agreement DRD.

Material Design Properties – The plan shall contain the philosophy describing how material properties will be determined, and if those properties do not exist, how the material properties will be developed including, but not limited to the statistical approaches to be employed.

Process Controls – The plan shall identify all process specifications used to implement specific requirements in NASA-STD(I)-6016. 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.

14.4   **FORMAT**: Electronic, Word-compatible document or Adobe PDF. For each paragraph in sections 4 of NASA-STD(I)-6016, the plan shall state the requirement from NASA-STD(I)-6016, identify the degree of conformance under the subheading "Degree of Conformance," and identify the method of implementation under the subheading "Method of Implementation."

14.5   **MAINTENANCE**: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **DRD NO.: TVC1-MP-MUA**
3. **DATA TYPE:** 1 (Category I and II MUAs), 2 (Category III MUAs)
4. **DATE REVISED:**
5. **PAGE:** 1
6. **TITLE:** Materials Usage Agreements (MUA)
7. **DESCRIPTION/USE:**
8. MUAs shall be submitted for all materials and processes that do not meet the technical requirements of NASA-STD(I)-6016, as implemented by the approved Materials and Processes Selection, Control, and Implementation Plan.
9. **DISTRIBUTION:** As determined by the Contracting Officer.
10. **INITIAL SUBMISSION:** 10 days prior to Preliminary Design Review (PDR).
11. **SUBMISSION FREQUENCY:** As the need for new MUAs is identified during the detailed design process. MUAs shall be revised and resubmitted whenever design modifications affect the part numbers identified on the MUA or the MUA rationale.
12. **REMARKS:**
13. **INTERRELATIONSHIP:** Parent SOW Paragraph: 2.5.5
14. **DATA PREPARATION INFORMATION:**

14.1 **SCOPE:**
MUAs shall be submitted as described in NASA-STD(I)-6016

14.2 **APPLICABLE DOCUMENTS:**
NASA-STD(I)-6016, Standard Materials and Processes Requirements for Spacecraft

14.3 **CONTENTS:**
The MUA package shall include all technical information required to justify the application.

14.4 **FORMAT:** Electronic. A sample MUA form is provided in NASA-STD(I)-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.

14.5 **MAINTENANCE:** Contractor updates to the Category I and Category II MUAs shall be submitted to NASA for approval. Complete re-issue of the MUA is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.**: CA01C
2. **DRD NO.**: **TVC1-MP-NDE**
3. **DATA TYPE**: 2
4. **DATE REVISED**:
5. **PAGE**: 1/2
6. **TITLE**: Nondestructive Evaluation Plan
7. **DESCRIPTION/USE**:
8. This plan shall identify all Nondestructive Evaluation (NDE) and nondestructive testing procedures and specifications employed in the inspection of materials.
9. **DISTRIBUTION**: As determined by the Contracting Officer.
10. **INITIAL SUBMISSION**: 10 days prior to Preliminary Design Review (PDR).
11. **SUBMISSION FREQUENCY**: Final submission 10 days prior to Critical Design Review (CDR).
12. **REMARKS**:
13. **INTERRELATIONSHIP**: Parent SOW Paragraph: 2.5.7
14. **DATA PREPARATION INFORMATION**:

14.1 **SCOPE**:
The NDE Plan shall describe the process for establishment, implementation, execution and control of NDE. The plan shall meet the intent of MIL-HDBK-6870 A, Inspection Program Requirements, Nondestructive for Aircraft and Missile Materials and Parts and MSFC-STD-1249, Standard NDE Guidelines and Requirements for Fracture Control Programs, as specified by NASA-STD(I)-6016.

14.2 **APPLICABLE DOCUMENTS**:
NASA-STD(I)-6016, Standard Materials and Processes Requirements for Spacecraft
MIL-HDBK-6870, Inspection Program Requirements, Nondestructive for Aircraft and Missile Materials and Parts
MSFC-STD-1249, Standard NDE Guidelines and Requirements for Fracture Control Programs

14.3 **CONTENTS**:
The plan shall define NDT planning and requirements to include the following:

Hardware Design -- The NDE plan shall define the system to assure all designs are reviewed to establish appropriate NDE inspection requirements and acceptance criteria and that final hardware design approval signifies agreement that the part is producible and inspectable or is subject to process controls.

Manufacturing Planning -- The NDE plan shall identify the process used to ensure that NDE inspection requirements are properly defined and are sequenced in the specific manufacturing process to optimizing inspection reliability and early flaw detection before unnecessary processing costs are incurred and/or processes are performed that may significantly reduce flaw detection capability.

Personnel Training -- The NDE plan shall identify formal training and certification requirements for flaw detection NDT Inspection

NDE Reliability Requirements for Fracture Critical Parts -- Demonstration of reliability is required when the inspection method differs from standard industry and government practices described in the MIL-HDBK-6870 or MSFC-STD-1249. Application of NDE methods for detection of cracks or crack like flaws smaller than

TITLE: Nondestructive Evaluation Plan

DRD NO.: **TVC1-MP-NDE**

DATA TYPE: 2

PAGE: 2/2

14.   **DATA PREPARATION INFORMATION (CONTINUED):**

those defined in MSFC-STD-1249 shall require a reliability demonstration. Such NDE methods are referred to as "Special NDE".

NDE Reporting – The NDE plan shall describe the NDE reporting system, including the means of coordinating design requirements such as critical crack size and NDT capabilities; means of implementing NDT specifications and procedures,

including personnel and facilities certification; and the means of coordinating NDT procedures and specifications with NASA.

14.4   <u>FORMAT</u>: Electronic, Word-compatible document or Adobe PDF.

14.5   <u>MAINTENANCE</u>: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

16. **DPD NO.:** CA01C
17. **ISSUE:** Standard
18. **DRD NO.: TVC1-QE-QP**
19. **DATA TYPE:** 1
20. **DATE REVISED:**
21. **PAGE:** 1/2
22. **TITLE:** Quality Plan
23. **DESCRIPTION/USE:** To define the contractor's planned methods for accomplishing the applicable tasks required to satisfy the quality requirements of NPD 8730.5, and the Quality Assurance requirements of CxP 70059, for the specific Flight and/or Flight associated hardware being procured.
24. **OPR:**
25. **DM:**
26. **DISTRIBUTION:** Per Contracting Officer's letter
27. **INITIAL SUBMISSION:** Due with proposal.
28. **SUBMISSION FREQUENCY:** Update as significant changes to the quality plan occur.
29. **INTERRELATIONSHIP:** SOW paragraph 2.5.1
30. **DATA PREPARATION INFORMATION:**

15.1 <u>**SCOPE**</u>: The Quality Plan shall identify, as applicable, the specific quality activities (implementation) related to the design and development, procurement of materials/subcomponents, fabrication, test, shipping, flight operations, refurbishment, and reuse to assure the quality of the items delivered. The plan shall reference the contractor's quality manual and procedures as necessary to fully describe the contractor's quality system.

15.2 <u>**APPLICABLE DOCUMENTS:**</u>

SAE AS9100 Revision B   Quality Management Systems – Aerospace - Requirements

ANSI/ISO/ASQ Q9001-2000 *American National Standard Quality Management Systems Requirements*

CxP 70059 Constellation Program Integrated Safety, Reliability, & Quality Assurance (SR&QA) Requirements (Draft)

SAE AS9003 Inspection and Test Quality System

NPD 8730.5 *NASA Quality Assurance Program Policy*

15.3 <u>**CONTENTS**</u>: Each quality element of SAE AS9100, Revision B, and as applicable the NASA Quality Assurance requirements per CxP 70059, or as applicable either ANSI/ISO/ASQ Q9001-2000 or SAE AS9003, shall be addressed to describe the philosophy and approach for implementation. This can be satisfied by contractor's existing quality manual and procedures. A copy of the Quality System Manual and 1st tier procedures shall be submitted with any required quality plan. As a minimum, the subparagraphs below shall be addressed by the present documented quality management system or subsequent submittal of a quality plan to include details of responsibilities and controls to adequately describe the specific quality assurance activities related to hardware being procured by NASA:

a. Customer quality requirements – include hardware specific quality requirements imposed by contract or component/equipment specification (i.e., traceability requirements, specific inspection points, specific quality activities including Government surveillance and inspection processing).

b. Responsibilities – describe which contractor organizations will be responsible to perform the applicable

TITLE: Quality Plan

DRD NO.: TVC1-QE-QP

DATA TYPE: 1

PAGE: 2/2

15. DATA PREPARATION INFORMATION (CONTINUED):

quality management system activities.

c. Article, Material, and Service Controls - describe the level of article, material, and service control including traceability requirements invoked by the contractor for the articles, materials, and/or services used in or performed as part of the hardware design and maintenance criteria, including how quality is assured for each material, part, assembly, and/or service performed.

d. Procurement – include the procurement quality requirements for all materials/parts/components the contractor purchases and the level of control exercised over the suppliers including how suppliers are approved, monitored, and maintained with controls for supplier nonconformances processing.

e. Milestone Reviews – describe how the contractor's quality system will support milestone reviews.

f. Configuration Assurance – describe how the configuration of the hardware build is compared and verified to the approved design baseline drawings and specifications. Describe how the configuration of Government Furnished Property/Equipment is maintained.

g. Special Process Controls – describe special process controls implemented for in-house processes and, if applicable, for sub-tier supplier processes.

h. Inspection and Test (describe who will be responsible to perform inspections to include any restrictions) – include: how the quality of purchased items is validated at receiving inspection or at sub-tier suppliers facilities, specific in-process (manufacturing) inspections performed, details of final inspection, functional and environmental test monitoring details, and pre-ship inspections. When applicable, provisions shall be included for development of site quality plans for major end item test and flight test.

i. Nonconforming Product (Material Review Board Process) - describe the process of convening a nonconforming product material review board to disposition nonconforming product using a defined board of qualified personnel including contractor quality assurance personnel and customer representatives. MRB limitations within the Statement of Work (SOW) and membership qualification shall be defined. An MRB membership listing shall be submitted within the quality plan or by contract letter.

j. Flight Operations, Refurbishment, and Reuse – when applicable, describe how the contractor's quality assurance system is implemented for flight operations, refurbishment and reuse.

k. Record retention – for those records not delivered to NASA, specify which records are required to be kept, who keeps them, for how long, and how they are to be dispositioned at the end of the retention period, and/or as specified in the contract.

15.4 **FORMAT:** Contractor format is acceptable.

15.5 **MAINTENANCE:** Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.: TVC1-QE-SAP**
4. **DATA TYPE:** 1
5. **DATE REVISED:**
6. **PAGE:** 1/1
7. **TITLE:** Software Assurance Plan
8. **DESCRIPTION/USE:** Document the activities associated with the software assurance disciplines.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** 30 days after Authority to Proceed.
13. **SUBMISSION FREQUENCY:** Update as required
14. **REMARKS:**
15. **INTERRELATIONSHIP:** DRD TVC1-SA-SSP, Systems Safety Plan, SOW Paragraph 2.4
16. **DATA PREPARATION INFORMATION:**

16.1   **SCOPE:** The Software Assurance Plan covers activities associated with software quality, reliability, safety, verification and validation and independent verification and validation.

16.2   **APPLICABLE DOCUMENTS:** NASA-STD-8739.8 *NASA Software Assurance Standard* NASA-STD-8719.13 B *NASA Software Safety Standard* IEEE 730 *IEEE Standard for Software Quality Assurance Plans*

16.3   **CONTENTS:** In accordance with NASA-STD-8739.8, the Software Assurance Plan shall include:
      a. Software Assurance Organization.
      b. Software Quality Assurance Activities per IEEE 730.
      c. Software Safety Activities per NASA-STD-8719.13.
      d. Software Reliability Activities.
      e. Software Verification and Validation Activities.
      f. Software Independent Verification and Validation Activities.
      g. Software Assurance Metrics.
      h. Training.

16.4   **FORMAT:** Contractor format is acceptable.

MAINTENANCE: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. DRD NO.: CADIC
2. ISSUE: Baseline-d
3. DRD NO.: **TVC1-QE-SAP**
4. DATA TYPE: 1
5. DATE REVISED:
6. PAGE: 1/1
7. TITLE: Software Assurance Plan
8. DESCRIPTION/USE: Document the activities associated with the software assurance disciplines.
9. OPR:
10. DM:
11. DISTRIBUTION: Per Contracting Officer's letter
12. INITIAL SUBMISSION: 30 days after Authority to Proceed.
13. SUBMISSION FREQUENCY: Update as required
14. REMARKS:
15. INTERRELATIONSHIP: DRD TVC1-SA-SSP, Systems Safety Plan, SOW Paragraph 2.4
16. DATA PREPARATION INFORMATION:

16.1 SCOPE: The Software Assurance Plan covers activities associated with software quality, reliability, safety, verification and validation and independent verification and validation.

16.2 APPLICABLE DOCUMENTS: NASA-STD-8739.8 NASA Software Assurance Standard NASA-STD-8719.13 B NASA Software Safety Standard IEEE 730 IEEE Standard for Software Quality Assurance Plans

16.3 CONTENTS: In accordance with NASA-STD-8739.8, the Software Assurance Plan shall include:
a. Software Assurance Organization.
b. Software Quality Assurance Activities per IEEE 730.
c. Software Safety Activities per NASA-STD-8719.13.
d. Software Reliability Activities.
e. Software Verification and Validation Activities.
f. Software Independent Verification and Validation Activities.
g. Software Assurance Metrics.
h. Training.

16.4 FORMAT: Contractor format is acceptable.

MAINTENANCE: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.**: CA01C
2. **ISSUE**: Standard
3. **DRD NO**: **TVC1-RM-FMEA**
4. **DATA TYPE**: FEMA – Type 2, CIL – Type 1
5. **DATE REVISED**:
6. **PAGE**: 1/3
7. **TITLE**: Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL)
8. **DESCRIPTION/USE**: <u>Failure Modes and Effects Analysis (FMEA)</u> – to identify and document the possible failures modes and causes of each hardware item of a subsystem/system, the worst case effect of such failures for each mission phase and assigns criticality per the applicable FMEA/CIL guidelines document. The FMEA and CIL shall be prepared in accordance with "CONSTELLATION PROGRAM REQUIREMENTS FOR PREPARATION OF HARDWARE FAILURE MODES AND EFFECTS ANALYSIS AND CRITICAL ITEMS LIST (FMEA/CIL)", 0000028494. This information is vital for design improvements, reliability and maintainability analysis. It will also support the Risk Based Design Activity for the Crew Launch Vehicle Project.

   Integrated Effort: Systems Engineering and Reliability shall collaborate on the development of the FMEA/CIL with Systems Engineering taking the lead. Systems Engineering, Systems Safety, and Reliability shall review the Hazard Analysis and the FMEA/CIL. This integrated effort is to assure that criticality 1 failure modes [failure modes with effects such as Loss of Crew (LOC), Loss of Vehicle (LOV)] have been covered in the hazard analysis and that the FMEA/CIL does not omit any crit 1 failure modes associated with catastrophic hazards.

   <u>Critical Items List (CIL)</u> – to identify and document the list of critical failure modes of item(s) in each subsystem/system with potential worst case effect(s), such as Loss of Crew (LOC), Loss of Vehicle (LOV) and/or Loss of Mission (LOM) or detrimental failure effects as applicable to system under study per the Constellation-FMEA/CIL requirements document. The CIL provides details of relevant design features, testing and inspections processes and controls, as applicable to the failure mode, to mitigate/minimize the risk. CIL retention rationale bridges the gap in the design, test/verification requirements, inspection and process controls. CIL also facilitates in the identification of Government Mandatory Inspection Points. CIL also provides a flight waiver rationale for those critical failure modes, per applicable ground rules, which could not be eliminated by design.

9. **OPR**:
10. **DM**:
11. **DISTRIBUTION**: Per Contracting Officer's letter
12. **INITIAL SUBMISSION**: 10 days prior to Preliminary Design Review (PDR).
13. **SUBMISSION FREQUENCY**: Update 10 days prior to Critical Design Review (CDR).
14. **REMARKS**: Reference is made to the instructions contained in: "CONSTELLATION PROGRAM REQUIREMENTS FOR PREPARATION OF HARDWARE FAILURE MODES AND EFFECTS ANALYSIS AND CRITICAL ITEMS LIST (FMEA/CIL)", 0000028494.
15. **INTERRELATIONSHIP**: DRD, TVC1-RM-RPAR, *Reliability Allocations, Predictions and Analysis Report*. SOW paragraph 2.6.6
16. **DATA PREPARATION INFORMATION**:

16.1   **SCOPE**: FMEA/CIL shall be performed for all flight hardware and payload items to meet applicable program/project requirements. A detailed Reliability Block Diagram (RBD) is required to document all key line replaceable units and/or assemblies and their interrelationship in terms of redundant and series configuration and number of success paths to ensure mission success.

       FMEA provides for each hardware item in a subsystem/system as identified on the RBD. The FMEA

TITLE: Failure Modes and Effects Analysis and Critical Items List

DATA TYPE: 1/2

DRD NO.: **TVC1-RM-FMEA**

PAGE: 2/3

16. DATA PREPARATION INFORMATION:

identifies potential failure modes of each item and its associated failure causes, analyzes and documents the effect of the failure mode during each critical phase of the mission and assigns a criticality number to substantiate the appropriate crew, vehicle and mission risk.

Critical Items List (CIL) analysis provides for failure modes which lead to worst case failure conditions such as Loss of Crew (LOC), Loss of Vehicle (LOV), Loss of Mission (LOM) and/or other criticalities which are detrimental to the program per its applicable FMEA/CIL guideline document. The CIL provides lists of hardware identified in the FMEA categorized as being "Critical", i.e., those items whose failure could result in a loss of life or degradation of the mission or those items that meet the criteria to be designated as critical items according to the criteria in the Constellation FMEA and CIL Requirements document, 0000028494. The CIL documents the retention rationale and controls specific to each critical failure mode of the LRU/assembly under discussion for its design features, testing, and inspections along with the failure history. This CIL retention rationale, when effectively implemented, mitigates the risk with high degree of confidence, leading to mission success.

Common Cause Failures Analysis shall be performed as part of FMEA/CIL analysis to assess the crew, vehicle and mission risks.

16.2 **APPLICABLE DOCUMENTS**:

16.3 **CONTENTS**:

a. FMEA documentation shall include:
1. Introduction: Concise statement on the objectives of the report.
2. Subsystem description in term of its function (s) and list of hardware/LRU items.
3. All assumptions and ground rules used in the analysis.
4. Reliability Block Diagram, Schematics and/or other simple models of the system.
5. List of all applicable and reference documents.
6. Completed Analysis worksheets for every identified failure mode for its worst case effects for each hardware item. Worksheet shall include all relevant information such as: identification of the item to be analyzed, identification of the analyst and responsible managers, revision dates, hardware part number and its functional description, FMEA number, failure mode identification and description, failure causes, mission phase in which the failure occurs, the worst case failure effect on the subsystem, interfacing subsystems, mission, Space Transportation System, Payloads and other applicable systems, failure detection and isolation methods, corrective action, functional criticality, redundancy screens, success paths after first failure, Remarks/Hazards, effectivity, disposition and rationale. However, the instructions found in the "CONSTELLATION PROGRAM REQUIREMENTS FOR PREPARATION OF HARDWARE FAILURE MODES AND EFFECTS ANALYSIS AND CRITICAL ITEMS LIST (FMEA/CIL)", 0000028494 shall be followed to assure that all required data is provided in the FMEA and CIL.

NOTE: FMEA results shall be documented by listing each identified failure mode for each component in the system being analyzed on a separate table or worksheet. The worksheet contains all the data elements to be addressed in the analysis. The failure effects, causes, criticalities etc., are individually assessed for each component depending upon the function of that component performs.

b. Critical Items List Analysis shall include:
1. Introduction: Concise statement on the objectives of the report.

DRD Continuation Sheet

16. DATA PREPARATION INFORMATION (CONTINUED):

2. Scope: Describe the major systems contained in the CIL and general information on what type of data is contained in the CIL.
3. List of all applicable and reference documents.
4. Critical LRU List: Provide a listing of LRU part numbers, reference designators (if appropriate), LRU nomenclature, LRU highest level criticality, lower level part numbers identified by the FMEA and respective nomenclature, failure mode number, quantity of items in the subsystem and FMEA/CIL criticality for each FMEA/CIL number, indicating redundancy screen (s) failed as applicable. The screens for determining critical items will be defined in the document titled "CONSTELLATION PROGRAM REQUIREMENTS FOR PREPARATION OF HARDWARE FAILURE MODES AND EFFECTS ANALYSIS AND CRITICAL ITEMS LIST (FMEA/CIL)", 0000028494 and shall be followed to assure that all of the critical items have been captured in the CIL.
5. Analysis Results: Individual CIL shall be prepared for each failure mode identified as critical to the mission and shall document its associated design rationale (including its design qualification details and/or reference), testing and inspection details specific to the failure mode and failure causes to mitigate the mission risks for all failure causes with high degree of confidence. Each CIL shall contain all the data elements called out in the approved program specific FMEA/CIL guideline document and/or applicable NSTS 22206 D/SSP 30234 FMEA/CIL guideline document. The rationale shall also contain failure history data and flight waivers data relevant to that failure mode along with the applicable recurrence controls. Each CIL shall contain all the data elements as called out and defined in the approved Constellation program requirements for preparation of the FMEA/CIL document.
c. As part of flight certification process, a CIL waiver matrix and/or a document shall be generated that lists the applicable CIL waiver code for each CIL item with a CR to obtain program approval of the risk presented by CIL. This shall support verification and validation activity. Ground rules shall be consistent with the general intent of NSTS 22206 D and NSTS 07700 or Constellation Program specific FMEA/CIL guidelines and Verification & Validation documents.

16.4 **FORMAT**: FMEA's worksheets shall use a matrix format with headings in accordance with the applicable Constellation program specific guideline document. FMEA/CIL shall be prepared and submitted to NASA/MSFC electronically as well as hard copies per program specific directions. Contractor format is acceptable for FMEA and CIL after concurrence by MSFC S&MA.

16.5 MAINTENANCE: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.**: CA01C
2. **ISSUE**: Standard
3. **DRD NO.**: **TVC1-RM-LLIL**
4. **DATA TYPE**: 2
5. **DATE REVISED**:
6. **PAGE**: 1/1
7. **TITLE**: Limited Life Items List
8. **DESCRIPTION/USE**: To provide a list of items possessing limited life characteristics, and their designed or allowed usage. The limited life Items list also provides data for a Preventative Maintenance Plan.
9. **OPR**:
10. **DM**:
11. **DISTRIBUTION**: Per Contracting Officer's letter
12. **INITIAL SUBMISSION**: 10 days prior to Preliminary Design Review (PDR)
13. **SUBMISSION FREQUENCY**: Update 10 days prior to Critical Design Review (CDR), update as required
14. **REMARKS**:
15. **INTERRELATIONSHIP**: DRD's TVC1-RM-FMEA, *Failure Modes and Effects Analysis and Critical Items List*; TVC1-RM-PAP, *Product Assurance Plan* and TVC1-SA-SSP, *System Safety Plan,* SOW Paragraph 2.6.5
16. **DATA PREPARATION INFORMATION**:

    16.1   **SCOPE**: The Limited Life Items List provides a list depicting items of hardware categorized as having "limited life", i.e., items having characteristics of quality degradation or drift with age or use.

    16.2   **APPLICABLE DOCUMENTS**: None

    16.3   **CONTENTS**: The Limited Life Items List shall contain the following for those items identified as time, cycle, or age sensitive:

        a.   Name of item.
        b.   Allowable time and/or cycles and age permitted.
        c.   Accumulated time and/or cycles at time of shipment.
        d.   Required time and/or cycles and age that must be remaining prior to conducting each major milestone test and launch.

    16.4   **FORMAT**: Contractor format is acceptable.

    16.5   **MAINTENANCE**: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.**: CA01C
2. **ISSUE**: Standard
3. **DRD NO**: **TVC1-RM-MPAR**
4. **DATA TYPE**: 2
5. **DATE REVISED**:
6. **PAGE**: 1/2
7. **TITLE**: Maintainability Allocation/Prediction and Analysis Report
8. **DESCRIPTION/USE**: The intent of the maintainability allocation and prediction and analysis report is to provide the process and tools to predict, evaluate, analyze, verify, and validate maintainability throughout all phases of the program and to generate the data necessary for other system analyses such as supportability and cost.
9. **OPR**:
10. **DM**:
11. **DISTRIBUTION**: Per Contracting Officer's letter
12. **INITIAL SUBMISSION**: 10 days prior to Critical Design Review (CDR)
13. **SUBMISSION FREQUENCY**: Update as needed for major design changes
14. **REMARKS**: See Tailoring Instructions. Reference is made to MIL-HDBK-470A, *Design and Developing Maintainable Products and Systems*
15. **INTERRELATIONSHIP**: DRD's TVC1-RM-FMEA, *Failure Modes and Effects Analysis and Critical Items List*; TVC1-RM-RPAR, *Reliability Prediction Analysis Report*; TVC1-SA-HA, *System Safety/Hazard Analysis Report*; and TVC1-SA-FTA, *Fault Tree Analysis*, SOW Paragraph 2.6.3
16. **DATA PREPARATION INFORMATION**:

16   **SCOPE**: Maintainability Allocation/Prediction and Analysis Report describes the integrated design effort that includes proactive participation of component designers to design-in maintainability early during system design efforts. This includes maintainability analysis and predictions (including allocations), maintainability trade studies/sensitivity analysis, identifying maintainability drivers, maintenance tasks for supportability analysis and maintainability demonstration testing to verify and validate the maintainability predictions.

16.1   **APPLICABLE DOCUMENTS**:
Constellation Program Integrated Safety, Reliability, &Quality Assurance (SR&QA) Requirements Constellation Program Reliability, Availability, and Maintainability Process and Methodology Document, CxP 70087
NPD 8720.1 B(R04) *NASA Reliability and Maintainability Program Policy*
MPD 8720.1 MSFC Reliability and Maintainability Program for Space Systems
MIL-HDBK-2165 *Testability Program for Systems and Equipments [This is applicable for systems using health monitoring, detection and isolation capability and/or advanced prognostics capabilities]*
Constellation Architecture Requirements Document (CARD)

16.2   **CONTENTS**: The Maintainability Allocation/Prediction and Analysis Report shall use the applicable documents in item 15.2 to provide the following:
    a.   General and programmatic information along with details of designing-in-maintainability right from the conceptual design stage.
    b.   The integration of maintainability predictions and analyses into the overall system management process and program milestones.
    c.   The integration of maintainability predictions and analyses with other system analyses such as supportability and cost.
    d.   Description of the process used in maintainability prediction and analysis, including allocation from system to lower levels of indenture.
    e.   The ground rules and assumptions used in performing maintainability predictions and analyses
    f.   Models used in maintainability analyses.
    g.   Data used in the maintainability predictions/analyses, including data sources.
    h.   Testability Analysis results to assess the effectiveness of Fault Detection and Fault Isolation.

16.   **DATA PREPARATION INFORMATION (CONTINUED):**

     i.   Maintainability allocation/predictions and analyses results. This includes methodology, models and results from:

         1.   Reliability-centered maintenance (RCM) analysis.

         2.   Maintainability allocations and predictions in support of maintainability requirements.

         3.   Availability analysis (parts, components, etc.).

     j.   Provide roadmap for evolution of design maturity to minimize risk, program schedule and cost. Include gap analysis if appropriate.

     k.   Maintainability demonstration testing to verify/validate the maintainability predictions for key LRUs/Systems.

     l.   Operational Availability Analysis: The contractor shall construct a reliability block diagram model for operational availability (OA) analysis of the actuator assembly. The OA model shall accept mean-time-between-failures (MTBF) data for each block, and Mean-time-to-Repair or Replace (MTTR) data. In addition, the OA model shall require input for specification of logistics delay time for spares: the estimated time to transfer a spare from its stowage location to the site of the required maintenance action. The model should provide an estimate of the system operational availability, the system mean time between maintenance actions, and the mean repair time.

     m.   Supportability: The required mass and volume for spares, and the mean repair time per mission required to attain the OA goal or requirement shall be compared to the program constraints on these resources. The actuator assembly shall be designed to be supportable: The required resources to attain the OA goal or requirement cannot exceed resource constraints.

16.4   **FORMAT**: Contractor format is acceptable.

16.5   **MAINTENANCE:** Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.: TVC1-RM-PAP**
4. **DATA TYPE:** 1
5. **DATE REVISED:**
6. **5. PAGE:** 1/5
7. **TITLE:** Product Assurance Plan
8. **DESCRIPTION/USE:** To identify and define the contractor's plans and planned method of accomplishing the Safety and Mission Assurance (S&MA) tasks required by the Statement of Work (SOW) and meet *program specific* Level I, II and III requirements.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** Final 60 days after Authority to Proceed (ATP)
13. **SUBMISSION FREQUENCY:** Update as required
14. **REMARKS:** Initial submittal of the document shall be submitted as one package; however, the Government may approve the volumes separately. The plan shall be organized by the major functions of S&MA organization with a separate volume for each discipline area. This process permits each volume to be revised and approved individually (i.e., System Safety, Ground Safety, Industrial Safety, Reliability, Maintainability, Quality Assurance and Software Assurance). Reference is made to the following documents:

    NPG 8715.3 *NASA Safety Manual Safety, Reliability, Maintainability and Quality provisions for the Space Shuttle Program Planning*

    NASA-STD-8729.1 *Developing and Managing an Effective Reliability and Maintainability (R&M) Program*

    NSTS 5300.4 (1D-2) Safety, Reliability, Maintainability and Quality Provisions for the Space Shuttle Program *Program Risk Management Plan (Program Specific)*

15. **INTERRELATIONSHIP:** SOW Paragraph 2.1
16. **DATA PREPARATION INFORMATION:**

    16.1 **SCOPE:** The Product Assurance Plan addresses the S&MA philosophy, organization, approach, and key processes. The plan shall be organized by the major functions of S&MA organization with a separate volume for each discipline area. This permits each volume to be revised and approved individually (i.e., System Safety, Ground Safety, Industrial Safety, Reliability, Maintainability, Quality Assurance and Software Assurance).

    16.2 **APPLICABLE DOCUMENTS:**
    NPD 8700.1 B(R04) NASA Policies for Safety and Mission Success
    NPD 8720.1 Reliability and Maintainability Policy
    NPR 8715.3 NASA Safety Manual Program Requirements and Procedures for Certification of Flight Readiness
    NSTS 08117 M Program Level I Requirements Document System Requirements Document (SRD)
    SSP 58318 *Certification of Flight Readiness for Space Station*
    ANSI/ISO/ASQ *Quality Management Systems - Requirements* Q9001-2000/AS 9100 NASA-STD-8739.8 *NASA Software Assurance Standard*
    NASA-STD-8719.13 *NASA Software Safety Standard*
    MPD 8720.1 *Marshall Reliability and Maintainability Program for Space Systems*

    16.3 **CONTENTS:** The Product Assurance Plan shall address S&MA philosophy, organization, approach and all the related processes/activities needed for program safety and mission success. Key processes include identifying, addressing and resolving safety and mission success concerns, risks and risk acceptance, and appropriate lessons learned at all management council reviews, other major milestone review activities and operational readiness reviews. The plan shall address the processes for reporting and tracking resolution of all corrective actions approved and resulting from investigations of mishaps, incidents, nonconformances, and anomalies. The plan shall document the key activities/tasks in each discipline supported by additional process details such as flow diagrams (where applicable), analysis tools/technologies, verification and

16.   **DATA PREPARATION INFORMATION (CONTINUED):**

validation system/tools to monitor the effectiveness and timely response Product Assurance System. The plan shall provide process details of integrating Reliability, Maintainability and Supportability (RMS) tasks/results to optimize the life cycle cost with reasonable, verifiable estimates with high degree of confidence. The plan shall describe the approach for the development and review of S&MA products to be applied by the contractor and Tier II subcontractors. The Product Assurance Plan shall meet the requirements of the applicable documents in 15.2 and consists of separate volumes for each S&MA discipline.

a.   **Volume 1, Safety Plan:** The Safety Plan shall contain sections related to System Safety, Ground Safety, Industrial Safety and Software System Safety. The Plan shall define the methodology and techniques for achieving the program safety requirements. This shall be a description of how the system safety (hardware and software) and industrial/occupational and health safety programs shall be conducted to meet requirements of the SOW and design specifications. [Note: Provide details of industrial safety in a separate plan with an overview provided in this document.] The plan includes a definition of the safety organization(s), the safety manager(s), and key personnel. Points of contact and interfaces with other organizations having responsibility for safety of product are to be identified. The plan includes:

1. The number and types of personnel required for the performance of the safety effort (hardware, software and industrial safety).
2. A description of the safety tasks performed during the preliminary phase, system definition, design, manufacture, test, or operations that shall be continued throughout the life of the system.
3. A description of the methods that shall be used to perform these safety tasks, control the effort, accomplish the objectives, and verify compliance with requirements.
4. A Software Safety Plan, either by incorporation or by reference, defining the method(s) to determine the activities and tools necessary to perform software safety activities for the entire life cycle of the Program.
5. Identification of the safety output shall have results from the expected application of the effort, with provisions for documentation of specific results of the safety effort.
6. Scheduling the safety effort, including milestone identification, program activities, program phasing, integration, and product delivery.
7. Support and planning for the Program specific phased safety review processes.
8. The System Safety Plan shall describe how the contractor plans to gain compliance with safety requirements for the International Space Station (if applicable).

b.   **Volume II, Reliability Plan**: The Reliability Plan shall provide full details of reliability organization, processes, modeling and analysis to accomplish higher system reliability, maintainability, safety and availability goals by designing–in–reliability right from the conceptual design stage and its progressive improvement throughout the life cycle of the system.

1. The Reliability Plan shall provide details of the organizational structure of reliability with reference to other organizations including maintainability, supportability, engineering etc., its interactions and interfaces.
2. The Reliability Plan shall provide a list and details of reliability tasks (includes Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL) Analysis, Reliability Prediction including Probabilistic Risk Assessment (PRA) as applicable, Reliability Testing etc), processes and analyses for each key milestone of the program with a roadmap to meet the operational reliability and safety requirements of development and flight system.
3. The Reliability Plan shall provide details of how reliability is integrated into the design function to improve system/subsystem reliability by influence the design as part of the systems engineering model.
4. The Reliability Plan shall identify ground-rules and baseline design assumptions, and planned reliability tools, including those for probabilistic design analysis (PDA) and structural reliability. Identify data assumptions, attributes of the model (including level, assumed relationships, etc.),

16.   **DATA PREPARATION INFORMATION (CONTINUED):**

timelines modeled, and capabilities modeled (i.e., crew escape). Identify the method to be utilized in verification of the models provided the Government has access to this material.

5. The Reliability Plan shall define and document the contractor's plan to fully implement and perform a Reliability Prediction using appropriate industry/DOD Standards and/or Probabilistic Risk Assessment (PRA) (if applicable) in support of Level I requirements.

6. If required, a separate PRA plan shall be submitted as part of the Product Assurance Plan. PRA plan to define the scope, content, basic approach, ground rules and assumptions that the contractor utilized in the development and performance of a Reliability Predictions/PRA for the System for loss-of-crew, loss-of-vehicle, and loss-of-mission (LOC, LOV and LOM) as applicable. The plan shall address the methods to be utilized along with any specific modifications to these methods. It shall also address data sources and model/data validation.

7. The Reliability Plan shall provide roadmap of quantitative reliability assessment to match program evolution such as ground test article to flight article using quantitative reliability predictions with data such as MTBF along with details of reliability growth modeling etc. The section shall utilize references to internal contractor/vendor procedures, processes and controls including EEE parts selection and control, data sources, studies, etc., provided the Government has access to this material.

8. The Reliability Plan shall provide process details and tools planned for effective integration of problem reporting, analyzing and corrective action system and Non-Conformance System. Provide details of planned Problem Trending System to assess risk and provide input to reliability and maintainability analyses.

9. The Reliability Plan shall provide verification and validation process to ensure compliance of design to key reliability goals per DRD STD/VR-VP, *Verification/Validation Planning* leading to qualification and certification of flight hardware.

10. The Reliability Plan shall provide process details and tools planned for implementation of statistical process control and process capability activities to minimize process variances during manufacturing, testing and system integration of flight critical hardware to help understand, document, communicate and facilitate minimizing flight safety risk.

c. **Volume III, Maintainability Plan** (if applicable): The Maintainability Plan shall provide full details of maintainability organization, processes, modeling and analysis to accomplish higher system reliability, maintainability, and higher safety and availability goals by designing–in–maintainability right from the conceptual design stage and its progressive improvement throughout the life cycle of the system.

1. The Maintainability Plan shall provide details of the organizational structure of maintainability with reference to other organization including reliability, supportability, operations and engineering etc, its interactions and interfaces.

2. The Maintainability Plan shall document all the relevant processes that are planned to ensure simplification and robustness of design, ease of access and details of reliability centered maintenance process (RCM) if applicable. Define the basis for decision logic for LRU and maintenance levels selection. Identity trade studies etc. planned to ensure an easily maintainable system to meet operational requirements at optimum life cycle cost.

3. The Maintainability Plan shall define testability requirement analyses and roadmap.

4. The Maintainability Plan shall identify the maintainability modeling and analysis performed by the contractor along with modeling relationships and assumptions, data sources and timelines. Identify the method for verification/validation of the models. The section shall utilize references to internal contractor processes, data sources, studies, etc., and provide Government with access to this material.

5. The Maintainability Plan shall provide methodology and techniques for achieving the program maintainability requirements. Describe how the maintainability program plans to meet the requirements of the SOW and the design specifications.

16. DATA PREPARATION INFORMATION (CONTINUED):

      6. Provide details of verification activities in accordance with DRD STD/VR-VP, *Verification/Validation Planning*.

  d. **Volume IV, Quality Assurance Plan.**

      1. The Quality Plan shall identify, as applicable, the specific quality activities (implementation) related to the design and development, procurement of materials/subcomponents, fabrication, test, shipping, flight operations, refurbishment, and reuse to ensure the quality of the items delivered. The plan shall reference the contractor's quality manual and procedures as necessary to fully describe the contractor's quality system. The Plan shall include the following: An identification of each Quality task to be accomplished under the QA Program (e.g. subcontractor monitoring, allocations process, etc.), a detailed description of how each quality task shall be performed or complied with, and, the procedures (where existing procedures are applicable) to evaluate the status and control of each task.

      2. Each quality element of ANSI/ISO/ASQ Q9001-2000 supplemented by AS 9100, shall be addressed to describe the philosophy and approach for implementation. This shall be satisfied by reference in the quality plan to the contractor's existing quality manual provided a copy of the manual is delivered with the quality plan and the attendant procedures are available for review.

      3. As a minimum, the subparagraphs below shall be addressed by the quality plan and details of responsibilities and controls shall be included to adequately describe the specific quality assurance activities related to hardware being procured by the Program:

          (a) Customer quality requirements – include hardware specific quality requirements imposed by contract or component/equipment specification (i.e., traceability requirements, specific inspection points, specific quality activities).

          (b) Responsibilities–describe which contractor organizations shall perform the applicable quality activities below.

          (c) Article, Material, and Service Controls- describe the level of article, material, and service control including traceability requirements invoked by the contractor for the articles, materials, and/or services used in or performed as part of the hardware design and maintenance criteria, including how quality is ensured for each material, part, assembly, and/or service performed.

          (d) Procurement– include the procurement quality requirements for all materials/parts/ components the contractor purchases and the level of control exercised over the suppliers (how are suppliers approved and monitored, how are supplier non-conformances monitored, etc.).

          (e) Milestone Reviews – describe how the contractor's quality system shall support milestone reviews.

          (f) Configuration Assuranc*e* – describe how the configuration of the hardware build is compared and verified to the approved design baseline drawings and specifications. Describe how the configuration of Government Furnished Property/Equipment is maintained.

          (g) Special Process Controls – describe special process controls implemented for in-house processes and, if applicable, for sub-tier supplier processes.

          (h) Inspection and Test (describe who performs what inspections where) – include how the quality of purchased items is validated at receiving inspection or at sub-tier suppliers facilities, specific in-process (manufacturing) inspections performed, details of final inspection, functional and environmental test monitoring details, and pre-ship inspections. When applicable, provisions shall be included for development of site quality plans for major end item test and flight test.

          (i) Nonconforming Product (Material Review Board Process) - describe the process of convening a nonconforming product material review board to disposition nonconforming product using a defined board of qualified personnel including contractor quality assurance personnel and

16.   DATA PREPARATION INFORMATION (CONTINUED):

> customer representatives. MRB limitations within the Statement of Work (SOW) and membership qualification shall be defined. An MRB membership listing shall be submitted within the quality plan or by contract letter.
>
> (j)   Flight Operations, Refurbishment, and Reuse – when applicable, describe how the contractor's quality assurance system shall be implemented for flight operations, refurbishment and reuse.
>
> (k)   Record retention – for those records not delivered to the Program, specify which records are required to be kept, who keeps them, for how long, and how they are to be dispositioned at the end of the retention period.
>
> (l)   Sampling and Process procedures.

e.   **Volume V, Software Assurance Plan**: The Software Assurance Plan (SAP) shall define the methodology and techniques for achieving the Program software quality, reliability, safety, verification and validation, and independent verification and validation requirements. The Software Assurance Plan shall provide the information defined in NASA-STD-8739.8. As a minimum the plan shall include:

1.   An overview of the organization responsible for implementing software assurance requirements.

2.   Detailed sections for each software assurance discipline describing specific tasks to be accomplished.

    a.   Software Quality Assurance.

    b.   Software Reliability.

    c.   Software Safety.

    d.   Verification and Validation.

    e.   Independent Verification and Validation.

3.   The procedures (where existing procedures are applicable) to evaluate the status and control of each task.

f.   **Volume VI, Certificate of Qualification Plan**: This plan shall define and document the process to enable S&MA to monitor and support (a) materials and qualification test procedures (b) the certification program to demonstrate that the hardware as designed, assembled and checked out is capable of meeting its requirements, including re-use through verification and validation processes and supporting (c) the qualification testing and (d) retaining the test reports.

The contractor shall maintain an effective system and documentation to substantiate and track the above activities in meeting certification requirements and provide NASA with all the certification and supporting documents including test plans and records to support design certification of all flight hardware.

g.   **Certificate of Flight Readiness (CoFR) Plan:** This plan shall provide system details to integrate various tasks and responsibilities of S&MA along with engineering and provide complete and comprehensive details, rationale and documentation for assessing flight risks, resolving them and making recommendation in support of Certificate of Flight Readiness. The contractor shall maintain Certificate of Flight Readiness log, a principle record, which denotes system flight readiness.

16.4   **FORMAT**: Contractor format is acceptable.

16.5   **MAINTENANCE**: Changes shall be incorporated by change page or complete reissue of individual volumes.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.:** **TVC1-RM-RPAR**
4. **DATA TYPE:** 2
5. **DATE REVISED:**
6. **PAGE:** 1/3
7. **TITLE:** Reliability Allocation, Predictions and Analysis Report
8. **DESCRIPTION/USE:** This report documents the reliability data and analysis that is needed to meet the applicable Constellation Level II Program Requirements for Reliability. The Constellation Level II SR&QA Requirements Document provides the list of required reliability analysis activities to support design analysis, availability, maintainability, and supportability analysis using quantitative analyses. For complex systems, if directed, the contractor shall utilize the probabilistic risk assessment (PRA), as a minimum, for the calculation of reliability estimates such as Loss of Crew, Loss of Vehicle, Loss of Mission estimates or other reliability parameters at system/subsystem level, as applicable. The linkage between the PRA and other supporting reliability analyses shall be clearly defined.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** 10 days prior to Preliminary Design Review (PDR).
13. **SUBMISSION FREQUENCY:** Update 10 days prior to Critical Design Review (CDR).
14. **REMARKS:** See Tailoring Instructions
15. **INTERRELATIONSHIP:** DRD TVC1-RM-001, *Failure Modes and Effects Analysis and Critical Items List*; SOW paragraph 2.6.2
16. **DATA PREPARATION INFORMATION:**

16.1 **SCOPE:** The contractor shall perform reliability allocation, predictions and analysis to assess various flight risks to meet program requirements. The Contractor shall provide a Reliability Allocation, Predictions and Analysis Report. Reliability Predictions shall document the reliability model(s) and their underlying ground-rules and assumptions used in the Reliability Allocation, Predictions, and Analysis Report along with supporting justification and limitations.

    a. Reliability Allocation, Predictions and Analysis Report shall assess the quantitative reliability of systems/subsystems using tools such as Reliability Block Diagram Models or Probabilistic Risk Assessment (PRA) and/or other quantitative reliability assessment processes, models and provide results. The numerical reliability requirement for the actuator assembly shall be used to allocate reliability requirements down to the subsystems and the components of the actuator assembly. The allocation is intended to provide a "design-to" target to meet or exceed. It provides a reliability roadmap with quantifiable goals at major program milestones (example, at PDR, CDR, proto-flight unit etc.) to achieve required system reliability. the flight certified system and a process to validate the results (predicted versus actual). The detailed analysis results shall include subsystem/Line Replacement Unit (LRUs) reliability for each critical mission phase. Reliability models, processes and tools shall be identified and validated for their application specific to program needs to provide reasonable and verifiable results.

16.2 **APPLICABLE DOCUMENTS:** MPD 8720.1 *MSFC Reliability and Maintainability Program for Space Systems* MIL-HDBK-2165 *Testability Handbook for Systems and Equipment* [This is applicable for systems using health monitoring, detection and isolation capability and/or advanced prognostics capabilities] NPR 8705.5 *Probabilistic Risk Assessment (PRA) Procedures for NASA Programs and Projects,* CxP 70017 Probabilistic Risk Assessment Methodology

DRD Continuation Sheet

TITLE: Reliability Allocation, Predictions and Analysis Report   **DRD NO.: TVC1-RM-RPAR**
DATA TYPE: 2   **PAGE**: 2/3

16.   **DATA PREPARATION INFORMATION (CONTINUED):**

16.3   **CONTENTS**: Reliability Allocations (Top-down): The mission reliability requirement will be allocated down to the upper stage level by use of Probabilistic Risk Assessment (PRA) for the vehicle. Reliability allocations for the sub-systems and components within the actuator assembly will be derived from the mission reliability allocation for the entire actuator assembly. These allocations will represent the "design to" quantitative reliability target to meet or exceed. The allocation values for components, when combined in an overall Reliability Model for the actuator assembly, will agree with the system allocation for the thrust vector system. The allocations must be expressed in terms of the appropriate reliability parameters that will integrate with the overall reliability model for the CLV upper stage. Allocations will be used to establish the appropriate reliability parameters for systems, elements, subsystems, LRUs and components. Examples of parameters include Mean Time Between Failure (MTBF) and the corresponding failure rates associated with each hardware item. The Reliability discipline will assure the correct implementation and iteration of reliability parameters.

The Reliability Prediction and Analysis ("Bottoms-up") shall use failure rates (or corresponding MTBFs) to compute system reliability. In the appropriate cases, the failure distribution of components may be other than exponential, and the analysts have the latitude to use other reliability functions such as Weibull, Normal, or log-normal as appropriate. The Reliability Prediction report shall describe the system analyzed and consist of: a Reliability block diagram (RBD) and other graphical representations of reliability model as needed, results of the analysis and a roadmap to design-in-reliability right from the conceptual design stage. Computations may be performed by failure simulation tools such as RAPTOR, or can be performed by direct analytical calculation. (Formulas)

To better understand the background for the analysis on the Constellation Program and how to perform the analysis so that it integrates in with the Program plan, the contractor should review the Constellation Reliability, Availability, and Maintainability Process and Methodology Document, CxP 70087.

Required Design Engineering Documentation for Support of Reliability Analyses.

TVC Components List and Functional Narrative

The contractor shall create and maintain a listing of all required components for the actuator assembly with a description of the component function.

TVC Functional Flow Block Diagram

The contractor shall create and maintain a functional flow block diagram. This diagram shall depict the functional inputs and outputs for the components that compose the actuator assembly. The components with inputs and outputs shall be linked together in a continuous system level flow so that the functional flow can be traced end-to-end for the actuator assembly. This functional flow diagram will be performed in accordance with the requirements of NASA's Constellation Program and will be used as a basis for development of reliability models.

Digraph Analysis

The contractor shall use the results of the FMEA to construct digraph models of failures and propagation of

16.   **DATA PREPARATION INFORMATION (CONTINUED):**

their effects through the actuator assembly to end states. The diagraph models will be used to verify that the actuator assembly does possess its required failure tolerance or does not meet failure tolerance requirements for particular failure modes. This will also serve as a verification of the failure modes and effects analysis. In addition, estimated probability of failure for initiating failure modes in the diagraph model will be used to calculate the probability of failure for the actuator assembly and provide a comparison to the reliability analysis models. The contractor should coordinate with the NASA logic modeling group to construct digraph models of the actuator assembly.

Failure modes and failure rate information may have to be based on physics of failure for various mechanisms or probabilistic design analysis (as applicable) to develop reliability data. Analysis must comprehensively cover system/subsystem mission profiles and environments. The required (planned) operating time must be considered in calculations. Early in the design process, initial failure rate estimates may be based on extrapolation of failures rates from similar existing systems. The result from this analysis must support the assessment of mission risks and future upgrades to minimize the risk.

Details on Report Content:

a. Description of the process used in the reliability quantification including reliability allocation from system to subsystem level.
b. Ground-rules and assumptions used in performing reliability predictions.
c. Reliability models, including reliability logic diagrams.
d. Data used in the Reliability predictions/analyses including data sources, derating factors and the environmental factors.
e. Validation of models/data (NOTE: Reliability models can be validated by using data from existing proven systems to repeatedly produce known outcome and then use this model to analyze data for the new system).
f. Identify the candidates for Probabilistic Design Analysis (PDA) and structural reliability. Provide the analysis and recommendation.
g. Provide details of: reliability growth process, planned Reliability Demonstration
h. Testing to ascertain physics of failure for better understanding of design uncertainties, design margins, safety factors, and design qualification testing etc.
i. Provide roadmap for evolution of design maturity to minimize risk, program schedule and cost. Include gap analysis if appropriate.
j. Provide reliability assessment results for each mission phase including Mean Time to Failure (MTTF), Mean Time between Failure (MTBF) and Mean Time between Maintenance Events (MTBME) information, as applicable, for each LRU/subsystem/ system.
k. Provide other details such as MTTF (Mean-time-to-Failure), MTBF (Mean-time-between Failures) and MTBME (Mean-time-between Maintenance Events) for each LRU/subsystem and system using failure rate information of each component as applicable. Failure rate information may be obtained from supplier data, reliability data bases, reliability demonstration or life testing, or in some cases as applicable, reliability assessment using engineering and physics based models.

16.4   **FORMAT**: Contractor format is acceptable.

16.5   **MAINTENANCE**: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.:** **TVC1-SA-FTA**
4. **DATA TYPE:** 2
5. **DATE REVISED:**
6. **PAGE:** 1/2
7. **TITLE:** Fault Tree Analysis (FTA)
8. **DESCRIPTION/USE:** The fault tree is a symbolic logic diagram showing the cause-effect relationship between a top undesired event (failure) and one or more contributing causes. It is a type of logic tree that is developed by deductive logic from a top undesired event to all related sub-events.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter

12. **INITIAL SUBMISSION:** 10 days prior to Preliminary Design Review (PDR).

13. **SUBMISSION FREQUENCY:** Update 10 days prior to Critical Design Review (CDR).

14. **REMARKS:** The Fault Tree Analyses shall be updated as the program progresses, providing continuity and covering the interrelated areas of design, operations, and system integration and processing throughout the program life-cycle. Submissions shall support safety risk assessments including Hazard Analysis and program risk assessments focused on specific issues.

15. **INTERRELATIONSHIP:** DRD's TVC1-RM-FMEA, *Failure Modes and Effects Analysis and Critical Items List*; TVC1-SA-HA, *System Safety Hazard Analysis*; TVC1-SA-SSP, *System Safety Plan*; and TVC1-RM-PAP, *Product Assurance Plan*, SOW Paragraph 2.2.2

16. **DATA PREPARATION INFORMATION:**

16.1 **SCOPE:** The Fault Tree Analysis shall identify single and/or combinations of failures that can result in mishaps. The assessment shall address internal (program) events and external events including those originating in hardware and operational interfaces and environments. The effort shall be developed in parallel and in support of the design, development, and operational phases of the program. The scope of the FTAs will be defined by program requirements and agency guidelines. While individual Fault Tree Analyses may be developed to support special case assessments; individual FTAs shall be structured to support the related integrated program FTA assessment.

16.2 **APPLICABLE DOCUMENTS:**

NPD 8700.1 B(R04)	*NASA Policy for Safety and Mission Success*
NPR 8715.3	*NASA Safety Manual*
NPR 8705.2 A	*NASA Human Rating Requirements and Guidelines for Space Flight Systems*
CxP 70055	*Constellation Program Safety, Reliability and Quality Assurance Plan*
CxP 70038	*Hazard Analyses Methodology*

TITLE: Fault Tree Analysis (FTA)　　　　　　　　　　　**DRD NO.**: **TVC1-SA-FTA**

DATA TYPE: 2　　　　　　　　　　　　　　　　　　　　**PAGE**: 2/2

16.　DATA PREPARATION INFORMATION (CONTINUED):

16.3　**CONTENTS**: The Fault Tree Analysis shall identify the top-level undesired event or hazardous condition, and lower level relationships to the degree necessary to provide the level of detail to identify potential failure modes and event causes. The FTA shall include Loss of Crew (LOC) and/or loss of vehicle as the highest undesirable event (failure) and should flow down to sufficient level of details using fault tree standard tools/symbols/logic to identify potential failure modes and hazard causes. It shall identify single and/or combinations of failures that can result in mishaps. The assessment shall address internal (program) events and external events including those originating in hardware and operational interfaces and environments. The Fault Tree Analysis shall support and be compatible with the Hazard Analysis and associated risk analyses tools including the Failure Modes and Effects Analysis (FMEA) and the Probabilistic Risk Assessment Analysis (PRA). It shall support both internal and external risk management processes including any required formal safety review processes. In addition the Fault Tree Analysis shall provide the following information:

  a. Definition of the top undesired event.
  b. Ground rules and assumptions.
  c. Scope of analysis.
  d. Fault tree symbols legend.
  e. Fault tree logic symbols legend.
  f. Diagram representation of the system being analyzed with associated logic and event/functions (tree diagram).
  g. Summary of analysis results.

16.4　**FORMAT**: Contractor format is acceptable after concurrence/approval by NASA. The analysis shall be provided in both hard copy and in a electronic format compatible with standard data processing tools.

16.5　**MAINTENANCE**: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.:** **TVC1-SA-HA**
4. **DATA TYPE:** 1
5. **DATE REVISED:**
6. **PAGE:** 1/2
7. **TITLE:** System Safety Hazard Analysis

8. **DESCRIPTION/USE:** The intent of the hazard analysis is to document the identifying, controlling, and verification activities associated with potential safety hazards and to support the risk management process which eliminates the identified hazard or reduces the risk of its occurrence to an acceptable level based on agency and program requirements. The analysis provides status of the resolution the potential safety risks and the supporting risk acceptance rationale for any hazards that are not eliminated. The analysis will support program and/or independent safety review panels and their evaluation of program compliance with the associated safety requirements. The Hazard Analysis shall be performed in accordance with the requirements of the Constellation Program. System Hazards originating from hardware, software, and human error shall be considered in combination with enabling events and conditions and shall be described in terms of fault tree analysis, The Fault Tree Analysis shall utilize the functional flow block diagrams.

9. **OPR:**

10. **DM:**

11. **DISTRIBUTION:** Per Contracting Officer's letter

12. **INITIAL SUBMISSION:** 10 days prior to Preliminary Design Review (PDR)

13. **SUBMISSION FREQUENCY:** Update as new hazards are identified, and 10 days prior to Critical Design Review (CDR)

14. **REMARKS:** The hazard analyses shall be updated as the program progresses, providing continuity and covering the interrelated areas of design, operations, and integration.

15. **INTERRELATIONSHIP:** DRD's TVC1-SA-FTA, *Fault Tree Analysis;* TVC1-RM-FMEA, *Failure Modes Effects Analysis and Critical Items List*; TVC1-RM-PAP, *Product Assurance Plan*; TVC1-SA-SSP, *System Safety Plan*;; TVC1-QE-QP, *Quality Plan*, SOW Paragraph 2.2.2

16. **DATA PREPARATION INFORMATION:**

    16.1 **SCOPE:** System Safety Hazard Analyses identify hazards, determine the methods used for controlling the hazards, support the program risk management process, and establish verification methods and assure closure for the identified hazard. The System Safety Hazard Analysis will provide a total assessment of the subject systems (hardware and software) and their operational environment. The analyses shall cover the complete program life cycle from concept definition until program completion and hardware disposal.

    16.2 **APPLICABLE DOCUMENTS:**

    NPD 8700.1B(R04) *NASA Policy for Safety and Mission Success*
    NPR 8715.3   *NASA Safety Manual*
    NPR 8705.2 A   *NASA Human Rating Requirements and Guidelines for Space Flight Systems*
    CxP   70055   *Constellation Program Safety, Reliability and Quality Assurance Plan*
    CxP   70038   *Hazard Analyses Methodology*
    NASA TM 104823 *NASA Technical Guide for Oxygen Hazard Analyses on Components and Systems*

16. **DATA PREPARATION INFORMATION (CONTINUED)**:

16.3   **CONTENTS**: The analyses shall identify hazards, determine the methods used for controlling the hazards, support the program risk management process, and establish verification methods applicable to design, development, manufacturing and assembly, testing, inspection, integration, and flight (of subject systems) including any interfacing ground support equipment (GSE), facilities, and ground operations in accordance with Applicable Documents in 15.2 and be an integrated effort. This analysis shall be a part of integrated system design effort for assessing all systems risks with processes such as Fault Tree Analysis, FMEA/CIL and quantitative reliability assessments, mitigating hazards and documenting the assessment with proper rationale to ensure safety of flight operations.

     a.   The reports shall be structured to be in compliance with the agency level guidelines and shall be consistent with any specific program requirements. Any special analyses efforts established by internal program agreements shall also be documented.

     b.   The analysis shall address the total system including hardware and related software.

     c.   The System Safety Hazard Analysis shall contain, as a minimum, the data required to support program milestone reviews and the associated safety panel reviews.

     1.   Fault Hazard Analysis:

         a.   The Contractor shall perform a software fault hazard analysis at the functional module level. The functional modules will be defined by the software engineering group. This analysis shall be performed by a construction of the software system design into a functional hierarchy down to the functional modules of code. The analysis shall consider the intended interface to the hardware and the data input conditions of : 1.) A hardware system fault , 2.) Input too early, 3.) Input too late, 4.) Missing input, 5.) Incorrect input, 6.) All inputs correct but with errors in the software module processing. The analysis shall determine the effects of outputs from the software functional modules: effect on interfacing hardware components (local effect), effect on the actuator subsystem (subsystem effect) and the effect on the CLV Upper Stage functionality (system effect). The analysis shall determine the worst case faults: those that have catastrophic or critical effects and recommend corrective actions and/or mitigations for these faults.

         b.   In particular, the fault hazard analysis shall consider the general control loop. This includes the system controller for the actuator assembly and its signals out to the effectors, the manipulated variables and inputs to the actuator assembly system components, and the TVC outputs (controlled variables) to the sensors and back to the overall controller. Particular attention shall be given to the System controller internal model which imposes safety constraints on the actuator assembly and assuring that this internal model is correct.

     2.   The contractor shall create and maintain a listing of all required components for the actuator assembly system with a description of the component function.

     3.   The contractor shall create and maintain a functional flow block diagram. This diagram shall depict the functional inputs and outputs for the components that compose the actuator assembly. The components with inputs and outputs shall be linked together in a continuous system level flow so that the functional flow can be traced end-to-end for the thrust vector control system.

16.4   **FORMAT**: The plan shall be provided in both hard copy and in an electronic format as specified by the program.

16.5   **MAINTENANCE**: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. ~~**ISSUE:**~~ **ISSUE:** Standard
3. **DRD NO.: TVC1-SA-MSR**
4. **DATA TYPE:** 3
5. **DATE REVISED:**
6. **PAGE:** 1/2
7. **TITLE:** Mishap and Safety Statistics Reports
8. **DESCRIPTION/USE:** To provide reporting of metrics, mishaps, close calls, and serious non-occupational injuries or illnesses.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:**
    a. Safety Statistics (e.g., contract number, subcontractors, SIC/NAIC codes, number of employees, number of supervisors, hours worked, etc.): submitted on MSFC Form 4371 by the 10th of each month following contract award.
    b. Mishaps, Close Calls, and serious non-occupational injuries or illnesses
        1. <u>Type A or B mishaps, high visibility mishaps or close calls, and onsite Type C lost time injury</u> or illness: Immediate telephone notification to the Contracting Officer, and Industrial Safety (256-544-0046 or 4-HELP, Safety Option) so that Center Director notifies the NASA Administrator within 24 hours of occurrence or awareness. Include location and time of incident, number of fatalities, number hospitalized, type of damage, estimated cost, brief description, and contact person and phone number.
        2. <u>Non-occupational fatality or serious injury occurring onsite or to an onsite contractor employee:</u> Notification to Contracting Officer and S&MA so that Center Director notifies the NASA Administrator within 24 hour of occurrence or awareness. (Offsite non-occupational injury or illness notification is at the discretion of the family.)
    a. All Onsite NASA mishaps and close calls: (**applicable to onsite contractors only**): NASA Initial Safety Incident Report within 4 hours of occurrence or awareness on MSFC Form 4370 or equivalent either by telephone 256-544-4357 (4-HELP); Safety Option or electronically by Quick Incident. Report at https://msfcsma3.msfc.nasa.gov/s&ma_01/mishap/index.htm.
    b. Offsite Mishaps and Close Calls Type C and below: Initial notification by next MSFC 4371.
        1. All Mishaps (Type A, B, C, Incidents and Close Calls): Mishap Report NASA Form 1627 or electronic update of NASA Incident Reporting Information System (IRIS) record within 6 calendar days of Mishap.
        2. Type A, B, and Close Calls with high Type A or B potential: Mishap Board Report after completion of investigation.
        3. All Mishaps: Monthly Follow-up Corrective Action Plan/Status as required until closed.

13. **SUBMISSION FREQUENCY:**
    a. MSFC Form 4370 or electronic equivalent -Each occurrence of a mishap except as identified in section 11.b.
    b. NASA Form 1627 or electronic equivalent -Each occurrence of a mishap. Corrective action status reports are due every 30 days until the final report is submitted.
    c. MSFC Form 4371 -By the 10th of each month.
    d. Mishap Board Report – Each occurrence of a Type A or B mishap, or as directed by Center management.

14. **REMARKS:**
15. **INTERRELATIONSHIP:** DRD TVC1-SA-SHP, *Safety, Health, and Environmental (SHE) Plan*, SOW Paragraph 2.3.2

16.   **DATA PREPARATION INFORMATION**:

16.1   <u>SCOPE</u>: The Mishap and Safety Statistics Reports document all mishaps and close calls as required in NPR 8621.1.

16.2   **APPLICABLE DOCUMENTS**: NPR 8621.1 A *NASA Procedural Requirements for Mishap Reporting, Investigating, and Recordkeeping* MWI 8621.1 *Close Call and Mishap Reporting and Investigation Program*

16.3   <u>CONTENTS</u>: The Mishap and Safety Statistics Reports shall contain the information required by NPR 8621.1 and MWI 8621.1. The contractor shall use the forms listed in 15.4 to report mishaps and related information required to produce the safety metrics.

16.4   **FORMAT**: The following formats or electronic equivalent shall be submitted:

   a.   MSFC Form 4370, "MSFC Flash Mishap Report."
   b.   NASA Form 1627, "NASA Mishap Report."
   c.   MSFC Form 4371, "MSFC Contractor Accident and Safety Statistics."
   d.   Mishap Board Report using the format provided in NPR 8621.1.

16.5   **MAINTENANCE**: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.: TVC1-SA-SHEWA**
4. **DATA TYPE:** 2
5. **DATE REVISED:**
6. **PAGE:** 1/2
7. **TITLE:** Safety, Health, and Environmental (SHE) Work Agreement
8. **DESCRIPTION/USE:** To provide the Government a signed work agreement confirming the contractor's commitment to comply with OSHA and DOT regulations and to use MSFC MPR 8715.1 as the contractor's safety program.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** 10 days after Authority to Proceed (ATP)
13. **SUBMISSION FREQUENCY:** Update as required
14. **REMARKS:**
15. **INTERRELATIONSHIP:** SOW Paragraph 2.3.1
16. **DATA PREPARATION INFORMATION:**

16.1   **SCOPE:** The Safety, Health, and Environmental (SHE) Work Agreement describes the contractor's method of implementing occupational safety, health, and environmental standards over the duration of the contract.

16.2   **APPLICABLE DOCUMENTS:** MPR 8715.1 *Marshall Safety, Health and Environmental (SHE) Program* MWI 8621.1 *Close Call and Mishap Reporting and Investigation Program*

16.3   **CONTENTS:** The Safety, Health and Environmental (SHE) Work Agreement shall document the contractor's commitment to comply with the requirements of MPR 8715.1 and MWI 8621.1. The Work Agreement shall include:

     a.   Company Name.
     b.   NASA Organization contractor is supporting.
     c.   Responsible Person's Name and Title.

A sample Work Agreement meeting all the requirements of this DRD is provided in **Attachment A**. Submission of a completed and signed version of the sample satisfies this requirement.

16.4   **FORMAT:** Contractor format is acceptable.

16.5   **MAINTENANCE:** Changes shall be incorporated by change page or complete reissue.

Attachment A - Contractor work agreement

Company Name

Safety, Health, and Environmental (SHE) Plan For Contract No. _____

In support of

NASA Organization

Marshall Space Flight Center Huntsville, AL

While performing the work associated with this contract, Company Name is committed to and will comply with the requirements of MPR 8715.1, "Marshall Safety, Health, and Environmental (SHE) Program". We will support and participate in the SHE Program as a regular member of the NASA Organization Name. Our employees will attend their monthly safety meetings and participate in their supervisor safety visits as requested (On-site only, Off-site contractors participate in company safety meetings and visits).

New employees SHE training shall include as a minimum SHE 101, or equivalent, and the NASA Safety Culture Training course. Each employee shall be provided a NASA SHE Pocket Guide and be encouraged to participate in SHE employee committees and teams.

Safety statistics, including hours worked, shall be submitted to the Industrial Safety Department/QD50 by the 10th of each month using MSFC Form 4371. Mishaps and close calls shall be reported within 4 hours using the SHE Report system on the MSFC SHE Web Page with follow-up reports as required per MWI 8621.1, "Close Call and Mishap Reporting and Investigation Program."

Contracts including potentially hazardous operations shall comply with the additional requirements:

1. Attach a list of all potentially hazardous operations to be performed onsite.
2. The potentially hazardous operations shall be assessed to identify the hazards and mitigation techniques in accordance with MWI 8715.15, "Ground Operations Safety Assessment & Risk Mitigation Program" or by using an equivalent assessment method.
3. All hazardous operation procedures shall have NASA Industrial Safety Department concurrence.
4. Employees shall provide proof of training, if required by OSHA, for work performed under the contracted effort and be certified in accordance with MWI 3410.1, "Personnel Certification Program" if required to operate NASA lifting equipment or performing potentially hazardous operations as determined by the NASA Industrial Safety Department.
5. Chemicals brought onsite and Hazardous Waste generated shall comply with the requirements of MPD 8500.1, MSFC Environmental Management Policy and MPR 8500.1, MSFC Environmental Management Program.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.: TVC1-SA-SHP**
4. **DATA TYPE:** 2
5. **DATE REVISED:**
6. **PAGE:** 1/4
7. **TITLE:** Safety, Health, and Environmental (SHE) Plan
8. **DESCRIPTION/USE:** To provide the contractor and the Government a baseline document for planning, management, control, and implementation of the contractor's industrial/occupational safety, health, and environmental program in accordance with NFS 1852.223-73.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** Due with Proposal
13. **SUBMISSION FREQUENCY:** Update as required
14. **REMARKS:**
15. **INTERRELATIONSHIP:** NFS 1852.223-70, *Safety and Health*; NFS 1852.223-72, *Safety and Health (Short Form)*; NFS 1852.223-73, *Safety and Health Plan*; FAR 52.223-3, *Hazardous Material Identification and Material Safety Data*; FAR 52.223-4, *Recovered Material Certification*; FAR 52.223-5, *Pollution Prevention and Right-to-Know Information*; FAR 52.223-7, *Notice of Radioactive Materials*; FAR 52.223-9, *Estimate of Percentage of Recovered Material Content for EPA-Designated Products*; FAR 52.223-10, *Waste Reduction Program*; FAR 52.223-11, *Ozone Depleting Substances*; FAR 52.223-12, *Refrigeration Equipment and Air Conditioners*; FAR 52.223-13, *Certification of Toxic Chemical Release Reporting*; and FAR 52.223-14, *Toxic Chemical Release Reporting*. DRD TVC1-SA-MSR, *Mishap and Safety Statistics Report*, SOW Paragraph 2.3.1

16. **DATA PREPARATION INFORMATION:**

16.1 **SCOPE:** The Safety, Health, and Environmental Plan describes the contractor's method of implementing occupational safety, health, and environmental standards over the duration of the contract.

16.2 **APPLICABLE DOCUMENTS:** Compliance with the following Occupational Safety and Health Standards and applicable requirements shall be specified in the plan (if applicable to the scope of this contract). 29 CFR 1910 *Department of Labor; Occupational Safety and Health Administration Standards for General Industry* 29 CFR 1926 *Department of Labor; Occupational Safety and Health Administration Standards for Construction Industry*

40 CFR *Protection of the Environment*
ANSI Standards applicable to the scope of this contract
ASME Boiler and Pressure Vessel Code applicable to the scope of this contract
NFPA Standards *National Fire Codes*
NASA-STD-8719.11 (R06) *Safety Standard for Fire Protection*
NPR 8715.3 *NASA Safety Manual*
MPD 8500.1 *MSFC Environmental Management Policy*
MPR 8500.1 *MSFC Environmental Management Program*
MPR 8500.2 *MSFC Environmental Management System Manual*

MWI 8540.2 Affirmative Procurement Program for Environmentally Preferable Products MWI 8550.1 Waste Management MWI 8550.2 Storm Water Management MWI 8550.3 Wastewater Compliance MWI 8550.4 Air Emissions Compliance MWI 8550.5 Chemical Management MPR 1040.3 MSFC Emergency Plan MPD 1800.1 MSFC Smoking Policy MPR 1800.1 Bloodborne Pathogens MPR 1810.1 MSFC Occupational Medicine MPD 1840.1 MSFC Environmental Health Program MPR 1840.1 MSFC Confined Space Entries MPD 1840.2 MSFC Hearing Conservation Program MPR 1840.2 MSFC Hazard Communication Program MPD 1840.3 MSFC Respiratory Protection Program MPR 1840.3 MSFC Hazardous Chemicals in Laboratories Protection Program

16.   DATA PREPARATION INFORMATION (CONTINUED):

MPD 1860.1 Laser Safety MPD 1860.2 MSFC Radiation Safety Program MPR 3410.1 Training MWI 3410.1 Personnel Certification Program MPR 8715.1 Marshall Safety, Health and Environmental (SHE) Program MWI 8715.1 Electrical Safety MWI 8715.2 Lockout/Tagout Program MWI 8715.3 Hazard Identification & Warning System MWI 8715.4 Personal Protective Equipment (PPE) MWI 8715.5 Building Manager Program MWI 8715.9 Occupational Safety Guidelines for Contractors MWI 8715.10 Explosives, Propellants, & Pyrotechnics Program MWI 8715.11 Fire Safety Program MWI 8715.12 Safety, Health, and Environmental Finding Tracking System (SHEtrak) MWI 8715.13 Safety Concerns Reporting System (SCRS) MWI 8715.15 Ground Operations Safety Assessment & Risk Mitigation Program MPD 8900.1 Medical Operations Responsibilities for Human Space Flight Programs (NOTE: This document only applies to Space Station contracts)

16.3   **CONTENTS**: The Safety, Health, and Environmental Plan shall describe the manner in which the contractor implements the requirements of the applicable documents as they pertain to the specific statement of work tasks to be performed and updated when necessary. The Safety, Health and Environmental Plan shall clearly state if the contracted effort contain potentially hazardous or nonhazardous operations and fully address the following applicable topics:

    a. Management leadership and employee involvement:

        1. Statement of management policy and commitment to provide a safe and healthful workplace for personnel (i.e., employees, customers, and public), to protect the property and the environment, and to ensure compliance with EPA, OSHA and NASA requirements.

        2. Description of procedures for insuring management and employees are held accountable for implementing their task in a safe and healthful manner through motivational techniques, disciplinary program, or other innovative techniques.

        3. Descriptions of safety, health, environmental awareness and motivation programs that, include documented safety meetings and safety awareness training for employees. (Onsite Safety meeting statistics shall be documented in the Supervisors Safety Web page: http://msfcsma3.msfc.nasa.gov/dbwebs/apps/sswp/SSWP_login.taf)

        4. Method of program evaluation that, identify the methods and frequency for internal evaluation of the safety, health, and environmental program.

        5. Method to ensure the flow down of safety, health, and environmental responsibilities between all company levels and subcontractors, when applicable.

        6. Identification by title the individual who will be responsible for the implementation of the SHE program elements.

        7. Method to ensure compliance with MPR 8715.1 [Applicable ONLY to onsite contracts]

    b. System and worksite analysis:

        1. Methods of hazard identification, e.g., hazard analysis, safety assessment, change analysis, risk assessment and employee identified concerns.

        2. Descriptions of OSHA programs that require documented programs (e.g., Respiratory Protection, Hazard Communication, Confined Space, and Lockout/Tagout, etc. Include the interrelationships with the MSFC programs.) (Note: Only programs applicable to the contracted effort need to be addressed.) [Applicable ONLY to contracts containing potentially hazardous operations]

        3. Requirements for formal worksite safety inspections as required by OSHA, to including schedule and documentation requirements. Onsite OSHA inspections are performed by NASA. [Applicable ONLY to offsite contracts]

        4. Requirements for documented supervisors' safety visits. Onsite safety visits shall be performed once per month per supervisor and documented in the Supervisors Safety Web page. [Applicable

16. **DATA PREPARATION INFORMATION (CONTINUED):**

ONLY to onsite contracts]

   c. Hazard prevention and control:

1. Methods to identify potentially hazardous operations and generate plans, procedures, and other working documents which clearly identify the hazardous situations in these operations and the necessary cautions taken to mitigate the hazard which includes an annual review of the plans and procedures. NOTE: MSFC Safety Department concurrence for onsite hazardous procedures. Provide a list of identified potentially hazardous operations in the SHE plan that are applicable to the contracted effort. [Applicable ONLY to contracts containing potentially hazardous operations]

2. Method of ensuring controls over the procurement, storage, issuance, and use of hazardous chemical and materials are in accordance with MPR 8500.1 including the procedures for recycling and disposal of hazardous waste in accordance with MWI 8550.1. [Applicable ONLY to contracts containing potentially hazardous operations or use chemicals or generate hazardous waste]

3. Method of ensuring a documented emergency management program. Include a list of emergency points of contract located onsite. (Note: Onsite contractors may use MPR 1040.3.) [Applicable ONLY to onsite contracts]

4. Method of investigating all mishaps and close calls to determine root cause, including an outline of reporting requirements. (Reference DRD STD/SA-MSR, *Mishap and Safety Statistics Report*).

5. Method for providing safety, health, and environmental services applicable to the contracted effort such as hazardous waste disposal, industrial hygiene monitoring, emergency medical support, hearing conservation program, and hazard communication. (These services can be provided by NASA for onsite work.) [Applicable ONLY to onsite contracts]

6. Method for employees to suspend work where safety or environmental conditions warrant such action.

   d. Safety and health training:

1. Method for training each employee to recognize hazards, avoid accidents, know the hazards specific to their job, and understand the disciplinary program.

2. Methods for assessing employee training needs specific to their job. (Onsite employee assessments shall be performed using the SHE Training Assessment located on the MSFC Supervisor Safety Web Page.) [Documentation in the Supervisor Safety Web Page is applicable ONLY to onsite contracts.]

3. Method for training and documenting this training when designating employees to be competent, qualified, authorized or certified to perform operations that require specific training in accordance with 29 CFR 1910 or 29 CFR 1926. [Applicable ONLY to contracts containing operations that require OSHA training applicable to the contracted effort.]

4. Identify the job categories under the contracted effort that require NASA safety certification in accordance with MWI 3410.1, "Personnel Certification Program". Example job categories that require NASA safety certification include, but not limited to, operating NASA lifting equipment (forklifts, cranes, etc.), working with chemicals, hazardous waste, pressure systems, etc. Personnel Certification for onsite job categories identified in MWI 3410.1 shall be tracked in the MSFC Certification Database (CERTRAK). (NOTE: offsite contracts shall list the job categories under the contracted effort that require OSHA documented training and certification.) [Applicable ONLY to contracts containing potentially hazardous operations]

   e. Environmental compliance – Methods to ensure compliance with environmental laws and regulations 40 CFR, Alabama Department of Environmental Management (ADEM, and MPR 8500.1 by:

1. Reporting hazardous and toxic substance use.

2. Implementing and reporting green procurements in accordance with MWI 8540.2.

DRD Continuation Sheet

16.   **DATA PREPARATION INFORMATION (CONTINUED):**

       3.   Reducing, reusing, and recycling of hazardous and toxic substances prior to disposal in accordance with MWI 8550.1.
       4.   Minimizing stormwater pollution in accordance with MWI 8550.2.
       5.   Ensuring equipment and processes permitted by applicable laws.
       6.   Disposing of solid and liquid materials as permitted by applicable laws.
       [Applicable ONLY to contracts containing potentially hazardous operations or use chemicals or generate hazardous waste]

16.4   **FORMAT:** Contractor format is acceptable.

16.5   **MAINTENANCE:** Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.: TVC1-SA-SSP**
4. **DATA TYPE:** 1
5. **DATE REVISED:**
6. **PAGE:** 1/3
7. **TITLE:** System Safety Plan (SSP)
8. **DESCRIPTION/USE:** The System Safety Plan (SSP) defines the objectives, responsibilities, and methods to be used for overall system safety program conduct and control. It describe the integration of system safety provisions into the total program based on early implementation, planned safety certification review/process, and total program life cycle support.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** Due with Proposal.
13. **SUBMISSION FREQUENCY:** Update as required.
14. **REMARKS:** This plan may be incorporated in more comprehensive safety and mission assurance plans or other general program plans provided the system safety data elements remain identifiable and completely reflect the requirements of this DRD.
15. **INTERRELATIONSHIP:** DRD's TVC1-SA-FTA, *Fault Tree Analysis*; TVC1-RM-FMEA, *Failure Modes and Effects Analysis and Critical Items List*; TVC1-SA-HA, *System Safety Hazard Analysis*; TVC1-QE-QP, *Quality Plan*, SOW Paragraph 2.2.1
16. **DATA PREPARATION INFORMATION:**

    16.1 **SCOPE:** The plan will be consistent with the status of the program's technical development providing a description of the system safety program necessary to support the total program life cycle. The plan will include detailed task requirements for the system safety task as tailored for this program. It will address requirements for safety organization participation in design, safety, and readiness reviews.

    16.2 **APPLICABLE DOCUMENTS:** See Tailoring Instructions for selection of applicable documents

        a. <u>All programs:</u>
            NPD 8700.1 B(R04) *NASA Policy for Safety and Mission Success*
            NPR 8715.3 *NASA Safety Manual*

        b. <u>ELV and ELV Payloads:</u>
            EWR 127-1 *Eastern and Western Range Safety Requirements*

        c. <u>Special Programs:</u> FAA Requirements *AC 431.35-2, Reusable Launch and Re-entry Vehicle System Safety Process* DoD Requirements, *MIL-STD-882 D Standard Practice for System Safety*

    16.3. **CONTENTS:** The System Safety Plan shall meet the requirements of the applicable documents in

    1. The level of detail in the plan directly correlates with the nature and complexity of the system safety effort required to meet program requirements and objectives. It shall provide a general description of the appropriate safety tasks that shall become the foundation for safety efforts during the system definition, design, manufacture, test, and operations. The SSP program shall be the vehicle for safety task planning. The elements of the SSP shall identify the interfaces with other program activities including design, development, test, operation, continuous risk management and program control (waivers, deviations, corrective actions). While individual program characteristics may vary the emphasis for a particular effort, the plan shall focus on the basic elements:
       a. Planning.

16.   **DATA PREPARATION INFORMATION (CONTINUED):**

1. Identify special safety studies that may be required during system definition or design.
2. Personnel requirements both in terms of skills and level of effort required for the safety program during the complete system life cycle.
3. Establish safety goals and objectives to determine the type of safety input for the overall program. The goals and objectives should be identified in the initial submittal and evaluated at the major milestone reviews.
   (a) Goals should be measurable and state what would be accomplished by performing the various safety tasks.
   (b) Goals should be structured so that safety tasks can be selected to accomplish them.
   (c) Task results should clearly demonstrate that the goals have been met.

b. Organization. The program organization and system safety relationships and responsibilities shall be described along with reporting channels for this task. The description will include any provisions for independent reporting of issues in addition to the program processes.

c. Contracting. The identification of the relationships to other program elements, subcontractor, and supplier system safety efforts will be done.

d. Interface/Coordination. Relationships to other program planning documentation shall be identified to assure proper coordination of activities.

e. Requirements. Applicable requirements and their sources (programmatic, agency or other) shall be listed.

f. Analysis. The plan shall stipulate hazard analysis methodologies and their intended application. The related DRDs for Hazard Reports (HRs) shall be identified along with the approval process for the reports. (Specific format, data and delivery milestones may be deferred to the System Safety Hazard Analysis DRD.) System Safety analysis strategies shall define that support:
   1. Concept trade studies (Initial hazard identification and recommended design alternatives).
   2. Utilization of HR results in the design development and the process to assure the analysis maintains currency with the evolving system and program requirements.
   3. Inputs to test and system verification activities.
   4. Definition of operational system safety requirements.
      (a) Redundancy.
      (b) Probabilistic Risk Level for loss of vehicle and/or loss of crew.
      (c) Technical and engineering.
   5. Evaluation of end of life and/or disposal safety issues.
      (a) Orbital Debris Generation Issues.
      (b) Flight Termination System Implementation.
      (c) Environmental hazards.

g. Safety review and certification process. The plan shall address safety review and   certification processes that apply to the program.

h. Risk assessment. The description of the role of system safety in the program risk management process shall address:
   1. The review of pertinent historical safety data from similar systems.
   2. The utilization of Hazard Analysis and related safety assessments. This shall include the process for recommending corrective action or alternatives to the appropriate management level for a decision to either eliminate the hazard or accept the risk.
   3. The program definition for acceptable or residual risk. If the risk management process allows for risk acceptance at varied levels, the plan shall address the role of system safety at each level and in the notification of risk acceptance to the program manager.

i. Reporting. The implementation of the requirements for reporting System Safety activities and products shall be provided at program milestone review.

16.   **DATA PREPARATION INFORMATION (CONTINUED):**

> j.   Mishap investigation. The role of System Safety in the investigation, development of corrective actions and the application of lesson's learned. Provisions for supporting related NASA activities in the investigation process.
>
> k.   Data retention. Planning for the maintenance of the system safety documentation shall be identified. Data documentation shall include safety risk acceptance rationale and the associated supporting information.

16.4   **FORMAT**: Contractor format is acceptable unless another format is specified in the general contract provisions. The plan shall be provided in both hard copy and in an electronic format as specified by the program.

16.5   **MAINTENANCE:** Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.: TVC1-SE-MPR**
4. **DATA TYPE:** 3
5. **DATE REVISED:**
6. **PAGE:** 1/2
7. **TITLE:** Mass Properties Report
8. **DESCRIPTION/USE:** To report on the status of the contractor's predicted mass properties, which includes allocated and non-allocated growth. The report also provides the mass properties required for other technical analyses and/or trade studies.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** 90 days after Authority to Proceed
13. **SUBMISSION FREQUENCY:** Update monthly
14. **REMARKS:** Reference is made to AIAA/ANSI R-020A-199, *Recommended Practice for Mass Properties Control for Satellites, Missiles and Launch Vehicles.*
15. **INTERRELATIONSHIP:** SOW paragraph 3.5.1
16. **DATA PREPARATION INFORMATION:**

16.1 <u>SCOPE</u>: Periodic Mass Properties Reports provide insight to the status of the mass properties of the program throughout all of its phases. The basis (Estimated, Calculated, or Measured) of each component mass shall be included as part of the recorded component data. Totals of each of these categories shall be recorded to provide an indication of the mass properties confidence.

16.2 <u>APPLICABLE DOCUMENTS</u>: None

16.3 <u>CONTENTS</u>: For the purposes of mass properties, coordinate systems for all flight elements shall be separate but parallel to the system coordinate system with defined offsets. The Mass Properties Report shall include the following:
   a. Dry Mass Properties
      1. Mass summary (last, predicted, contract end item (CEI), maturity level in percent).
      2. Comprehensive reasons for changes since the previous status report.
      3. List of pending and potential changes.
      4. Weight history plot.
      5. Status of basic and predicted weight versus control weight.
      6. Mass properties coordinate system description.
      7. Detailed mass properties reflecting the predicted mass (sufficient detail in the report to reflect major items and subsystems). A copy of the complete electronic mass properties database must be provided to NASA upon request.
      8. Summary performance margins.
      9. References, if applicable.
      10. Critical mass properties status.
      11. Government Furnished Equipment (GFE).

TITLE: Mass Properties Report

DRD NO.: **TVC1-SE-MPR**

DATA TYPE: 3

PAGE: 2/2

16. DATA PREPARATION INFORMATION (CONTINUED):

16.4 **FORMAT**: The contractor and the government shall agree to a functional breakdown of the mass properties data. Microsoft Excel or compatible or other electronic transmission must be acceptable to NASA.

16.5 **MAINTENANCE**: None required

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.: TVC1-SE-OPS**
4. **DATA TYPE:** 2
5. **DATE REVISED:**
6. **PAGE:** 1/2
7. **TITLE:** Operations Plan
8. **DESCRIPTION/USE:** A technical document used to describe the recommended life cycle operations concepts for the Actuator Assembly.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** 10 days prior to Preliminary Design Review
13. **SUBMISSION FREQUENCY:** 10 days prior to Critical Design Review (CDR). Update as required.
14. **REMARKS:**
15. **INTERRELATIONSHIP:** SOW paragraph 3.7
16. **DATA PREPARATION INFORMATION:**

16.1   **SCOPE**: The Operations Plan includes definitions of operations for both the Engineering Model and the Flight hardware and software. It defines all of the ground operations for the Engineering Model Actuator Assembly as it is used in various facilities. The Plan shall also define operations for the Flight Actuator Assembly from delivery to the assembly site, through assembly, transportation, pre-launch processing, pre-launch check out, launch, and flight.

16.2   **APPLICABLE DOCUMENTS**: Ares I CLV Operational Concepts (OpsCon) Document (CxP 72032)

16.3   **CONTENTS**: The document shall consist of two volumes that cover the Contractor's plan and recommendation for Actuator Assembly operations.

I Ground Operations for Engineering Model Actuator Assembly
II Concept of Operations for Flight Actuator Assembly

The specific content of each volume shall include:

1. Volume I: Ground Operations for Engineering Model Actuator Assembly

    a.) The Contractor shall provide recommendations and guidance for the use and operation of the Actuator Assembly as it is installed and operated in various ground test facilities. Handling provisions, maintenance actions, operating limits, constraints and environments, shall be identified.

2. Volume II: Concept of Operations for the Flight Actuator Assembly

    a) The Contractor shall describe the complete concept of operations for the flight assembly. This includes scenarios from delivery to the assembly site, through assembly, transportation, pre-launch processing, pre-launch check out, launch, and flight.

    b) Fundamental assembly capabilities, constraints and limitations, including cycle and load limits

    c) Description of operational environments.

16.4   **FORMAT**: Contractor format is acceptable. Data shall be delivered by hard copy and electronic media.

16.5   **MAINTENANCE**: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.**: CA01C
2. **ISSUE**: Standard
3. **DRD NO.**: **TVC1-SE-SPEC**
4. **DATA TYPE**: 1
5. **DATE REVISED**:
6. **PAGE**: 1/1
7. **TITLE**: Specifications
8. **DESCRIPTION/USE**: A technical document used to describe the functional and physical characteristics of the actuator assembly and how these characteristics are met. The specification must describe all components and sub-assemblies contained within the actuator assembly.
9. **OPR**:
10. **DM**:
11. **DISTRIBUTION**: Per Contracting Officer's letter
12. **INITIAL SUBMISSION**: Performance Specification, 90 days prior to Engineering Model Final Design Review
13. **SUBMISSION FREQUENCY**: Design Specification, 10 days prior to Engineering Model Final Design Review, 10 days prior Preliminary Design Review (PDR) and 10 days prior to Critical Design Review (CDR). Update as required.
14. **REMARKS**:
15. **INTERRELATIONSHIP**: SOW paragraph 3.1
16. **DATA PREPARATION INFORMATION**:

16.6   **SCOPE**: Performance Specifications provide the requirements for the Actuator Assembly in terms of required results with criteria for verifying compliance. Design Specifications provide the design detail and verification requirements for the Actuator Assembly. A Design Specification is equivalent to a detail specification as defined in MIL-STD-961. The Contractor shall develop the Performance Specifications and Design Specifications in conjunction with GRC to meet all performance, interface, and other requirements of the actuator assembly.

16.7   **APPLICABLE DOCUMENTS** MIL-STD-961 E *Department of Defense Standard Practices for Defense Specifications, National Consensus Standard for Configuration Management, EIA-649 A*

16.8   **CONTENTS**: The specifications shall be prepared in accordance with MIL-STD-961.

16.9   **FORMAT**: The format shall be in accordance with the instructions in MIL-STD-961.

16.10   **MAINTENANCE**: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.**: CA01C
2. **ISSUE**: Standard
3. **DRD NO.**: **TVC1-SW-IDD**
4. **DATA TYPE**: 2
5. **DATE REVISED**:
6. **PAGE**: 1/1
7. **TITLE**: Interface Design Description
8. **DESCRIPTION/USE**: To define and record the interface design of one or more systems, subsystems, hardware configuration items (HWCI's), computer software configuration items (CSCI's), manual operations, or other system components.
9. **OPR**:
10. **DM**:
11. **DISTRIBUTION**: Per Contracting Officer's letter
12. **INITIAL SUBMISSION**: Preliminary version 10 days prior to Software Preliminary Design Review.
13. **SUBMISSION FREQUENCY**: Update as required.
14. **REMARKS**:
15. **INTERRELATIONSHIP**: SOW Paragraph 4.3.7
16. **DATA PREPARATION INFORMATION**:

16.1 **SCOPE**: The Interface Design Description describes the interface characteristics of one or more systems, subsystems, HWCI's, CSCI's, manual operations, or other system components. An interface design description may describe any number of interfaces.

16.2 **APPLICABLE DOCUMENTS**: None

16.3 **CONTENTS**: The Interface Design Description shall include:
   a. Priority assigned to the interface by the interfacing entity(ies).
   b. Type of interface (i.e., real-time data transfer, storage-and-retrieval of data) to be implemented.
   c. Specification of individual data elements, format, and data content including bit-level descriptions of data interface that the interfacing entity(ies) will provide, store, send, access, and receive.
   d. Specification of data element assemblies, format, and data content including bit-level descriptions of data interface that the interfacing entity(ies) will provide, store, send, access, receive.
   e. Specification of communication methods that the interfacing entity(ies) will use for the interface.
   f. Specification of protocols the interfacing entity(ies) will use for the interface.
   g. Other specifications, such as physical compatibility of the interfacing entity(ies).
   h. Traceability from each interfacing entity to the system or CSCI requirements addressed by the entity's interface design, and traceability from each system or CSCI requirement that affects an interface.
   i. Interface compatibility.

16.4 **FORMAT**: Contractor format is acceptable.

16.5 **MAINTENANCE**: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.: TVC1-SW-SCMP**
4. **DATA TYPE:** 1
5. **DATE REVISED:**
6. **PAGE:** 1/1
7. **TITLE:** Software Configuration Management Plan
8. **DESCRIPTION/USE:** To describe a plan for performing software configuration management (SCM). To develop and record plans for software configuration management activities.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** 60 days after Authority to Proceed (ATP)
13. **SUBMISSION FREQUENCY:** Update as required
14. **REMARKS:**
15. **INTERRELATIONSHIP:** SOW Paragraph 3.4
16. **DATA PREPARATION INFORMATION:**

16.1 **SCOPE:** The Software Configuration Management Plan describes the functions, responsibilities, and authority for the accomplishment and implementation of software configuration management to be performed during the software life cycle. This plan identifies the required coordination of software configuration management activities with other activities of the project. This plan also identifies the tools and the physical and human resources required for the execution of the plan.

16.2 **APPLICABLE DOCUMENTS:** None

16.3 **CONTENTS:** Using The Software Configuration Management Plan shall contain:
   a. The project organization(s) within which Software Configuration Management is to apply.
   b. Responsibilities of the software configuration management organization.
   c. References to the software configuration management policies and directives that apply to the project.
   d. All functions and tasks required to manage the configuration of the software, including configuration identification, configuration control, status accounting, and configuration audits and reviews.
   e. Schedule information, which establishes the sequence and coordination for the identified activities and for all events affecting the Plan's implementation.
   f. Resource information, which identifies the software tools, techniques, and equipment necessary for the implementation of the activities.
   g. Plan maintenance information, which identifies the activities and responsibilities necessary to ensure continued planning during the life cycle of the project.
   h. Release management and delivery.

16.4 **FORMAT:** Contractor format is acceptable.

16.5 **MAINTENANCE:** Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.:** **TVC1-SW-SCR**
4. **DATA TYPE:** 3
5. **DATE REVISED:**
6. **PAGE:** 1/1
7. **TITLE:** Software Change Request/Problem Report
8. **DESCRIPTION/USE:** To provide a means for identifying and recording the resolution to software anomalous behavior, process noncompliance with plans and standards, and deficiencies in life cycle data, or to identify and record the implementation of a change or modification in a software item.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** As required
13. **SUBMISSION FREQUENCY:** As required
14. **REMARKS:** Additional content to support project or organizational defect tracking and analysis is acceptable.
15. **INTERRELATIONSHIP:** SOW Paragraph 4.3.9
16. **DATA PREPARATION INFORMATION:**

16.1 **SCOPE:** The Software Change Request/Problem Report is used to identify and record changes or problem resolution for a software item.

16.2 **APPLICABLE DOCUMENTS**

16.3 **CONTENTS:** The Software Change Request/Problem Report shall contain:
   a. Identification of the software item.
   b. Description of the problem or change to enable problem resolution or justification for and nature of change, including: assumptions/constraints, change to correct software error.
   c. Originator of Software Change Request/Problem Report, and originator's assessment of priority/severity.
   d. Description of the corrective action taken to resolve the reported problem or analysis and evaluation of change, including impact to safety, schedules, cost, products, and test.
   e. Lifecycle phase in which problem was discovered or in which change was requested.
   f. Approval or disapproval of Software Change Request/Problem Report
   g. Verification of the implementation and release of modified system.
   h. Date problem discovered.
   i. Status of problem resolution.

16.4 **FORMAT:** Contractor format is acceptable.

16.5 **MAINTENANCE:** None required

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.**: CA01C
2. **ISSUE**: Standard
3. **DRD NO.**: **TVC1-SW-SDD**
4. **DATA TYPE**: 2
5. **DATE REVISED**:
6. **PAGE**: 1/1
7. **TITLE**: Software Design Description
8. **DESCRIPTION/USE**: To define and record the design of a computer software configuration item (CSCI). To be used as the basis for implementing the software, and to provide visibility into the design and the information needed for software support.
9. **OPR**:
10. **DM**:
11. **DISTRIBUTION**: Per Contracting Officer's letter
12. **INITIAL SUBMISSION**: Preliminary EM version 10 days prior to Engineering Model Final Design Review.
13. **SUBMISSION FREQUENCY**: Flight design version 10 days prior to Software Preliminary Design Review.
14. **REMARKS**: Software design specifications need not be textual, and may include representations in rigorous specification languages, graphical representations, or specifications suitable for requirements or design analysis tools or methodologies.
15. **INTERRELATIONSHIP**: SOW Paragraph 4.3.8
16. **DATA PREPARATION INFORMATION**:

16.1 **SCOPE**: The Software Design Description describes the design of a CSCI. It describes the CSCI-wide design decisions, the CSCI architectural design, and the detailed design needed to implement the software.

16.2 **APPLICABLE DOCUMENTS**: None

16.3 **CONTENTS**: The Software Design Description shall include:
   a. CSCI-wide design decisions/trade decisions.
   b. CSCI architectural design.
   c. CSCI decomposition and interrelationship between components.
      1. CSCI components:
         (a) Description of how the software item satisfies the software requirements, including algorithms, data structures, and functional decomposition.
         (b) Software item input/output description.
         (c) Static/architectural relationship of the software units.
         (d) Concept of execution including data flow, control flow, and timing.
         (e) Requirements traceability.
         (f) CSCI's planned utilization of computer hardware resources.
      2. Rationale for software item design decisions/trade decisions including assumptions, limitations, safety and reliability related items/concerns or constraints in design documentation.
      3. Interface design.
   d. CSCI Implementation Plan.

16.4 **FORMAT**: Contractor format is acceptable.

16.5 **MAINTENANCE**: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.**: CA01C
2. **ISSUE**: Standard
3. **DRD NO.**: **TVC1-SW-SDP**
4. **DATA TYPE**: 2
5. **DATE REVISED**:
6. **PAGE**: 1/2
7. **TITLE**: Software Development Plan
8. **DESCRIPTION/USE**: To describe a plan for conducting a software development effort. To develop and record plans for software development activities.
9. **OPR**:
10. **DM**:
11. **DISTRIBUTION**: Per Contracting Officer's letter
12. **INITIAL SUBMISSION**: 60 days after Authority to Proceed (ATP)
13. **SUBMISSION FREQUENCY**: Update as required
14. **REMARKS**: The term "software development" is meant to include new development, modification, reuse, reengineering, maintenance, and all other activities resulting in software products.
15. **INTERRELATIONSHIP**: SOW Paragraph 5.3.4
16. **DATA PREPARATION INFORMATION**:

16.1   **SCOPE**: The Software Development Plan provides insight into, and a tool for monitoring, the processes to be followed for software development, the methods to be used, the approach to be followed for each activity, and project schedules, organization, and resources. This plan details the system software, project documentation, project schedules, resources requirements and constraints, and general and detailed software development activities.

16.2   **APPLICABLE DOCUMENTS**: NPR 7150.2 *NASA Software Engineering Requirements*

16.3   **CONTENTS**: The Software Development Plan shall contain:
   a. Project organizational structure showing authority and responsibility of each organizational unit, including external organizations (i.e., Safety and Mission Assurance, Independent Verification and Validation (IV&V), Independent Technical Authority (ITA), NASA Engineering and Safety Center (NESC)).
   b. The classification of each of the systems and subsystems containing software as defined in Appendix B of the NASA Software Engineering Requirements, NPR 7150.2.
   c. Tailoring compliance matrix for approval by the designated ITA Warrant Authority, if the projects has any variants, waivers or exceptions to NPR 7150.2.
   d. Engineering environment (for development, operation, or maintenance, as applicable), including test environment, library, equipment, facilities, standards, procedures, and tools.
   e. Work breakdown structure of the life cycle processes and activities, including the software products, software services, nondeliverable items to be performed, budgets, staffing, physical resources, software size, and schedules associated with the tasks.
   f. Management of the quality characteristics of the software products or services.
   g. Management of safety, security, privacy, and other critical requirements of the software products or services.

16.   **DATA PREPARATION INFORMATION (CONTINUED):**

    h. Subcontractor management, including subcontractor selection and involvement between the subcontractor and the acquirer, if any.

    i. Verification and validation approach.

    j. Acquirer involvement.

    k. User involvement.

    l. Risk management.

    m. Security policy.

    n. Approval required by such means as regulations, required certifications, proprietary, usage, ownership, warranty, and licensing rights.

    o. Process for scheduling, tracking, and reporting.

    p. Training of personnel, including project unique software training needs.

    q. Software life cycle model including description of software integration and hardware/software integration processes, software delivery, and maintenance.

    r. Configuration management.

    s. Software documentation tree.

    t. Peer review/inspection process of software work products.

    u. Process for early identification of testing requirements that drive software design decisions; e.g., special system level timing requirements/checkpoint restart.

    v. Software metrics.

    w. Content of software documentation to be developed on the project.

Note: Verification approach includes:

    a. Identification of selected software verification procedures and criteria across the life cycle (e.g., peer review procedures, inspection procedures, re-inspection criteria, testing procedures).

    b. Identification of selected work products to be verified (e.g., peer reviews of requirements and test plans, peer reviews/inspections of critical code, testing code against requirements and design).

    c. Description of software verification environments that are to be established for the project (e.g., software testing environment, system testing environment, regression testing environment).

    d. Identification of where actual software verification records and analysis of the results will be documented (e.g., test records, peer review records, inspection records), and where software verification corrective action will be documented.

Note: Validation approach includes:

    a. Identification of selected software validation procedures and criteria across the life cycle (e.g., prototyping, user groups, simulation, analysis, acceptance testing, operational demonstrations).

    b. Identification of selected work products to be validated (e.g., user groups reviewing requirements and prototypes, acceptance testing of software product, operational demonstrations of software product).

    c. Description of software validation environments that are to be established for the project (e.g., simulators for operational environment).

    d. Identification of where actual software validation records and analysis of the results will be documented (e.g., user group records, prototyping records, acceptance testing records) and where software validation corrective action will be documented.

16.4   **FORMAT**: Contractor format is acceptable.

16.5   **MAINTENANCE**: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.: TVC1-SW-SMP**
4. **DATA TYPE:** 2
5. **DATE REVISED:**
6. **PAGE:** 1/2
7. **TITLE:** Software Maintenance Plan
8. **DESCRIPTION/USE:** To define the objectives, standards, and procedures to be used in the software maintenance process.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** 60 days after Authority to Proceed (ATP)
13. **SUBMISSION FREQUENCY:** Update as required
14. **REMARKS:**
15. **INTERRELATIONSHIP:** SOW Paragraph 4.3.5
16. **DATA PREPARATION INFORMATION:**
16.1 **SCOPE:** The Software Maintenance Plan provides insight into the method, approach, responsibility, and processes to be followed for maintenance of software and its associated documentation

16.2 **APPLICABLE DOCUMENTS:**

16.3 **CONTENTS:** The Software Maintenance Plan shall provide separate volumes for each system element, e.g., ground operations, flight operations, mission operations, and spacecraft. The Software Maintenance Plan shall include:
   a. Plan information for the following activities:
      1. Maintenance process implementation.
      2. Problem and modification analysis.
      3. Modification implementation.
      4. Maintenance review/acceptance.
         Migration.
      5. Software Retirement.
      6. Software Assurance.
   b. Specific standards, methods, tools, actions, procedures, and responsibilities associated with the maintenance process. In addition, the following elements are included:
      1. Development and tracking of required upgrade intervals, including implementation plan.
      2. Approach for the scheduling, implementation, and tracking of software upgrades.
      3. Equipment and labs required for software verification and implementation.
      4. Updates to documentation for modified Commercial-Off-The-Shelf (COTS) or non-COTS software.
      5. Licensing agreements for COTS.
      6. Plan for and tracking of operational backup software.
      7. Approach for the implementation of modifications to operational software (e.g., testing of software in development lab prior to operational use).
      8. Approach for software delivery process including distribution to facilities and users of the software products and installation of the software in the target environment (including, but not limited to, spacecraft, simulators, Mission Control Center, and ground operations facilities).
      9. Approach for providing NASA access to the software version description data; e.g., revision number, licensing agreement.

16.   **DATA PREPARATION INFORMATION (CONTINUED):**

16.4   <u>FORMAT</u>: Contractor format is acceptable.

16.5   <u>MAINTENANCE</u>: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.:** **TVC1-SW-SRS**
4. **DATA TYPE:** 1
5. **DATE REVISED:**
6. **PAGE:** 1/2
7. **TITLE:** Software Requirements Specification
8. **DESCRIPTION/USE:** To define and record the software requirements to be met by a computer software configuration item (CSCI). To specify the requirements for a CSCI and the methods to be used to ensure that each requirement has been met; the basis for design and qualification testing of a CSCI.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** 90 days prior to Engineering Model Final Design Review for EM
13. **SUBMISSION FREQUENCY:** One document for each software configuration end item; 10 days prior to Software Requirements Review, SWRR, and 10 days prior to Critical Design Review (flight design); update as required.
14. **REMARKS:** Requirements pertaining to the CSCI's external interfaces are presented in the Software Requirements Specification (SRS). Software requirements specifications need not be textual, and may include representations in rigorous specification languages, graphical representations, or specifications suitable for requirements or design analysis tools or methodologies.
15. **INTERRELATIONSHIP:** SOW Paragraph 5.3.5
16. **DATA PREPARATION INFORMATION:**

16.1   **SCOPE**: The Software Requirements Specification details the software performance, interface, operational, and quality assurance requirements.

16.2   **APPLICABLE DOCUMENTS**

16.3   **CONTENTS**: The Software Requirements Specification shall contain:
   a. System overview.
   b. CSCI requirements.
      1. Functional requirements.
      2. Required states and modes.
      3. External interface requirements.
      4. Internal interface requirements.
      5. Internal data requirements.
      6. Adaptation requirements.
      7. Safety requirements.
      8. Performance and timing requirements.
      9. Security and privacy requirements.
      10. Environment requirements.
      11. Computer resource requirements.
         (a) Computer hardware resource utilization requirements.
         (b) Computer software requirements.
         (c) Computer communications requirements.
      12. Software quality characteristics.
      13. Design and implementation constraints.
      14. Personnel-related requirements.
      15. Training-related requirements.

TITLE: Software Requirements Specification

DRD NO.: **TVC1-SW-SRS**

DATA TYPE: 1

PAGE: 2/2

16.   **DATA PREPARATION INFORMATION (CONTINUED):**

> 17. Logistics-related requirements.
> 18. Packaging requirements.
> 19. Precedence and criticality of requirements.

> c. Qualification provisions.
> d. Requirements traceability and verification data.
> e. Requirements partitioning for phased delivery.
> f. Testing requirements that drive software design decisions; e.g., special system level timing requirements/checkpoint restart.

16.4   **FORMAT**: Contractor format is acceptable.

16.5   **MAINTENANCE**: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.**: CA01C
2. **ISSUE**: Standard
3. **DRD NO.**: **TVC1-SW-STP**
4. **DATA TYPE**: 2
5. **DATE REVISED**:
6. **PAGE**: 1/1
7. **TITLE**: Software Test Plan
8. **DESCRIPTION/USE**: To develop and record plans for conducting computer software configuration item (CSCI) qualification testing and/or system qualification testing of a software system. To assess the adequacy of planning for CSCI and, if applicable, software system qualification testing.
9. **OPR**:
10. **DM**:
11. **DISTRIBUTION**: Per Contracting Officer's letter
12. **INITIAL SUBMISSION**: 10 days prior to Engineering Model Final Design Review (EM design)
13. **SUBMISSION FREQUENCY**: Update 10 days prior to Engineering Model Test Readiness Review (EM design). 10 days prior to Software Preliminary Design Review, update 10 days prior to Critical Design Review (flight design). Update as required.
14. **REMARKS**: Requirements pertaining to CSCI interfaces are presented in the *Software Requirements Specification* (DRD STD/SW-SRS).
15. **INTERRELATIONSHIP**: SOW Paragraph 4.3.1
16. **DATA PREPARATION INFORMATION**:

16.1 **SCOPE**: The Software Test Plan describes the plans for software component level testing, software integration testing, software qualification testing, and system qualification testing of software systems. The plan describes the software test environment to be used for testing, identifies the tests to be performed, and provides schedules for environment, development, and test activities. The plan provides an overview of software testing, test schedules, and test management procedures.

16.2 **APPLICABLE DOCUMENTS**

16.3 **CONTENTS**: The Software Test Plan shall include:
   a. Test levels.
   b. Test types (e.g., unit testing, software integration testing, systems integration testing, end-to-end testing, acceptance testing, regression testing).
   c. Test classes.
   d. General test conditions.
   e. Test progression.
   f. Data recording, reduction, and analysis.
   g. Test coverage (breadth and depth) or other methods for ensuring sufficiency of testing.
   h. Planned tests, including items and their identifiers.
   i. Test schedules.
   j. Requirements traceability (or verification matrix).
   k. Qualification testing environment, site, personnel, and participating organizations.

16.4 **FORMAT**: Contractor format is acceptable.

16.5 **MAINTENANCE**: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.:** **TVC1-SW-STPR**
4. **DATA TYPE:** 2
5. **DATE REVISED:**
6. **PAGE:** 1/1
7. **TITLE:** Software Test Procedures
8. **DESCRIPTION/USE:** To define and record the test preparation, test cases, and test procedures to be used for computer software configuration item (CSCI) qualification testing or for system qualification testing of a software system. To assess the adequacy of the qualification testing to be performed.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** : 10 days prior to Engineering Model Test Readiness Review (EM design)
13. **SUBMISSION FREQUENCY:** Update as required.
14. **REMARKS:**
15. **INTERRELATIONSHIP:** SOW Paragraph 4.3.3
16. **DATA PREPARATION INFORMATION:**

16.1 <u>SCOPE</u>: The Software Test Procedures describe the test preparations, test cases, and test procedures to be used to perform qualification testing of a CSCI or a software system or subsystem.

16.2 <u>APPLICABLE DOCUMENTS</u>

16.3 <u>CONTENTS</u>: The Software Test Procedures shall contain:
   a. Test preparations, including hardware and software.
   b. Test descriptions, including:
      1. Test identifier.
      2. System or CSCI requirements addressed by the test case.
      3. Prerequisite conditions.
      4. Test input.
      5. Instructions for conducting procedure.
      6. Expected test results, including criteria for evaluating results, and assumptions and constraints.
      7. Criteria for evaluating results.
   c. Requirements traceability.
   d. Identification of test configuration

16.4 <u>FORMAT</u>: Contractor format is acceptable.

16.5 <u>MAINTENANCE</u>: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.: TVC1-SW-STR**
4. **DATA TYPE:** 3
5. **DATE REVISED:**
6. **PAGE:** 1/1
7. **TITLE:** Software Test Report
8. **DESCRIPTION/USE:** To assess, analyze and record the results of the computer software configuration item (CSCI) qualification testing, system qualification testing of a software system, or other testing identified in the contract.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** Three weeks after completion of software qualification testing
13. **SUBMISSION FREQUENCY:** Upon completion of software regression testing for each CSCI
14. **REMARKS:**
15. **INTERRELATIONSHIP:** SOW Paragraph 4.3.4
16. **DATA PREPARATION INFORMATION:**

16.1 SCOPE: The Software Test Report is a record of the qualification testing performed on a CSCI, a software system or subsystem, or other software-related item. This report covers the qualification of individual contract end items of software.

16.2 **APPLICABLE DOCUMENTS**

16.3 CONTENTS: The Software Test Report shall include:
   a. Overview of the test results.
      1. Overall assessment of the software as demonstrated by the test results.
      2. Remaining deficiencies, limitations, or constraints detected by testing.   (e.g., including description of the impact on software and system performance, the impact a correction would have on software and system design, and recommendations for correcting the deficiency, limitation, or constraint).
      3. Impact of test environment.
   b. Detailed test results.
      1. Project-unique identifier of a test and test procedure(s).
      2. Summary of test results (e.g., including requirements verified).
      3. Problems encountered.
      4. Deviations from test cases/procedures.
   c. Test log.
      1. Date(s), time(s), and location(s) of tests performed.
      2. Test environment, hardware, and software configurations used for each test.
      3. Date and time of each test-related activity, the identity of the individual(s) who performed the activity, and the identities of witnesses, as applicable.
   d. Rationale for decisions.

16.4 FORMAT: Contractor format is acceptable.

16.5 MAINTENANCE: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.**: CA01C
2. **ISSUE**: Standard
3. **DRD NO.**: **TVC1-SW-SUM**
4. **DATA TYPE**: 2
5. **DATE REVISED**:
6. **PAGE**: 1/1
7. **TITLE**: Software User Manual
8. **DESCRIPTION/USE**: To provide for hands-on software users information on installation and use of a computer software configuration item (CSCI), a group of related CSCI's, or a software system or subsystem. The Software User Manual may also cover a particular aspect of software operation, such as instructions for a particular position or task.
9. **OPR**:
10. **DM**:
11. **DISTRIBUTION**: Per Contracting Officer's letter
12. **INITIAL SUBMISSION**: 10 days prior to EM Test Readiness Review (EM Design)
13. **SUBMISSION FREQUENCY**: Update as required
14. **REMARKS**: The Software User Manual is developed for software that is run by the user and has a user interface requiring on-line user input or interpretation of displayed output. If the software is embedded in a hardware-software system, user manuals or operating procedures for that system may make separate Software User Manuals unnecessary.
15. **INTERRELATIONSHIP**: SOW Paragraph 4.3.7
16. **DATA PREPARATION INFORMATION**:

16.1 <u>SCOPE</u>: The Software User Manual defines user instructions for the software.

16.2 <u>**APPLICABLE DOCUMENTS**</u>

16.3 <u>**CONTENTS**</u>: The Software User Manual shall contain:
    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.

16.4 <u>FORMAT</u>: Contractor format is acceptable.

16.5 <u>**MAINTENANCE**</u>: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.**: CA01C
2. **ISSUE**: Standard
3. **DRD NO.**: **TVC1-SW-SVDD**
4. **DATA TYPE**: 2
5. **DATE REVISED**:
6. **PAGE**: 1/1
7. **TITLE**: Software Version Description
8. **DESCRIPTION/USE**: To identify and record the exact version of software to be delivered to a user, support, or other site.
9. **OPR**:
10. **DM**:
11. **DISTRIBUTION**: Per Contracting Officer's letter
12. **INITIAL SUBMISSION**: 10 days prior to EM Test Readiness Review (EM Design)
13. **SUBMISSION FREQUENCY**: With each delivery of a software build
14. **REMARKS**: The term "version" may be applied to the initial release of the software, to a subsequent release of that software, or to one of multiple forms of the software released at approximately the same time (for example, to a different site).
15. **INTERRELATIONSHIP**: SOW Paragraph 4.3.2
16. **DATA PREPARATION INFORMATION**:

16.1 **SCOPE**: The Software Version Description identifies and describes a software version consisting of one or more Computer Software Configuration Items (CSCI's). The description is used to release, track, and control software versions.

16.2 **APPLICABLE DOCUMENTS**: None

16.3 **CONTENTS**: The Software Version Description shall identify and provide:
   a.   Full identification of the system and software (i.e., numbers, titles, abbreviations, version numbers, and release numbers).
   b.   Executable software (i.e., batch files, command files, data files, or other software needed to install the software on its target computer).
   c.   Software life cycle data that defines the software product.
   d.   Archive and release data.
   e.   Instructions for building the executable software, including, for example, the instructions and data for compiling and linking and the procedures used for software recovery, software regeneration, testing, or modification.
   f.   Data integrity checks for the executable, object code, and source code.
   g.   Software product files (any files needed to install, build, operate, and maintain the software).

16.4 **FORMAT**: Contractor format is acceptable.

16.5 **MAINTENANCE**: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.:** **TVC1-SW-SWDD**
4. **DATA TYPE:** 1
5. **DATE REVISED:**
6. **PAGE:** 1/1
7. **TITLE:** Software Data Dictionary
8. **DESCRIPTION/USE:** To define, manage, and record all data elements that interface with the core avionics software and subsystem specific software. Specific data elements include: channelization information, calibration information, telemetry formats, and command information required to define the entire software system/architecture.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** 10 days prior to Software Requirements Review (Flight Design)
13. **SUBMISSION FREQUENCY:** One document for each software configuration end item; final 10 days prior to Critical Design Review; update as required.
14. **REMARKS:**
15. **INTERRELATIONSHIP:** SOW Paragraph 5.3.6
16. **DATA PREPARATION INFORMATION:**

16.1 **SCOPE:** The Software Data Dictionary applies to all flight, ground, simulation, and test software on the project.

16.2 **APPLICABLE DOCUMENTS:** None

16.3 **CONTENTS:** The Software Data Dictionary shall include:
   a. Channelization data (e.g., bus mapping, vehicle wiring mapping, Multiplexer-Demultiplexer hardware channelization).
   b. I/O variables.
   c. Rate group data.
   d. Raw and calibrated sensor data.
   e. Telemetry format/layout and data.
   f. Data recorder format/layout and data.
   g. Command definition (e.g., on-board, ground, test specific).
   h. Effector command information.
   i. Operational limits (e.g., maximum/minimum values, launch commit criteria information).

16.4 **FORMAT:** Contractor format is acceptable.

16.5 **MAINTENANCE:** Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.:** **TVC1-SW-SWR**
4. **DATA TYPE:** 1
5. **DATE REVISED:**
6. **PAGE:** 1/2
7. **TITLE:** Software Review
8. **DESCRIPTION/USE:** A Requirements Review of the finalized Computer Software Configuration Item (CSCI) requirements and operational concept. The SRR is conducted when CSCI requirements have been sufficiently defined to evaluate the contractor's responsiveness to and interpretation of the system, segment, or prime item level requirements. A successful SRR is predicated upon the contracting agency's determination that the Software Requirements Specification, Interface Requirements Specification(s), and Operational Concept Document form a satisfactory basis for proceeding into preliminary software design. PDR and CDR reviews will focus on: (1) the evaluation of the progress, consistency, and technical adequacy of the selected top-level design and test approach, (2) compatibility between software requirements and preliminary design, and (3) on the preliminary and final versions for PDR and CRR respectively, of the operation and support documents.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** 10 days prior to Software Requirements Review (Flight Design), 10 days prior to Software Preliminary Design Review and 10 days prior to Critical Design Review (Flight Design)
13. **SUBMISSION FREQUENCY:** One document for each software configuration end item; update as required.
14. **REMARKS:**
15. **INTERRELATIONSHIP:** SOW Paragraph 1.4.8
16. **DATA PREPARATION INFORMATION:**

16.1 <u>**SCOPE:**</u> The SWRR shall be a formal review of a CSCI's requirements as specified in the Software Requirements Specification and the Interface Requirements Specification(s).

The SWPDR shall be a formal technical review of the basic design approach for a software configuration item or for a functionally related group of software configuration items. It shall be held after the hardware Development Specification(s), the Software Top Level Design Document (STLDD), the Software Test Plan (STP), the HWCI Test Plan, and preliminary versions of the Computer System Operator's Manual (CSOM), Software User's Manual (SUM), Computer System Diagnostic Manual (CSDM), and Computer Resources Integrated Support Document (CRISD) are available, but prior to the start of detailed design. A technical understanding shall be reached on the validity and the degree of completeness of the STLDD, STP, and the preliminary versions of the CSOM, SUM, CSDM, and CRISD.

The SWCDR shall be an update of the SWPDR.

16.2 <u>**APPLICABLE DOCUMENTS:**</u>

16.3 <u>**CONTENTS:**</u> The Software Requirements Review shall review the following:
   a. Functional overview of the CSCI, including inputs, processing, and outputs of each function.
   b. Overall CSCI performance requirements, including those for execution time, storage requirements, and similar constraints.
   c. Control flow and data flow between each of the software functions that comprise the CSCI.
   d. All interface requirements between the CSCI and all other configuration items both internal and external to the system.
   e. Qualification requirements that identify applicable levels and methods of testing for the software requirements that comprise the CSCI.

16.   **DATA PREPARATION INFORMATION (CONTINUED):**

    f.   Any special delivery requirements for the CSCI.

    g.   Quality factor requirements; i.e., Correctness, Reliability, Efficiency, Integrity, Usability, Maintainability, Testability, Flexibility, Portability, Reusability, and Interoperability.

    h.   Mission requirements of the system and its associated operational and support environments.

    i.   Functions and characteristics of the computer system within the overall system.

    j.   Milestone schedules.

    k.   Updates since the last review to all previously delivered software related CDRL items.

    l.   Any actions or procedures deviating from approved plans.

The Software Preliminary Design Review shall review the following:

    a.   Functional flow. The computer software functional flow embodying all of the requirements allocated from the Software Requirements Specification and Interface Requirements Specification(s) to the individual Top-Level Computer Software Components (TLCSCs) of the CSCI.

    b.   Storage allocation data. This information shall be presented for each CSCI as a whole, describing the manner in which available storage is allocated to individual TLCSCs. Timing, sequencing requirements, and relevant equipment constraints used in determining the allocation are to be included.

    c.   Control functions description. A description of the executive control and start/recovery features for the CSCI shall be available, including method of initiating system operation and features enabling recovery from system malfunction.

    d.   CSCI structure. The contractor shall describe the top-level structure of the CSCI, the reasons for choosing the components described, the development methodology which will be used within the constraints of the available computer resources, and any support programs which will be required in order to develop/maintain the CSCI structure and allocation of data storage.

    e.   Security. An identification of unique security requirements and a description of the techniques to be used for implementing and maintaining security within the CSCI shall be provided.

    f.   Reentrancy. An identification of any reentrancy requirements and a description of the techniques for implementing reentry routines shall be available.

    g.   Computer software development facilities. The availability, adequacy, and planned utilization of the computer software development facilities shall be addressed.

    h.   Computer software development facility versus the operational system. The contractor shall provide information relative to unique design features which may exist in a TLCSC in order to allow use within the computer software development facility, but which will not exist in the TLCSC installed in the operational system. The contractor shall provide information on the design of support programs not explicitly required for the operational system but which will be generated to assist in the development of the CSCI(s). The contractor shall also provide details of the Software Development Library controls.

    i.   Development tools. The contractor shall describe any special simulation, data reduction, or utility tools that are not delivered under the terms of the contract, but which are planned for use during software development.

    j.   Test tools. The contractor shall describe any special test systems, test data, data reduction tools, test computer software, or calibration and diagnostic software that are not deliverable under terms of the

contract, but which are planned for use during product development.

k. Description and characteristics of commercially available computer resources, including any optional capabilities such as special features, interface units, special instructions, controls, formats, etc. Include limitations of commercially available equipment such as failure to meet human engineering, safety and maintainability requirements of the specification and identify deficiencies.

l. Existing documentation (technical orders, commercial manuals, etc.) for commercially available computer resources and copies of contractor specifications used to procure computer resources shall be made available for review by the contracting agency.

m. Support resources. The contractor shall describe those resources necessary to support the software and firmware during operational deployment of the system, such as operational and support hardware and software, personnel, special skills, human factors, configuration management, test, and facilities/space.

n. Operation and support documents. The preliminary versions of the CSOM, SUM, CSDM, and CRISD shall be reviewed for technical content and compatibility with the top-level design documentation.

o. Updated since the last review to all previously delivered software related CDRL items.

The Software Critical Design Review shall review the following:
a   Software Detailed Design, Data Base Design, and Interface Design Document(s). In cases where the CDR is conducted in increments, complete documents to support that increment shall be available.

b. Supporting documentation describing results of analyses, testing, etc., as mutually agreed by the contracting agency and the contractor.

c. System Allocation Document for CSCI inclusion at each scheduled location.

d. Computer Resources Integrated Support Document.

e. Software Programmer's Manual

f. Firmware Support Manual

g. Progress on activities required by CSCI PDR.

h. Updated operation and support documents (CSOM, SUM, CSDM).

i. Schedules for remaining milestones.

j. Updates since the last review to all previously delivered software related CDRL items.

16.4 **FORMAT**: Briefing format, contractor format is acceptable.

16.5 **MAINTENANCE**: None required.

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DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.: TVC1-VR-ATP**
4. **DATA TYPE:** 2
5. **DATE REVISED:**
6. **PAGE:** 1/1
7. **TITLE:** Acceptance Test Plan
8. **DESCRIPTION/USE:** To develop and record plans for conducting engineering model acceptance testing. To assess the adequacy of planning for engineering model hardware testing.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** 10 days prior to Engineering Model Final Design Review (EM Design)
13. **SUBMISSION FREQUENCY:** Update as required
14. **REMARKS:**
15. **INTERRELATIONSHIP:** SOW Paragraph 6.2
16. **DATA PREPARATION INFORMATION:**

16.1 **SCOPE:** The Acceptance Test Plan (ATP) describes the plans for acceptance testing of the engineering model hardware of the actuator assembly. The plan describes the hardware test environment to be used for testing, identifies the tests to be performed, and provides schedules for environment, development, and test activities. The plan provides an overview of testing, test schedules, and test management procedures.

16.2 **APPLICABLE DOCUMENTS**

16.3 **CONTENTS:** The Acceptance Test Plan shall include:
   a. Test levels.
   b. Test types (e.g., unit testing, integration testing, systems integration testing, end-to-end testing, acceptance testing, regression testing).
   c. Test classes.
   d. General test conditions.
   e. Test progression.
   f. Data recording, reduction, and analysis.
   g. Test coverage (breadth and depth) or other methods for ensuring sufficiency of testing.
   h. Planned tests, including items and their identifiers.
   i. Test schedules.
   j. Requirements traceability (or verification matrix).
   k. Acceptance testing environment, site, personnel, and participating organizations.

16.4 **FORMAT:** Contractor format is acceptable.

16.5 **MAINTENANCE:** Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.:** **TVC1-VR-DTP**
4. **DATA TYPE:** 2
5. **DATE REVISED:**
6. **PAGE:** 1/1
7. **TITLE:** Development Test Plan
8. **DESCRIPTION/USE:** To develop and record plans for conducting hardware development testing. To assess the adequacy of planning for hardware development testing.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** 10 days prior to Engineering Model Final Design Review (Engineering Model)
13. **SUBMISSION FREQUENCY:** Provide updated test plan 10 days prior to Test Readiness Review (Engineering Model).
14. **REMARKS:**
15. **INTERRELATIONSHIP:** SOW Paragraph 6.2
16. **DATA PREPARATION INFORMATION:**

16.1   **SCOPE:** The Development Test Plan describes the plans for component level testing, integration testing of the actuator assembly. The plan describes the hardware test environment to be used for testing, identifies the tests to be performed, and provides schedules for environment, development, and test activities. The plan provides an overview of hardware testing, test schedules, and test management procedures.

16.2   **APPLICABLE DOCUMENTS**

16.3   **CONTENTS:** The Development Test Plan shall include:
       a. Test levels.
       b. Test types (e.g., unit testing, integration testing, systems integration testing, end-to-end testing, regression testing).
       c. Test classes.
       d. General test conditions.
       e. Test progression.
       f. Data recording, reduction, and analysis.
       g. Test coverage (breadth and depth) or other methods for ensuring sufficiency of testing.
       h. Planned tests, including items and their identifiers.
       i. Test schedules.
       j. Requirements traceability (or verification matrix).
       k. Development testing environment, site, personnel, and participating organizations.

16.4   **FORMAT:** Contractor format is acceptable.

16.5   **MAINTENANCE:** Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.: TVC1-VR-REQ**
4. **DATA TYPE:** 1
5. **DATE REVISED:**
6. **PAGE:** 1/1
7. **TITLE:** Verification/Validation Requirements
8. **DESCRIPTION/USE:** To identify the verification/validation required to be performed to satisfy each of the requirements.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** 10 days prior to Engineering Model Final Design Review (Engineering Model.
13. **SUBMISSION FREQUENCY:** 10 days prior to Preliminary Design Review (PDR) and 10 days before Critical Design Review (CDR) (Flight Design)
14. **REMARKS:** Reference is made to MSFC-HDBK-2221, *Verification Handbook, Volume I: Verification Process*, and *Volume II: Verification Documentation Examples*. Volume II provides examples of verification documentation as specified in Volume I that can be used as a guide in the development of or in the assessment of similar documentation.
15. **INTERRELATIONSHIP:** SOW paragraph 6.1
16. **DATA PREPARATION INFORMATION:**

16.1 <u>SCOPE</u>: The Verification/Validation Requirements information identifies the method(s) (e.g., test, analysis, inspection), level(s) (e.g., component, subsystem, system), and phase(s) (e.g., qualification, acceptance) of the verification /validation to be performed to satisfy each of the requirements.

16.2 <u>APPLICABLE DOCUMENTS</u>: Performance Specification , Design Specification

16.3 <u>CONTENTS</u>: The Verification/Validation Requirements information shall include the following:
   a. Identification of the method(s) (e.g., test, analysis, inspection) in which the verification/ validation is performed to satisfy each of the requirements documented in the Performance Specification or Design Specification.
   b. Identification of the level(s) (e.g., component, subsystem, system) at which the verification/ validation is performed to satisfy each of the requirements documented in the Performance Specification or Design Specification.
   c. Identification of the phase(s) (e.g., qualification, acceptance) during which the verification/ validation is performed to satisfy each of the requirements documented in the Performance Specification or Design Specification.

16.4 <u>FORMAT</u>: Contractor format is acceptable.

16.5 <u>MAINTENANCE</u>: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.**: CA01C
2. **ISSUE**: Standard
3. **DRD NO.**: **TVC1-VR-TR**
4. **DATA TYPE**: 3
5. **DATE REVISED**:
6. **PAGE**: 1/1
7. **TITLE**: Hardware Test Report
8. **DESCRIPTION/USE**: To assess, analyze and record the results of the acceptance and development hardware testing, system qualification testing, or other testing identified in the contract.
9. **OPR**:
10. **DM**:
11. **DISTRIBUTION**: Per Contracting Officer's letter
12. **INITIAL SUBMISSION**: Three weeks after completion of testing
13. **SUBMISSION FREQUENCY**: Update as required
14. **REMARKS**:
15. **INTERRELATIONSHIP**: SOW Paragraph 6.2
16. **DATA PREPARATION INFORMATION**:

16.1   <u>SCOPE</u>: The Hardware Test Report is a record of the acceptance or development testing performed on the actuator assembly EM or otherwise.

16.2   <u>**APPLICABLE DOCUMENTS**</u>

16.3   <u>CONTENTS</u>: The Hardware Test Report shall include:
        a.   Overview of the test results.
             1.   Overall assessment of the hardware as demonstrated by the test results.
             2.   Remaining deficiencies, limitations, or constraints detected by testing.   (e.g., including description of the impact on hardware and system performance, the impact a correction would have on component and system design, and recommendations for correcting the deficiency, limitation, or constraint).
             3.   Impact of test environment.
        b.   Detailed test results.
             1.   Project-unique identifier of a test and test procedure(s).
             2.   Summary of test results (e.g., including requirements verified).
             3.   Problems encountered.
             4.   Deviations from test cases/procedures.
        c.   Test log.
             1.   Date(s), time(s), and location(s) of tests performed.
             2.   Test environment and hardware configurations used for each test.
             3.   Date and time of each test-related activity, the identity of the individual(s) who performed the activity, and the identities of witnesses, as applicable.
        d.   Rationale for decisions.

16.4   <u>FORMAT</u>: Contractor format is acceptable.

16.5   <u>MAINTENANCE</u>: Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:**
3. **DRD NO.: TVC1-VR-VC**
4. **DATA TYPE:** 3
5. **DATE REVISED:**
6. **PAGE:** 1/1
7. **TITLE:** Verification/Validation Compliance
8. **DESCRIPTION/USE:** To identify and correlate the submitted verification/validation reports against the requirements.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** 10 days prior to Engineering Model Pre-Ship Review. (Engineering Model)
13. **SUBMISSION FREQUENCY:** Update and maintain throughout project. Supply status as needed.
14. **REMARKS:** Reference is made to MSFC-HDBK-2221, *Verification Handbook, Volume I: Verification Process*, and *Volume II: Verification Documentation Examples*. Volume II provides examples of verification documentation as specified in Volume I that can be used as a guide in the development of or in the assessment of similar documentation.
15. **INTERRELATIONSHIP:** DRD TVC1-VR-REQ, *Verification/Validation Requirements*. SOW paragraph 6.2.
16. **DATA PREPARATION INFORMATION:**

16.1   **SCOPE:** The Verification/Validation Compliance information identifies the compliance data associated with each requirement.

16.2   **APPLICABLE DOCUMENTS:** None

16.3   **CONTENTS:** The Verification/Validation Compliance information shall include the following:
    a.   Identification of the agreed-upon verification/validation requirements associated with each requirement.
    b.   Identification of the verification/validation reports (i.e., test report, analysis, procedure) that identify compliance to the requirement(s).
    c.   Identification of traceability of the compliance data to the requirement(s).
    d.   Identification of any non-conformances (e.g. waivers, deviations, discrepancy report) against the requirement(s).

16.4   **FORMAT:** Contractor format is acceptable.

16.5   **MAINTENANCE:** Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.:** CA01C
2. **ISSUE:** Standard
3. **DRD NO.:** **TVC1-VR-VP**
4. **DATA TYPE:** 1
5. **DATE REVISED:**
6. **PAGE:** 1/2
7. **TITLE:** Verification/Validation Planning
8. **DESCRIPTION/USE:** To document the verification/validation approach, verification/validation activities, and organizations necessary to define and execute the project's verification/validation program.
9. **OPR:**
10. **DM:**
11. **DISTRIBUTION:** Per Contracting Officer's letter
12. **INITIAL SUBMISSION:** 10 days prior to Engineering Model Final Design Review (Engineering Model)
13. **SUBMISSION FREQUENCY:** Update EM submission as required. 10 days prior to Preliminary Design Review (PDR) and 10 days prior to Critical Design Review (CDR) (Flight Design).
14. **REMARKS**
15. **INTERRELATIONSHIP:** SOW paragraph 6.1
16. **DATA PREPARATION INFORMATION:**

16.1 **SCOPE:** The Verification/Validation Planning information provides a detail description of the project's verification/validation approach and structure for implementing the verification/validation program, as well as detail descriptions for the planned verification/validation requirements.

16.2 **APPLICABLE DOCUMENTS:** None

16.3 **CONTENTS:** The Verification/Validation Planning information shall include the following:
   a. Overview of the project's verification/validation program (i.e., qualification/acceptance vs. protoflight, verification/validation of spares, refurbishment/reverification/revalidation plans).
   b. Description of the project's organizational structure for implementing the verification/ validation program (i.e., organization's involved in component vs. system tests, review and signoff authority for compliance data).
   c. Detail descriptions of all verification/validation activities (i.e., tests, analyses, inspections) to be performed based on the identified verification/validation requirements. Identify any prerequisites, constraints, and objectives for all the verification/validation activities.
   d. Detail time correlated sequence of verification/validation activities.
   e. Description and planned usage of the support equipment, software, facilities, and tooling necessary to execute the verification/validation activities.

16.4 **FORMAT:** Contractor format is acceptable.

16.5 **MAINTENANCE:** Changes shall be incorporated by change page or complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. DRD NO.: CADC
2. ISSUE: Standard
3. DRD NO.: TVCI-VR-VP
4. DATA TYPE: 1
5. DATE REVISED:
6. PAGE: 1/2
7. TITLE: Verification/Validation Planning
8. DESCRIPTION/USE: To document the verification/validation approach, verification/validation activities, and organizations necessary to define and execute the project's verification/validation program.
9. OPR:
10. DM:
11. DISTRIBUTION: Per Contracting Officer's letter.
12. INITIAL SUBMISSION: 10 days prior to Engineering Model Final Design Review (Engineering Model)
13. SUBMISSION FREQUENCY: Update EM submission as required. 10 days prior to Preliminary Design Review (PDR) and 10 days prior to Critical Design Review (CDR) (Flight Design).
14. REMARKS:
15. INTERRELATIONSHIP: SOW paragraph 6.1
16. DATA PREPARATION INFORMATION:

16.1 SCOPE: The Verification/Validation Planning information provides a detail description of the project's verification/validation approach and structure for implementing the verification/validation program, as well as detail descriptions for the planned verification/validation requirements.

16.2 APPLICABLE DOCUMENTS: None

16.3 CONTENTS: The Verification/Validation Planning information shall include the following:

a. Overview of the project's verification/validation program (i.e., qualification/acceptance vs. protoflight, verification/validation of spares, refurbishment/reverification/revalidation plans).

b. Description of the project's organizational structure for implementing the verification/validation program (i.e., organization's involved in component vs. system tests, review and signoff authority for compliance data).

c. Detail descriptions of all verification/validation activities (i.e., tests, analyses, inspections) to be performed based on the identified verification/validation requirements, identify any prerequisites, constraints, and objectives for all the verification/validation activities.

d. Detail time correlated sequence of verification/validation activities.

e. Description and planned usage of the support equipment, software, facilities, and tooling necessary to execute the verification/validation activities.

16.4 FORMAT: Contractor format is acceptable.

16.5 MAINTENANCE: Changes shall be incorporated by change page or complete reissue.