OMB Approval #: 2700-0042

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE	01
PAGE OF PAGES	1 of 9
2. AMENDMENT/MODIFICATION NO.	235
3. EFFECTIVE DATE	See Block 16C
4. REQUISITION/PURCHASE REQ. NO.	N/A
5. PROJECT NO. (If applicable)	N/A
6. ISSUED BY CODE BT / JGC	NASA Lyndon B. Johnson Space Center Attn: BT/ Michael Duckworth 2101 NASA Parkway Houston, TX 77058
7. ADMINISTERED BY (If other than Item 6) CODE	
8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State, and Zip Code)	Lockheed Martin Corporation Attn: Mr. John A. Torrez Contracts Manager Crew Exploration Vehicle, Space Systems Company 2625 Bay Area Blvd. Suite 80 Houston, TX 77528
9A. AMENDMENT OF SOLICITATION NO.	
9B. DATED (SEE ITEM 11)	
(x) 10A. MODIFICATION OF CONTRACT/ORDER NO.	X NNJ06TA25C
10B. DATED (SEE ITEM 13)	09/08/2006
CODE	100141
FACILITY CODE	04236

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.
Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods:

(a) By completing Items 8 and 15, and returning ____ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (If required)
N/A

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

CHECK ONE	
	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b)
X	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF: **FAR 52.243-2, CHANGES-COST REIMBURSEMENT (AUG 87), ALT V (APR 84); MUTUAL AGREEMENT OF THE PARTIES**
	D. OTHER (Specify type of modification and authority)

E. **IMPORTANT:** Contractor ☐ is not, ☒ is required to sign this document and return **3** copies to the issuing office.

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

The purpose of this modification is to:

1. Definitize Contract Change Order (CCO) 199, including all revisions,
2. Definitize the provisional increase from Modification 220, and
3. Implement contract changes defined in RECP, dated September 3, 2012

For a detailed description of the changes, see pages 2- 9.

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

15A. NAME AND TITLE OF SIGNER (Type or print)	Linda Dozier, Contract Management
15B. CONTRACTOR/OFFEROR	Linda Dozier (Signature of person authorized to sign)
15C. DATE SIGNED	27 Feb 2014
16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)	Michael Duckworth, Contracting Officer
16B. UNITED STATES OF AMERICA	(Signature of Contracting Officer)
16C. DATE SIGNED	2/28/2014

NSN 7540-01-152-8070
PREVIOUS EDITION UNUSABLE

STANDARD FORM 30 (Rev. 10-83)
Prescribed by GSA
FAR (48 CFR) 53.243

The negotiated agreements affect Schedule A of this contract as follows:

I. Based on the mutually agreed upon negotiated price of $4,550,000,000 for this action, contract value of Schedule A Completion Form Work is equitably adjusted as follows:

	Estimated Cost	Award Fee	Total
Previous	[redacted]		6,673,206,103
Mod 235			4,550,000,000
Less Provisional Increase (Mod 220)			(378,000,000)
New Cost Reimbursable Total			10,845,206,103
Schedule A Firm Fixed Price Total (Clause B.7)			266,400,000
New Schedule A Total			11,111,606,103

II. Contract Schedule A, Section B Clause B.3 entitled "Estimated Cost and Award Fee (NFS 1852.216-85)(Sep 1993)" is revised as set forth below:

"**B.3 <u>ESTIMATED COST AND AWARD FEE (NFS 1852.216-85) (SEP 1993)</u>**

The estimated cost and award fee for Schedule A *(base fee not applicable)* of this contract is broken out as follows:

.3 **<u>ESTIMATED COST AND AWARD FEE (NFS 1852.216-85) (SEP 1993)</u>**

The estimated cost and award fee for Schedule A *(base fee not applicable)* of this contract is broken out as follows:

	Delivery Order Number	Estimated Cost	Maximum Award Fee	Total Cost and Award Fee
Completion Form Work*	Not Applicable	[redacted]		
~~**Provisional Increase**~~	~~Not Applicable~~			
Completion Form – Recovery Effort	Not Applicable			
IDIQ Delivery Orders**	NNJ07TA26T			
	NNJ07TA27T			
	NNJ07TA28T			
	NNJ07TA29T			
	NNJ07TA30T			
	NNJ07TA31T			
	NNJ07TA32T			
	NNJ07TA33T			
	NNJ07TA34T			
	NNJ07TA35T			
	NNJ08TA15T			

	NNJ08TA16T	(b) (4) [redacted]	(b) (4) [redacted]
	NNJ08TA17T	[redacted]	[redacted]
	NNJ08TA18T	[redacted]	[redacted]
	NNJ08TA19T	[redacted]	[redacted]
	NNJ08TA20T	[redacted]	[redacted]
	NNJ08TA21T	[redacted]	[redacted]
	NNJ09TA01T	[redacted]	[redacted]
	NNJ09TA02T	[redacted]	[redacted]
	Task Order 20	[redacted]	[redacted]
	Task Order 21	[redacted]	[redacted]
	Task Order 22	[redacted]	[redacted]
	Task Order 23	[redacted]	[redacted]
	Task Order 24	[redacted]	[redacted]
	Task Order 25	[redacted]	[redacted]
	Task Order 26	[redacted]	[redacted]
	Task Order 27	[redacted]	[redacted]
	Task Order 28	[redacted]	[redacted]
	Task Order 29	[redacted]	[redacted]
Delivery Order Total		[redacted]	[redacted]
Grand Total		[redacted]	$10,845,206,103

*NOTE: Completion Form Work is all work not identified as IDIQ
** NOTE: Work subject to IDIQ provisions are separately identified in the statement of work. Amounts for estimated cost and available fee for cost reimbursable IDIQ delivery orders issued will be periodically updated unilaterally as these IDIQ delivery orders are issued/amended. The IDIQ value shown here identifies the current authorized work as of **Modification 236.** There may be some discrepancy with the total amount for the IDIQ task/delivery orders issued listed in this clause and the total amount for cost reimbursable IDIQ delivery orders that have been issued during intervals between periodic updates of this clause. The maximum potential IDIQ contract value is identified in Clause I.7 ORDER LIMITATIONS.

(End of Clause)"

III. Contract Schedule A, Section F, Clauses are updated as follow:

Amend clause F.2, COMPLETION OF WORK, paragraph (a) as follows:
"(a) Design, Development, Test and Evaluation – *Per the Integrated Project Schedule (Attachment J-16). Unless dictated by another Contract Attachment, the Contract Period of Performance is through 31 December 2020."

Amend clause F.7, OPTION TO EXTEND ORDERING PERIOD, paragraph 1, to reflect an ordering period through 30 December 2020.

Amend Clause F.8, PRODUCTION AND SUSTAINING ENGINEERING OPTION, to replace "no later than 120 days after formal CDR" with "no later than May 31, 2017."

IV. Contract Schedule A, Section G, Clause G.3 is deleted in its entirety and replaced with the following:

"G.3 AWARD FEE FOR END ITEM CONTRACTS

(a) The Contractor can earn award fee, or base fee, if any, from a minimum of zero dollars to the maximum stated in NASA FAR Supplement (NFS) clause 1852.216-85, "Estimated Cost and Award Fee" in this contract. Award fee evaluations, with the exception of evaluation periods 8 and 14, will be interim evaluations. At evaluation periods 8 and 14, which are final, the Contractor's performance for that period and all previous periods not evaluated as final in a previous determination, will be evaluated to determine earned award fee for that period of performance (e.g. Award Fee Period 8 is the final determination for Award Fee Periods 1-8 and Award Fee Period 14 is the final determination for Award Fee Periods 9-14). No award fee or base fee will be paid to the Contractor for that period of performance if that final award fee evaluation is "poor/ unsatisfactory."

(b) Beginning with the first interim Period of Performance (POP) Award Fee period as listed in Attachment J-7, the Government will evaluate the Contractor's performance at the end of every POP Award Fee period to monitor Contractor performance prior to contract completion and to provide feedback to the Contractor. The evaluation will be performed in accordance with Attachment J-7 to this contract.

(c) (1) Base fee, if applicable, will be paid in quarterly installments based on the percent of completion of the work as determined by the Contracting Officer.

(2) Interim award fee payments will be made to the Contractor based on each interim evaluation and includes award fee for both the POP and milestones completed during the award fee evaluation period. For purposes of interim evaluations and fee payments, mission milestones (e.g. PA-1, AA-2, EM-1 and EM-2) will be complete once the actual mission has been completed at which point the interim evaluation for that milestone will include evaluation of the delivered hardware's actual mission performance. For purposes of interim evaluations and fee payments, Programmatic and review milestones (e.g. PDR, CDR, FRR, EFT-1 Initial Power Up, etc.) will be complete after all the required deliverables for the milestone have been submitted and all completion criteria for the actual meetings have been met, or completion criteria described in Attachment J-7 is met.

The amount of the interim award fee payment is limited to the lesser of the interim evaluation score or 80 percent of the fee allocated to that period less any provisional payments made during the period or a prior period for any milestone(s) receiving an interim payment in the period for which a provisional payment was already made during a prior period. All interim award fee payments will be superseded by the final award fee determination period in which it falls.

(3) Provisional award fee payments for POP Award Fee will be made under this contract pending each interim evaluation. If applicable, provisional award fee payments will be made to the Contractor on a quarterly basis of each interim evaluation. The amount of award fee which will be provisionally paid every quarter of each evaluation period will be calculated based on the available POP award fee as described in Attachment J-7 using the following formula:

(Available POP Award Fee for the Interim Period) x
[(the percent score of the prior interim evaluation) x (80%)]

4

For purposes of provisional fee payments, mission milestones (e.g. PA-1, AA-2, EM-1 and EM-2) will be complete once all required mission hardware has been delivered and formally accepted by the Government (i.e. DD250 date). For purposes of provisional fee payments, Programmatic and review milestones (e.g. PDR, CDR, FRR, EFT-1 Initial Power Up, etc.) will be complete after all the required deliverables for the milestone have been submitted and all completion criteria for the actual meetings have been met, or completion criteria described in Attachment J-7 is met. The amount of award fee which will be provisionally paid upon the completion of the milestone will be calculated based on the available award fee as described in Attachment J-7 using the following formula:

(Available Award Fee for the Completed Milestone) x
[(the percent score of the prior interim evaluation) x (80%)]

Provisional award fee payments for milestones will be made immediately upon the completion of each individual milestone. For purposes of making provisional milestone award fee payments for completed milestones, the parties recognize milestone dates for each mission milestone are in accordance with Contract Attachment J-9 for DD250 Hardware, and Contract Attachment J-16 for Contract Reviews and Mission Completions.

Although provisional award fee payments will be made for mission milestones after the hardware or milestone is accepted, the interim evaluation and resultant interim award fee payment for that same milestone will not be made until the conclusion of the actual POP during which the Government is reasonably able to perform a thorough evaluation of the actual mission performance of the milestone. If the actual review is held and the review's completion criteria met during the same period during which all requirements for that milestone were met, then the interim evaluation and award fee payment for that review milestone will be accomplished at the conclusion of that period of performance. However, if the actual review is held or its completion criteria met in a period subsequent to the one during which all requirements were met, the interim evaluation will be conducted at the end of the period of performance during which the completion criteria for that review milestone is completed.

Provisional award fee payments made each evaluation period, for POP Award Fee and completed milestones, will be superseded by the interim award fee evaluation for that period. If provisional payments made exceed the interim evaluation score, the Contractor will either credit the next payment voucher for the amount of such overpayment or refund the difference to the Government, as directed by the Contracting Officer. If the Government determines that (i) the total amount of provisional fee payments will apparently substantially exceed the anticipated final evaluation score, or (ii) the prior interim evaluation is poor/ unsatisfactory," the Contracting Officer will direct the suspension or reduction of the future payments and/or request a prompt refund of excess payments as appropriate. Written notification of the determination will be provided to the Contractor.

(4) All interim (and provisional, if applicable) fee payments will be superseded by the fee determination made in the final award fee evaluation of that period of performance (i.e. Award Fee Periods 1-8, inclusive of Milestones, and Award Fee Periods 9-14, inclusive of Milestones). The Government

will then pay the Contractor, or the Contractor will refund to the Government, the difference between the final award fee determination for that period of performance and the cumulative interim (and provisional, if applicable) fee payments. If the final award fee evaluation is "poor/ unsatisfactory", any base fee paid will be refunded to the Government.

(5) Payment of base fee, if applicable, will be made based on submission of an invoice by the Contractor. Payment of award fee will be made by NASA Accounts Payable based on an issuance of a unilateral modification by the Contracting Officer.

(d) Award fee determinations are unilateral decisions made solely at the discretion of the Government.

(End of clause)"

V. Contract Schedule A, Section H, Clauses are updated as follows:

"H.28, ORION CONTRACTS TAILORING.

Reserved"

Insert the following Clauses:

"H.39 ADVANCED AGREEMENT WITH RESPECT TO GOVERNMENT IN- LINE SUPPORT ACTIVITIES

(a) For purposes of this clause, "Government In-Line Support Activities" is defined as Government involvement and participation in the day-to-day ongoing performance of contract activity. By way of example, Government In-Line Support Activities may include, but are not limited to, the performance of contract work in a collaborative work environment by Government personnel possessing select critical skills such as in loads and dynamics test and analysis support, or performing systems engineering analysis and trades, or software development. The parties agree that the performance of Government In-Line support activities does not change the Statement of Work or any terms and conditions of this contract.

(b) In those instances where cross-functional teams of both Government In-Line support and Contractor employees are involved in the day-to-day decision making associated with completion of contract required tasks, the Contractor agrees that it is ultimately accountable for the outcome of decisions made and services performed. Ideas, theories, interpretations, technical advice and assistance, or solutions may surface during cross-functional team discussions with respect to Contractor's work under this Contract, but this shall not be construed by the Contractor as contractual direction or changing the existing contractual requirements in any way, and nothing in these discussions shall alter any obligation under the contract, unless confirmed in writing by the Contracting Officer.

(c) Notwithstanding the paragraphs (a) and (b) above, the Contractor shall notify the Contracting Officer in writing in accordance with FAR clause 52.243-2, Changes- Cost Reimbursement, and as required by FAR clause 52.243-7, Notification of Changes, in any instance where the Contractor believes the Government In-Line Support Activities:

1. Constitutes an assignment of additional work outside the Statement of Work;
2. Constitutes a change as defined in the applicable Changes clause;
3. Constitutes a basis for any increase or decrease in the total estimated contract cost, the fixed fee (if any), or the time required for contract performance;
4. Changes any of the expressed terms, conditions, or specifications of the contract; or
5. Interferes with the Contractor's rights to perform the terms and conditions of the contract.

(d) In accordance with FAR clause 52.243-2, Changes- Cost Reimbursement, the Contractor shall not proceed until the Contracting Officer provides a response to the Contractor's notice provided pursuant to paragraph (c).

(e) A failure of the Contractor and Contracting Officer to agree that the Government In-Line Support Activities are both within the requirements of the contract and do not constitute a change under the applicable Changes clause, or a failure to agree upon the contract action to be taken with respect to the Government In-Line Support Activities which the Contractor believes are within any of the five categories listed at paragraph (c), shall be subject to the Disputes clause of this contract.

(End of Clause)"

"H.40 ADVANCE AGREEMENT FOR LOCKHEED MARTIN USE OF JSC MACHINE SHOP

In accordance with FAR 31.109, Advance Agreements, this Advance Agreement is entered into between NASA Johnson Space Center and Lockheed Martin under contract NNJ06TA25C. Lockheed Martin has requirements to build and deliver spacecraft hardware. As a prime contractor, it is Lockheed Martin's responsibility to perform all services and provide all deliverables required by this contract. Lockheed Martin has identified the JSC Machine Shop (JSC MS) as a potential source for meeting some of its requirements under the contract.

The purpose of this agreement is to document how cost associated with JSC MS work will be handled under this contract, and to document the conditions for Lockheed Martin's use of the JSC MS.

1. Lockheed Martin has selected this source to fulfill their obligations under NNJ06TA25C for machined items; they are not directed by NASA to do so. NASA does not guarantee availability of the JSC MS to meet Lockheed Martin need dates. Use by Lockheed Martin of the JSC MS will be on a non-interference basis, and the work of the JSC MS contractor takes priority.

2. Lockheed Martin accepts responsibility for the work performed by the JSC MS. This work will be treated as if Lockheed Martin had acquired the hardware from any other source (i.e. it will become Government Property accountable to Contract NNJ06TA25C and be subject to applicable contract provisions). JSC MS delays, nonconformance or cost growth issues will not give rise to an equitable adjustment request by Lockheed Martin and this work is not considered Government Provided Services as described elsewhere in the contract.

3. Lockheed Martin's requirement to provide the overall Orion system is unchanged by their decision to route work through the JSC MS.

4. Lockheed Martin does not have privity of contract with the JSC MS and therefore, may not direct work by the JSC MS contractor; all work completed in the shop on Lockheed's behalf will be authorized by the NASA CO via task order.

5. The Parties agree that the work performed by JSC MS may be incorporated into the spacecraft, test vehicles, labs and other areas of the Prime Orion Contract work scope. This clause does not negate (a) the liability and risk of loss provision provided by FAR clause 52.245-5 of this Contract, (b) any limitation of liability provisions of the Contract, or (c) any indemnity as may be provided by NASA or the United States Government to Lockheed Martin under Public Law 85-804 pertaining to, Unusually Hazardous Risks, the Commercial Space Launch Act, or other statutory authority.

On a periodic basis (at a minimum to be performed annually during the Period of Performance Award Fee evaluation, and/or at the discretion of the CO), the contract value (both cost and the associated Lockheed Martin fee from the award fee pool) will be unilaterally reduced by the CO for the actual cost of work performed by the JSC MS. These costs will be determined by the actual cost in the job order cost system maintained by the JSC MS. This advance agreement is for the duration of the contract period of performance unless terminated by mutual agreement of the parties.

(End of Clause)"

"H.41 ESTABLISHMENT OF FLIGHT WINDOWS

NASA and the Contractor agree to establish flight launch windows for EM1, AA2 and EM2. These flight windows allow for delay in launch dates, by either party, with no entitlement to equitable adjustment, as long as the actual launch occurs within the established flight windows listed below.

The flight windows are based on the program planning flight dates for EM1, AA2, and EM2 as depicted in the Orion Project Contract Attachment J-16, Integrated Project Schedule (IPS). For schedule performance purposes Attachments J-16, IPS, and J-9, Deliverables, are held to the below flight window dates. This clause does not limit future Schedule changes to Attachments J-16 and J-9.

Flight Windows:

- EM1: December 1, 2017 through Dec 31, 2018
- AA2: December 15, 2018 through Dec 31, 2019
- EM2: September 1, 2020 through Dec 31, 2020

In the event of a NASA or Contractor driven delay beyond the flight window(s), the Contracting Officer shall direct the Contractor, in writing, of the revised launch date window, and request the Contractor to submit a proposal for the impact of the extended delay. Any equitable adjustment will be calculated from the end of the window noted above and the newly established launch date window.

(End of clause)"

VI. Contract Schedule A, Section I, Clauses are updated as follows:

Update Clause I.9, PAYMENT FOR OVERTIME PREMIUMS, value to (b) (4) [redacted]

VII. The following contract J-Attachments are deleted in their entirety and replaced with the updated attachments included in this modification:

Attachment	Title
J-1	Statement of Work
J-2 & J-2.2	Data Procurement Documents (DPD) & DRD Submission Matrix
J-3	Applicable, Guidance and Information Document List
J-7	Award Fee Plan
J-8	Subcontracting Plan for Small Business
J-9	Deliverables Items List
J-10	List of Installation Accountable Property and Services
J-11	Government Furnished Property (GFP)
J-12	Government Facilities
J-13	Acronyms List
J-15	Integrated Master Plan – Deleted and Reserved
J-16	Integrated Project Schedule
J-26	Tailored Requirements – Deleted and Reserved

VIII. Contract Configuration Matrix (CCM)

The CCM for this action is updated through changes dated 11 December 2013.

IX. Contractor Release Statement

In consideration of the modification agreed to herein as complete equitable adjustment for all claims arising out of or attributable to the issuance of the contract changes and/or contractor proposal listed below, the contractor hereby releases the Government from any liability under this contract for further equitable adjustment attributable to such facts or circumstances giving rise to said contract changes and/or contractor proposals, and for such additional obligations as may be required by this modification.

Contract Change: Contract Change Order 199, dated February 15, 2013, and all updates provided thereto

Contract Proposal: Proposal NS0112, dated March 29, 2013 and all updates provided thereto

ATTACHMENT J-1

STATEMENT OF WORK

As Of: 2/24/14

INTRODUCTION

The Crew Exploration Vehicle (CEV) (also called the Multi-Purpose Crew Vehicle (MPCV)) is the spacecraft that NASA plans to use to send human and cargo items into space and to return them to earth. The CEV is an element of the overall Exploration Systems Development (ESD) architecture that includes launch vehicles, spacecraft, mission systems and ground systems needed to embark on a robust space exploration program. This space exploration program will advance the Nation's scientific, security, and economic interests.

SCOPE

The Contractor shall develop and certify the CEV System to meet the mission requirements for ESD Exploration Flight Test (EFT)-1, Exploration Mission (EM)-1 and EM-2 mission scenarios. The Contractor shall deliver the CEV spacecraft configurations below per requirements in the CXP-72000, System Requirements for the Crew Exploration Vehicle Element (CEV SRD).

The following defines the different design reference missions which the MPCV Spacecraft was developed around:

- EFT-1: Configuration that supports an uncrewed test flight to demonstrate critical systems and high speed re-entry
- EM-1: Configuration that supports un-crewed Distant Retro-grade Orbit (DRO) with free return trajectory and high speed entry, with a mission duration of approximately 25 days, to demonstrate integrated spacecraft systems performance prior to crewed flight.
- EM-2: Configuration that supports crewed lunar orbit mission with a mission duration of approximately 10-14 days, to demonstrate crewed flight beyond LEO.

The EM-1 and EM-2 configurations includes:

- A Crew Module (CM),
- A Service Module (SM) which includes:
    - Crew Module Adapter (CMA)
    - European Service Module (ESM)
    - Spacecraft Adapter (SA)
    - Spacecraft Adapter Jettisonable (SAJ)
- A Launch Abort System (LAS) to provide a method for crew abort

Modifications of the CEV necessary to develop configurations to support missions after EM-2 will be addressed in an extensibility plan (IDIQ). The Contractor shall develop and deliver an extensibility plan (IDIQ) that shows extensibility of the CEV System design to meet proposed mission requirements for future missions, and explain how the CEV design can accommodate these additional needs.

CEV IMPLEMENTATION STRATEGY

The CEV implementation strategy requires a detailed implementation schedule to design the spacecraft, and implement, certify, and deliver it. NASA will work closely with the Contractor to develop the details of an implementation strategy that maintains the required standards for safety, reliability, and mission assurance. Ways that NASA will work closely with the Contractor include the following: NASA will participate in management and design meetings and decisions, NASA will work with the Contractor on the shop floor during development, NASA will participate in the Contractor Material Review Board (MRB) process, as described in MPCV 70059-S&MA Requirements, in order to help prevent stop-work conditions, and NASA will work with the Contractor in the test facilities during integration and test activities. The purpose of the level of participation is for access to NASA for timely decisions.

NASA will provide the oversight of all spacecraft design activities. However, the Contractor will retain responsibility for delivery of a design that meets the requirements. The detailed process discussion to accomplish this can be found in MPCV-72008, Orion Multi-Purpose Crew Vehicle Program Plan. Some areas of spacecraft design will be provided by NASA and NASA will perform independent activities for requirements validation and design certification in other areas. In these areas NASA will establish design requirements teams to integrate the activities of NASA and the Contractor. The Contractor will participate in and support these design requirements teams. NASA has responsibility for all GFE provided equipment. In addition, ESA will be developing, manufacturing, verifying and delivering the ESM to NASA. The Contractor will be responsible for integration of the ESM into the SM, and the Contractor maintains overall responsibility for the spacecraft system engineering, integration, and verification.

The Contractor will deliver a design that ensures simplicity, minimizes life cycle cost and addresses all aspects of human spacecraft development, production, certification and operations. The Contractor will design, develop, certify, and deliver the hardware required to achieve Uncrewed Lunar Flyby (EM-1) and Crewed Beyond Earth Orbit (BEO) Lunar Orbit (EM-2) mission requirements as defined in MPCV-72093, MPCV Program Concept of Operations in Schedule A. The Contractor shall develop an extensibility plan (IDIQ) that shows extensibility of the CEV System design to meet anticipated mission requirements as defined in MPCV-72000, Multipurpose Crew Vehicle System Requirements Document (MPCV SRD). The extensibility plan will identify those system design items that have a development deferral to a future contract action. The concept is to develop a “common” design for the spacecraft variants, where the vehicle can be extended for future missions. The common design and life cycle approaches will lead to an effective implementation of subsystem and spacecraft deliveries.

The Contractor is expected to develop and verify mission software during Schedule A, with future mission software being developed in future contract action with other upgrades. However, lunar mission software requirements must be evaluated to ensure the command and data handling hardware can accommodate the additional software required for lunar missions, as well as other mission objectives. The “common” vehicle design shall be configured to accommodate integrating the future upgrades to achieve the future mission objectives while remaining within the vehicle requirements constraints.

NASA will perform the CEV ground, flight, and training operations; design and develop CEV ground operations facilities, facility systems, and NASA-provided ground support equipment (GSE); and provide high-fidelity simulators and trainers. Further, NASA will conduct flight testing to demonstrate vehicle performance characteristics. In support of the NASA operations, risk reduction flight testing, and safety and mission assurance activities, the Contractor must provide the necessary data products and expertise as detailed in the SOW.

NASA will use the technical Data Requirements Documents (DRDs) to sustain and operate the CEV over the life of the Project. It is NASA’s intent to use the technical DRDs to document the CEV requirements, design, and certification activities.

CONTRACT STRUCTURE

To help differentiate the type of activities that comprise the Phase 2 contract, NASA has developed multiple "schedules." These include:

1. Schedule A (DDT&E). This includes all design, development, test and evaluation activities to certify EFT-1, EM-1 and EM-2 vehicles as well as the production activities for the first EM-1 and EM-2 flight vehicles along with other deliverables described in this SOW. Schedule A incorporates completion form and indefinite delivery, indefinite quantity (IDIQ) paragraphs. All paragraphs are completion form unless specifically marked as "IDIQ."

2. Schedule B (Production). This includes production of all future vehicles.

3. Schedule C (Sustaining Engineering and follow-on development and certification). This includes any new DDT&E effort required beyond the scope of Schedule A.

This statement of work applies to Schedule A only. Descriptions of other contract schedules are provided for reference only.

1 PROJECT MANAGEMENT

The Contractor shall develop, implement and maintain a set of common project management processes, systems and data deliverables to be utilized for all contract schedules (A, B and C) throughout the life of the contract.

1.1 PROJECT MANAGEMENT AND ADMINISTRATION

An anchoring capability of the Exploration Systems Development (ESD) programs is a human-rated CEV that will carry human crews from Earth into space and back again.

a) The Contractor shall design, develop, certify, and deliver the hardware and software required to achieve the mission requirements as defined in MPCV-72000, Multipurpose Crew Vehicle System Requirements Document (MPCV SRD).
b) The Contractor should minimize life cycle cost in the design, development, certification, and delivery of the hardware and software required to achieve the mission requirements in accordance with paragraph 1.1a.
c) The Contractor shall ensure crew/ground safety while meeting system performance requirements and achieving mission objectives.
d) The Contractor shall design the CEV System to accommodate all the design reference missions defined in MPCV-72093, MPCV Program Concept of Operations.
e) The Contractor shall design the CEV System to the requirements and terms specified in CXP-72000, System Requirements for the Crew Exploration Vehicle Element (CEV SRD).
f) The Contractor shall implement designs for the CEV spacecraft and ground systems to achieve efficient and effective operations.
g) The Contractor shall perform to the negotiated cost, schedule, and technical baseline.
h) Reserved
i) The Contractor should maximize the use of existing technology in the design of the CEV, unless new technology is required to meet NASA requirements.
j) The Contractor shall base the vehicle design on an open system architecture.

k) The Contractor should qualify components, subsystems, modules, and systems by test, to the maximum extent possible.
l) The Contractor shall provide a CEV System that shall have a lifecycle that ends no less than 20 years after the first human flight.
m) Contractor shall perform an extensibility assessment that shows extensibility of the CEV System design to meet future mission requirements**.** The plan will identify those system design items that have a development deferral to a future contract action. (IDIQ)
n) The Contractor shall support a reproducibility assessment of the ESM as part of the MPCV Extensibility Plan, including identification of potential US suppliers for components for future builds. (IDIQ)

1.1.a Project Management, Systems, Planning and Reporting

a) The Contractor shall implement an organizational structure for the management, coordination, and control of contract activities including the project's cost, schedule, performance, risks, contracts, and subcontracts using as guidance ISO 14300-1, Space Systems - Program Management - Part 1: Structuring of a Program. The Contractor shall develop and implement a project management plan that covers all aspects of project management for the CEV Project in accordance with **DRD CEV-M-001**, *CEV Prime Project Management Plan*. The contractor shall incorporate the proposed Streamlining Plan in **DRD CEV-M-001**, *Prime Project Management Plan*.

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-M-001: CEV Prime Project Management Plan**

1.1.b Performance Management Reviews and Performance Metrics

a) The Contractor shall conduct Quarterly Program Performance Reviews (QPPRs) with the Crew Exploration Vehicle Project Office (CEVPO) in accordance with **DRD CEV-M-002**, *Performance Assessment Plan and Reports*. The reviews shall provide insight into the Contractor's, subcontractors', and vendors' overall technical, schedule, and cost performance and status.
b) The Contractor shall define the metrics, to be approved by government, in accordance with the **DRD CEV-M-002**, *Performance Assessment Plan and Reports*. The Contractor shall update the metrics and performance data monthly and make it available for NASA review in the Contractor's collaborative environment and during working-level discussions. The Contractor shall present the metrics and performance data at the QPPRs.
c) The Contractor shall recommend the technical performance parameters, to be approved by NASA, in the Performance Assessment Plan. The Contractor shall status the technical performance parameters quarterly in their Performance Assessment Reports.
d) The Contractor shall report on each SOW and SRD "should" statement at major program design reviews until the "shoulds" are satisfactorily accomplished.

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-M-002: Performance Assessment Plan and Reports**

1.1.c External Relationships

1.1.c.1 Associate Contractors

a) When the working environment requires interaction with other NASA contractors, the Contractor shall establish cooperative relationships with other NASA contractors, defined as associate contractor relationships. Associate relationships are required for expeditious exchange of management and technical data among NASA contractors.

1.1.c.2 NASA Centers

a) The Contractor shall establish cooperative relationships at the NASA centers to provide support (e.g. technical analyses, data, etc.) or understand NASA GFE and associated data deliverables (reference SOW paragraph 6.b), schedules, interfaces, and interactions. The contractor shall work jointly with NASA to establish contractor/NASA GFE integration teams. These relationships shall be documented in accordance with **DRD CEV-M-001**, *CEV Prime Project Management Plan*.
b) The Contractor shall provide resident office space, including phone, computer, and desk space, to accommodate NASA program office personnel.

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-M-001: CEV Prime Project Management Plan**

1.1.c.3 ESA and ESA Related Entities

a) The Contractor shall establish cooperative relationships with ESA related entities to support the implementing arrangement between NASA and ESA for the development of the ESM.
b) The Contractor shall perform technical interactions with ESA-related entities necessary for exchange of data, hardware and software.
c) For the export of hardware, NASA will be responsible for obtaining the Export Licenses for Orion shipments. The Contractor shall be responsible for “freight forwarding” of the items on the government’s behalf. The Contractor shall support the procurement of hardware as defined in the J-9 Table 2.

1.1.d Internal/External Project Review Support

a) The Contractor shall develop briefing materials and analyses for CEV System meetings with various internal and external review groups. Examples of these internal and external groups include the flight technique panels, Aerospace Safety Advisory Panel (ASAP), Inspector General/Government Accountability Office (IG/GAO), and cost assessments teams.
b) The Contractor shall prepare and present various topics, such as CEV Project technical, cost, and schedule status, specific safety or risk issues, design and development issues, and responses to external inquiries, as directed by NASA.

1.1.e Security Management

Security management includes management of information technology security, physical/facility security, personnel security, flight vehicle security and flight test article security.

a) The contractor shall use the following standards and requirements documents as applicable documents for developing and executing all security management processes and products:
   - CxP 70170, Constellation Program Information Technology (IT) Functional Security Requirements

- NIST SP 800-53, Revision 3, Recommended Security Controls for Federal Information Systems.
- NPR 1600.1, NASA Security Program Procedural Requirements (Chapters 4, 6, and 8 only)
- NPR 2810.1A, Security of Information Technology. See 1.1 e paragraph c) for additional clarification on requirements in NPR 2810.1A for contractor roles and responsibilities.

NASA will be responsible for encryption handling key management, storage, COMSEC custodial activities, and operational integration.

b) The following documents are provided for informational purposes for the contractor to support development of all security management processes and products:
   1. NPR 1600.1, NASA Security Program Procedural Requirements (Chapter 7 only)
   2. ITS-HBK 0202 Security Assessment and Authorization: FIPS 199 Moderate & High Systems
   3. ITS-HBK 0302 Planning: Information System Security Plan Template, Requirements, Guidance and Examples
   4. ITS-HBK 0402 Risk Assessment: Procedures for Information System Security Penetration Testing and Rules of Engagement

c) NPR 2810.1A clarification on contractor roles and responsibilities:
   - Certification and Accreditation (C&A)
   - Certification and Accreditation (C&A) requirements shall be Applicable only to those systems delivered to NASA by the contractor, e.g. Electrical Ground Support Equipment (EGSE), Command and Control Monitoring System (CCMS).
   - All contractor delivered systems requiring C&A shall be considered a "Moderate" criticality level, unless otherwise stated by NASA.
   - The engineering technical expertise responsible for implementing and delivering systems to NASA shall provide support to the NASA-led C&A activities. [Level of support for C&A is currently provided during existing working groups, as part of architectural information delivered with the systems and gathered through technical discussions. The current level of support meets the C&A support requirements.]
   - For delivered systems, the contractor shall provide existing security risk assessments (utilizing existing corporate processes) upon delivery.
   - Wireless Local Area Networks (WLAN) Applicable Requirements
   - WLAN requirements shall be Applicable for systems on NASA facilities utilizing NASA wireless networks. The contractor shall meet the hosting Center's requirements for WLAN implementation. Examples include Glenn Research Center Plumbrook facilities.
   - WLAN requirements shall meet the intent of the hosting Center's WLAN requirements for wireless systems located on a NASA facility and utilizing the Contractor's wireless network. Examples are Kennedy Space Center O&C and Glenn Research Center Plumbrook facilities.
   - WLAN requirements for wireless implementations on a contractor's facility shall be based on the contractor's existing policies and procedures to meet the intent of NPR 2810.1A, Chapters 11.3.10 through 11.3.13.

d) Existing Corporate Policies and Subcontracts

   All subcontracts are required to secure and protect information technology, facilities, personnel, flight vehicle, and flight test articles. Subcontractors should utilize their existing corporate security measures to the maximum extent practicable to comply with the contract security requirements. If a subcontractor system is connected to a NASA network, the subcontractor shall follow the NASA policies.

1.2 BUSINESS MANAGEMENT

1.2.(a) Financial Management

Financial Management provides summary-level cost reporting by fund source, Work Breakdown Structure (WBS), elements of cost and workforce including labor equivalent personnel (EP), overhead, and other direct and indirect costs.

1) The Contractor shall develop, deliver, and implement monthly financial management reporting in accordance with **DRD CEV-B-001**, *Financial Management Report* (NASA Form 533).
2) The Contractor shall provide project-wide data once a year to be used in NASA's budget planning process (e.g., Program Planning and Budget Execution (PPBE) budget calls). The Contractor shall provide an annual Operating Plan (OP) update to that data for the upcoming fiscal year as requested by NASA. NASA will specify the format and content of the Contractor's inputs and rationale.
3) Upon request by NASA, the Contractor shall provide project-wide budget data a maximum of three times per year. This data will be used for the purposes of gathering budget impacts for various re-planning scenarios. NASA will specify the format and content of the Contractor's inputs and rationale.
4) The Contractor shall provide property financial reports in accordance with **DRD CEV-B-004**, *Property Financial Reporting*.
5) The Contractor shall provide Rough Order of Magnitude (ROM) estimates as requested to support the NASA decision making process. ROM estimates shall be delivered to NASA within 7 days of the formal request unless the contractor notifies NASA within 2 days of request receipt that the ROM will requires more time due to effort required to bound the scope, additional reviews required, or significant complexity. The contractor shall use best available estimating techniques given the ground rules and assumptions provided by NASA. Prior to delivery to NASA, ROM estimates will be reviewed by the contractor technical community.

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-B-001: Financial Management Report (533)**
- **DRD CEV-B-004: Property Financial Reporting**

1.2.(b) Workforce Reporting

Workforce Reporting provides workforce information by geographic location.

1) The Contractor shall develop, deliver and implement workforce data in accordance with **DRD CEV-B-002**, *Workforce Reporting*.

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-B-002: Workforce Reporting**

1.2.(c) Integrated Baseline Review (IBR)

1) The Contractor shall perform an Integrated Baseline Review (IBR) with NASA to establish the contract baseline. Subsequent baseline reviews will be required by NASA to update the performance measurement baseline when the contract has a significant restructure or change in cost phasing. The IBR shall include the following accomplishment criteria and subsequent baseline reviews should identify only changes:

- Project organization fully established with cost control accounts and organization members identified, including interfaces and interactions with NASA. Organization and teaming roles and responsibilities defined.
- Organizational staffing plans in place
- IMS review
- Risk management system and process review
- Metrics base-lined
- Earned value management system and process review

2) The Contractor shall ensure the technical contents of work packages and control accounts are consistent with the scope of work defined in the WBS, SOW and SRD.
3) The Contractor shall work jointly with NASA to develop and document an integrated performance measurement baseline. This baseline consists of all contract work including the integration of GFE.
4) NASA will provide agreed-to specific GFE performance measurement baseline data.
5) The Contractor shall provide a logical, resource-loaded, integrated/interdependent sequence (i.e. predecessor/successor network) of tasks supporting the contract schedule.
6) The Contractor shall demonstrate to NASA that metric collection methods are in place to monitor agreed-to requirements of the contract.

1.2.(d) Cost Performance Report

The Cost Performance Report (CPR) will be used to provide information for: (1) integrating cost and schedule performance data with technical performance measures, (2) assessing the magnitude and impact of actual and potential problem areas causing significant cost and schedule variances, and (3) providing valid, timely status information to the CEV Project.

1) The Contractor shall establish, maintain, and use in the performance of this contract, an integrated earned value management system in accordance with ANSI/EIA-748-98, Earned Value Management Systems.
2) The Contractor will perform earned value analysis and shall capture, maintain, and provide NASA access to the earned value analysis data. The earned value analysis data, at both the cost account and overall project-level, shall be presented as part of the QPPR. Reference **DRD CEV-M-002**, *Performance Assessment Plan and Reports*. In addition, the contractor shall provide electronic access to the Contractor's weekly earned value data.
3) The Contractor shall develop, deliver and implement CPR data in accordance with **DRD CEV-B-003**, *Cost Performance Report*, and shall support informal working-level discussions on the content.
4) The Contractor shall make available the following via Lockheed Martin Windchill:
    a) Monthly XML file to include:
        i) Data by Control Accounts identifying:
            1) WBS, Control Account Number, CAM and IPT Leader
            2) BCWS, BCWP, ACWP and ETC/EAC
        ii) Undistributed Budget (UB) and Management Reserve (MR)
    b) Monthly Integrated Master Schedule (IMS) in native Microsoft Project format
    c) Monthly Work Force Report/Graph

Deliverables

The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-B-003: Cost Performance Report**

1.2.(e) Life Cycle Cost Management

1) The Contractor shall capture, maintain, and provide access to life cycle cost analysis data in the NASA ICE as it evolves through the project life cycle. Life cycle cost definitions to be used in the analysis are defined in Attachment J-5, Appendix 1, Life Cycle Cost Analysis. Life cycle cost analysis data for DDT&E and operability shall be generated and presented at each major design review (e.g. SDR, PDR, CDR) and at each QPPR. These presentations shall include the latest LCC estimate, as well as a detailed discussion of the impact from the current design, design and operations changes since the last review, and the rationale for the changes. In addition, the contractor shall utilize an integrated management assessment tool to perform affordability analysis to support life cycle cost management. Reference SOW paragraph 2.4 Integrated Analysis.

1.2.(f) Contracts Management

1) The Contract Management organization shall develop, review, interpret, negotiate, modify and administer the Project Orion contract. Contracts Management is the primary point of contact with the Orion NASA Contracting Officer(s), the delegated Defense Contracting Management Agency (DCMA) and the delegated Defense Contract Audit Agency (DCAA). Contracts Management shall resolve and document contract issues. Contracts Management shall ensure that Contract requirements are fully defined and implemented by the contractor team.

1.3 CONFIGURATION MANAGEMENT AND DATA MANAGEMENT

1.3.(a) Configuration Management

1) The Contractor shall develop and implement Configuration Management (CM) processes and systems.
   - The Contractor CM process and system shall use NASA-STD-0005, NASA Configuration Management Standards, as guidance.
   - The Contractor’s CM process and system shall provide the following: (1) configuration identification, (2) configuration control, (3) configuration status accounting, and (4) configuration management verification and audits.
   - The Contractor CM plan shall define how the Software Configuration Management Plan (see **DRD CEV-T-006**) supports this CM process and system.
   - The Contractor shall work with NASA to develop a configuration management process that also integrates with the Exploration Systems Development (ESD) elements.
2) The Contractor shall integrate the CM system across all CEV project elements including modeling and simulation, engineering drawing development and release, manufacturing, test equipment and test articles, operations, and quality, as well as acquisition organizations including customer and vendor CM systems.
3) The Contractor shall implement and maintain a configuration status accounting system that provides information defining and maintaining the as-designed and as-built configuration of the system hardware and software and the status of changes to this configuration.

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-M-003: Configuration and Data Management Plan and Reports**

1.3.(b) Data Management

a) The Contractor shall develop and implement Data Management (DM) processes and systems.
   - The Contractor's DM process and system shall provide the following: (1) data identification, (2) data control, (3) data status accounting, and (4) data management verification and audits.
   - The Contractor shall work with NASA to develop a data management process that also integrates with the Exploration Systems Development (ESD) elements.

b) The Contractor shall integrate the DM system across all CEV project elements such as modeling and simulation, engineering drawing development, manufacturing, test equipment and test articles, operations, and quality, as well as acquisition organizations including customer and vendor DM systems.

Deliverables

The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-M-003: Configuration and Data Management Plan and Reports**

1.4 RISK MANAGEMENT

a) The Contractor shall identify, evaluate, manage, and control the safety, technical, cost, and schedule-related risks associated with all aspects of the CEV Project in accordance with MPCV-72091 Orion MPCV Program Integrated Risk Management Plan.

b) Reserved

c) The Contractor shall substantiate each identified risk in the form of historical information, and analysis. These analyses and information may be integrated with Probabilistic Risk Assessment (PRA) analysis, as appropriately applied to high risk hardware/software development and operations. Reference S&MA **DRD CEV-S-010**, *Probabilistic Risk Assessment Results*.

d) The Contractor shall communicate and elevate multi-element and external interface risks to the CEV Project office for the purpose of multi-element risk integration.

e) The Contractor shall perform integrated risk analysis, mitigation, tracking/control for the CEV Project office. This effort is for the purpose of communication of external interface and multi-element risk integration data for the ESD-level risk management process.

f) The Contractor shall manage risks utilizing a risk management tool. The Contractor shall integrate their risk management tool with ICE.

1.5 INFORMATION TECHNOLOGY MANAGEMENT

For IT applications, other than mission-specific software, the Contractor shall:

- Where cost effective to NASA, use Commercial-Off-The-Shelf (COTS) and existing Government Off-The-Shelf (GOTS) products.
- Ensure compatibility with existing NASA applications and systems.
- Comply with NASA requirements for NPR 7150.2, NASA Software Engineering Requirements for the appropriate software classes, limited to classes E, F, and G.

1.5.(a) NASA Integrated Collaborative Environment (ICE)

The NASA Integrated Collaborative Environment (ICE) is the primary means of sharing, reporting, collecting, recording, and accessing project information between NASA, the CEV Contractor, subcontractors and authorized Government personnel connected with the CEV Project. ICE provides secure, real-time collaborative access to a single source of management information, product information, and technical data. ICE is the principal mechanism for integrating a project's digital information management environment.

1) The Contractor shall use ICE for delivery of all data.
2) The Contractor shall use the interactive collaborative configuration management and document management environments of ICE for configuration management of CEV project directives and change control activities.
3) The Contractor shall comply with Attachment J-14, ICE Operating Environment.
4) The Contractor shall implement the ICE interface using one of the two options described in J-14, ICE Operating Environment, Section II, Data Access Requirements.
5) The Contractor's collaborative environment shall be available within 30 days of contract award.
6) The Contractor's collaborative environment shall be updated with the latest status information based on the Contractor-determined interval(s) and as approved by NASA.
7) Non Deliverable information such as week to week coordination, working level analysis, action item responses, etc. shall be transmitted via an LM established data sharing system (e.g. project link).

1.6 RESERVED

1.7 INTEGRATED SCHEDULE MANAGEMENT

1.7.(a) Integrated Master Plan (IMP)

a) The Contractor shall develop and maintain an Integrated Master Plan (IMP). All changes to the IMP shall be via bilateral modification.
b) The Contractor shall manage the execution of the CEV System using the IMP. The Contractor shall report on contract progress in accordance with the IMP at each QPPR.

1.7.(b) Integrated Master Schedule (IMS)

a) The Contractor shall develop, maintain, and provide NASA access to an Integrated Master Schedule (IMS) and IPT level supplemental schedules. The Contractor shall use these schedules for day-to-day management of the contract tasks. Reference contract Clause H.12, Electronic Data Access.
b) The Contractor shall create and maintain a schedule that supports automated time phasing of tasks, is resource loaded, predecessor/successor structured, networked schedule, with critical path identification and schedule assessment capability. The Contractor shall incorporate NASA provided delivery schedules for GFE products and data and delivery schedules for ESM products and data into their IMS providing an integrated IMS that reflects the entire CEV project scope.
c) The Contractor shall maintain and update the IMS to reflect changes in the IMP and Make it available electronically to NASA in accordance with SOW paragraph 1.2 (d) 4.
d) The Contractor shall integrate Program Level risk mitigation activities into the IMS.

1.8 SPECIAL STUDIES (IDIQ)

a) The Contractor shall perform special CEV-related studies and analyses as directed by NASA. The Contractor shall define the resources required as part of their response to NASA's request for a task order plan. The trade studies and analyses resulting from special studies shall also include the impact to system safety and life cycle cost.

2 CEV VEHICLE INTEGRATION

CEV Vehicle Integration consists of the technical and management efforts of directing and controlling the integrated CEV System Engineering and Integration effort to achieve a solution that satisfies all CEV Project requirements and otherwise balances performance, cost/affordability, schedule, and risk. This effort includes the development and integration of the CEV System with all ESD elements, and integration of the ESA-provided items. This element also includes task efforts in managing Technical Reviews required by NASA.

2.1 VI MANAGEMENT AND ADMINISTRATION

Vehicle Integration Management and Administration consists of the efforts for planning, organizing, directing, coordinating, controlling, and approval processes used to accomplish Vehicle Integration objectives. Vehicle Integration consists of the efforts to manage the Contractor's systems engineering and integration activities and to manage the Contractor's participation in NASA-led Exploration Systems Development (ESD) elements systems engineering and integration activities in accordance with NASA requirements and the Contractor's documented plans.

a) The Contractor shall manage their systems engineering and integration activities consistent with MPCV-72008, Orion MPCV Program Plan.
b) The Contractor shall participate in MPCV Program and ESD systems engineering and integration activities in accordance with MPCV-72008, Orion MPCV Program Plan.
c) The Contractor shall implement plans for managing technical data products, processes and organizational roles and responsibilities used to accomplish their systems engineering and integration activities and document their plans in the Contractor's PMP (**DRD CEV-M-001**, *CEV Prime Project Management Plan*).
d) The contractor shall support the NASA/Orion Change process from Change Request (CR) initiation through the Change Directive approval when requested by NASA/Orion. The contractor shall provide a CR evaluation response which includes a technical assessment of the CR as well as a Life Cycle Cost (LCC) estimate. The CR evaluation response shall identify major cost drivers. The schedule for the evaluation response will be worked for each CR; however, on average the CR evaluation response shall be submitted to NASA/Orion Configuration Management (CM) within 5-15 working days after the CR is received by the contractor.

2.1.(a) Technical Reviews

1) The Contractor shall support the planning and execution of technical integration reviews conducted by NASA. The Contractor shall support integrated analysis and assessment efforts in support of the integration reviews to identify and resolve integration issues with other Exploration elements, as required.
2) The jointly-conducted reviews are contained in the Integrated Master Plan. At these reviews, the Contractor shall develop and present data and respond to Review Item Discrepancies (RIDs) and identified CoFR exceptions.

2.2 CEV REQUIREMENTS DEFINITION AND MANAGEMENT

a) The Contractor shall address all life cycle processes including development, manufacturing, test, distribution, operation, support, training, and disposal to derive a complete requirements (functional) baseline and functional architecture.
b) The Contractor, in conjunction with NASA, shall allocate the MPCV-72000, Systems Requirements for the Multi-Purpose Crew Vehicle Systems Requirement Document (MPCV SRD), and External IRDs to the Spacecraft and ground support equipment. The Contractor shall document the requirements

developed from this process in the Spacecraft <System> Requirements Specification and the Ground Support Equipment <System> Requirements Specification per **DRD CEV-T-031**, *CEV <Level> Requirements Specification*, and in **DRD CEV-T-032**, *CEV Specification and Drawing Trees*. The Contractor shall integrate Module Specific Drawing Trees identified in Sections 6.1.2, 6.2.2, 6.4.2 into the Integrated Stack Drawing Tree.

c) The Contractor shall document the functional decomposition, requirements allocation, and design to the component level in **DRD CEV-T-033**, *Architecture Design Document*.

d) The Contractor shall provide a requirements database (compatible with CRADLE®) to maintain bi-directional requirements traceability from the CEV System level/EIRDs and the CEV subsystem level requirements throughout the requirements allocation process to the component level. The database shall also include a functional model to which the requirements are linked. The Contractor shall provide NASA access to this capability through NASA ICE and provide traceability reports at all milestone reviews to verify requirements traceability. This traceability shall be maintained and continue through the design, procurement specifications, hardware and software configuration items requirements, and verification of the requirements and results.

e) Software requirements shall be maintained in a contractor specified system and will include bi-directional requirements traceability between software requirements and software parent requirements, provided within the CSCI Software Requirements Specifications (SRS) **DRD CEV-T-048**, and between software requirements and software development lifecycle artifacts.

f) The Contractor shall configuration manage the allocated requirements baseline and architecture throughout the performance period of this contract in accordance with Section 1.3 (a) Configuration Management.

g) The Contractor shall perform iterative and on-going analyses to validate the allocation of requirements and include results in **DRD-CEV-T-009**, *CEV Analysis Reports*.

h) The Contractor shall assign each requirement an owner who is responsible for ensuring that the requirement is 1) consistent with evolving requirements and the design baseline; 2) complete and sufficient relative to similar requirements; 3) correctly and clearly written; 4) verifiable via test or other approved method; 5) mapped to specific verification event(s); 6) if appropriate, tracked with a TPM for its predicted compliance within allocated resources; 7) decomposed, allocated, and linked to related requirements; 8) assigned a validation method and validation plan cross-reference; and 9) properly represented in trade studies, analysis, and risk assessment.

i) The Contractor shall support the CEV SRR and develop, deliver and maintain the following documents: in addition to standard products delivered as part of 2.4 Integrated Analysis: CEV-S-003, System Safety Hazard Analyses, **DRD CEV-T-031**, *CEV Spacecraft System Requirements Specification* and **DRD CEV-T-032**, *CEV Specification and Drawing Trees*.

j) The Contractor shall define the modules, subsystems, components, and software units that make up the CEV Spacecraft per the requirements and deliverables included in this section.

k) The Contractor shall allocate CEV Spacecraft requirements down to the component level for the design of flight articles and maintain the allocations/specifications over the life of the contract.

l) The Contractor shall document spacecraft, LAS module, and GSE level requirements using **DRD CEV-T-031**, *CEV <Module> Requirements Specifications*.

m) The Contractor shall support NASA in the development of the ESM System Requirements Document and the ESM IRDs, including maintaining the trace of requirements allocated to the ESM SRD to ensure continuity with the requirements in the MPCV Spacecraft Specification.

n) The Contractor shall integrate ESM requirements into the overall Orion baseline set of requirements.

o) The contractor shall address HSIR Should statements contained within MPCV-72000 System Requirements Document using NASA provided templates for capability within MPCV architecture.

Deliverables
The Contractor shall deliver and maintain the following document(s):
- **DRD CEV-T-031: CEV Spacecraft Requirements Specification**
- **DRD CEV-T-031: CEV <Module> Requirements Specifications**
- **DRD CEV-T-032: CEV Specification and Drawing Trees**
- **DRD CEV-T-033: CEV Architecture Design Document**
- **DRD CEV-T-009: CEV Analysis Reports**

2.3 MPCV INTEGRATION AND INTERFACES MANAGEMENT

MPCV Integration and Interfaces Management consists of the efforts to integrate the MPCV System and integrate the MPCV with the ESD elements, including test boosters, launch vehicles, mission operations and ground operations.

2.3.(a) ESD External Integration

a) The Contractor shall support NASA in the performance of all work necessary to successfully integrate the MPCV into the ESD programs, as defined by the following documents:
   - MPCV-70026, MPCV to Space Launch System (SLS) IRD
   - MPCV-70028, MPCV to Ground Systems IRD
   - MPCV-70029, MPCV to Mission Systems IRD
   - CxP-70118-1 Constellation Program Systems to Communications and Tracking Network Interface Requirements Document, Volume 1: Orion.

   Support shall include:
   - Coordination of the development, allocation, maintenance, and implementation of integration requirements between the MPCV System and other ESD elements.
   - Development and maintenance of the MPCV to other ESD element External Interface Control Documents per **DRD CEV-T-029**, *Interface Control Documents*.
   - Design, development, test, and evaluation of the interfaces between the MPCV System and other ESD Program elements and the integrated performance of the CEV with the other ESD elements for nominal, as well as critical, contingency design cases including abort design cases as appropriate. NASA will provide aerodynamic and aerothermodynamic analyses for the CEV while mated to its launch vehicle and while unmated. The Contractor shall design the CEV for the resultant induced structural and thermodynamic loads. The Contractor shall use the applicable requirements. CxP-72385, CEV Government Furnished Data for Orion System Design and Analysis.
   - Participation in the ESD programs and other Project System Reviews.
   - Participation in the requirements reconciliation activities that will occur after ESD element and other Project Reviews.

b) The Contractor shall perform analyses and tests and provide reports and engineering data supporting integration and operation of MPCV and other ESD elements such as:
   - Structural models and analyses for static, dynamic and coupled-loads analyses
   - Mass properties, dimensions and physical (material, thermal, etc.) properties
   - Rendezvous, proximity operations, and abort mode trigger condition and implementation assessments
   - Integrated compatibility analyses (EMC, RF, etc.)
   - Interface and integration drawings and build/test procedures

The reports and engineering data shall be provided as specified in Paragraph 2.4 for analysis reports and mass property reporting.

c) The Contractor shall perform analyses and support integrated assessments in support of periodic Exploration (ESD) Integrated Reviews conducted in conjunction with other NASA elements as described in **DRD CEV-M-001**, *CEV Prime Project Management Plan*.

Deliverables
The Contractor shall deliver and maintain the following(s):

- **DRD CEV-T-029: External Interface Control Documents for ESD Elements**

ESD Integration related information is incorporated into the following documents delivered under Section 2.4, Integrated Analysis:

- **DRD CEV-T-009: CEV Analysis Report**

2.3.(b) CEV to International Space Station Program Integration

a) The Contractor shall support NASA in assessment of MPCV capability necessary to integrate the MPCV System with the ISS Program. The Contractor shall include extensibility to meet ISS mission requirements as defined in CXP-72000, MPCV System Requirements Document (MPCV SRD).

2.3.(c) Spacecraft Integration

Spacecraft Integration incorporates the efforts required to define and manage the internal spacecraft interfaces. Spacecraft Integration includes tasks to perform analyses and provide reports and engineering data supporting integration, verification and operation of CEV and provide technical data, and models required to perform integrated CEV level analyses

a) The Contractor shall develop, maintain, provide access and deliver as required by contract attachment J-2 all drawings and technical Computer Aided Design (CAD) models of the CEV Spacecraft system, modules, subsystems and components.

b) The Contractor shall develop and maintain models and simulations for the CEV Spacecraft, modules, subsystems, and components as required to support analysis and test per paragraph 2.4. The management, identification and access location of models and simulations used on the program shall be defined in **DRD CEV-T-001**, *Models, Simulations and Integrated Support Plan*.

c) The Contractor shall document and maintain interface requirements using **DRD CEV-T-031**, *CEV <Level> Requirement Specification*.

d) The Contractor shall perform the system integration effort required to manage and control the internal spacecraft interface definition process.

e) Reserved

f) The Contractor shall document all internal interface design details. The Contractor shall produce an ICD (CEV-T-029) for each deliverable Module defined in Attachment J-9 that interfaces with another Module.

g) The Contractor shall develop and maintain the overall vehicle system design which ensures all subsystems are integrated into the vehicle and that the total vehicle performance closes in compliance with the system requirements. The Contractor shall invite NASA personnel to all design teams established by the Contractor.

h) Reserved

i) The Contractor shall design and develop the spacecraft in compliance with the NASA CxP-72167, Orion Aerodynamic Database, CxP-72168, Orion Aerothermodynamic Database.

j) NASA will provide the products to the Contractor in accordance with Attachment J-11 Government Furnished Property. All Government Furnished Equipment (GFE) product teams will produce data deliverables equivalent to the contractor furnished equipment product data deliverables.

k) The Contractor shall integrate the NASA-provided products into the spacecraft design and flight configurations to ensure that the integrated spacecraft meets MPCV-72000, MPCV Systems Requirements Document for the MPCV. The Contractor shall integrate the NASA-provided products and documentation into applicable product deliverables included in this SOW (these include requirements, drawings, certification packages, integrated analyses, and the spacecraft).
l) NASA will maintain oversight of all spacecraft design activities. The Contractor shall maintain responsibility for delivery of a design that meets the requirements. The detailed process discussion to accomplish this can be found in MPCV-72008, MPCV Program Plan. The Contractor shall invite NASA personnel on all design teams established by the Contractor.
m) The Contractor shall allocate requirements to the following government furnished products:
   - Parachute system in support of nominal and abort entries
   - Pyrotechnics initiators
   - Launch and Entry Suits and umbilicals
   - Flight Crew Equipment (FCE)
   - Crew Survival Equipment
   - Heatshield DFI
n) The Contractor shall ensure that traceability between the levels is in accordance with the capability established in Section 2.2, Requirements Definition and Management.
o) The Contractor shall use the following standards for developing all subsystems:
   - AIAA-S-080, AIAA Standard for Space Systems – Metallic Pressure Vessels Pressurized Structures, and Pressure Components
   - ANSI/AIAA-S-081A-2006, AIAA Standard for Space Systems – Composite Overwrapped Pressure Vessels

Deliverables
The Contractor shall deliver and maintain the following document(s):
- **DRD CEV-T-029: <Module-Module> Interface Control Documents**
- **DRD CEV-T-031: CEV <Level> Requirements Spec (for each Module that interfaces with another Module)**

2.4 INTEGRATED ANALYSIS

Integrated Analysis includes Systems Engineering and Integration Analysis activities to provide consistency across all aspects of the MPCV development efforts. This element includes the work to identify and conduct trade studies and cost-effectiveness analyses across the CEV System and the overall ESD architecture. It includes efforts to develop design and analysis tools, and models and simulations. It also includes tasks to define, control and verify CEV mass properties and other controlled technical margins across the CEV vehicle.

a) The Contractor shall manage crosscutting engineering issues within the spacecraft, such as the allocation of resources into the design elements including the management of margins and design and operational performance estimates for various modules and below. This information shall be documented in **DRD CEV-T-036**, *Margins Management Plan/Report*, and implemented by the Contractor.
b) Reserved
c) The Contractor shall identify and conduct trade studies and cost-effectiveness analyses to ensure realistic options and alternatives are assessed for key CEV System requirements and design decisions. The assessment of cost shall address all elements of life cycle cost significantly affected by the matters being traded.

d) The Contractor shall develop and implement a CEV System Analysis Plan. The Contractor shall deliver the analysis plan per **DRD CEV-T-008**, *CEV System Analysis Plan*. The Contractor shall establish objectives of all analysis cycles and their products consistent with objectives of the major milestones, events, etc. they are to support in the Integrated Master Schedule. The Contractor shall report results of the analysis performed per **DRD CEV-T-009**, *CEV Analysis Reports* at major milestone reviews and at analysis cycles prescribed in the J-2 DRD Submission Matrix.

e) Reserved

f) The Contractor shall provide the analysis to validate all CEV System requirements through the lowest level of decomposition and document the validation per **DRD CEV-T-009**, *CEV Analysis Reports*.

g) The Contractor shall provide/receive existing mathematical models, configuration data, and analytical data necessary to perform integrated assessments and analysis to integrate with the ESD elements.

h) The Contractor shall provide/receive existing mathematical models, configuration data, and analytical data necessary to perform integrated assessments and analysis to integrate with the external programs.

i) The Contractor shall define a plan for managing mass properties and document this plan in **DRD CEV-T-042**, *Mass Properties Control Plan*. The Contractor shall implement this plan and document the results in **DRD CEV-T-043**, *Mass Properties Reports*.

j) The Contractor shall develop, implement, deliver and maintain a Modeling and Simulation Support Plan in accordance with **DRD CEV-T-001**, *Models, Simulations and Integrated Support Plan* for Models and Simulations developed by the contractor.

k) The Contractor shall deliver and maintain models supporting discipline-oriented engineering analysis and trade studies in accordance with **DRD CEV-T-001**, *Models, Simulations and Integrated Support Plan* for Models and Simulations developed by the contractor. These models shall be consistent with the coordinate system described in SLS-SPEC-048 SLSP Integrated Vehicle Coordinate System.

l) The Contractor shall deliver and maintain a discrete-event simulation to evaluate effectiveness and performance of the vehicle design in accordance with **DRD CEV-T-001**, *Models, Simulations and Integrated Support Plan*.

m) The Contractor shall deliver and maintain modular, high-fidelity, time-stepped simulations of vehicle behavior for avionics hardware and software integration and test in accordance with **DRD CEV-T-001**, *Models, Simulations and Integrated Support Plan*.

n) The Contractor shall make available to NASA all Contractor-developed design and analysis tools, models and simulations used in the development of the CEV System, including source-code and geographic models/block diagrams from Computer Aided Software Engineering Tools, in accordance with the Electronic Data Access Clause (H.12). Supplemental data to support the NASA design and analysis tools, models and simulations provided shall be IDIQ.

o) Reserved

p) The Contractor shall provide the configuration management data for all technical models and drawings to the NASA ICE per **DRD CEV-M-003**, *Configuration and Data Management Plan and Reports*.

q) The Contractor shall deliver all CAD models per **DRD CEV-T-003**, *CEV CAD Models*, and drawings per **DRD CEV-T-004**, *CEV Drawings*.

r) Reserved

s) If the Contractor utilizes modeling and simulation to conduct analysis in support of verification specification compliance, the Contractor shall comply with **DRD CEV-T-001**, *Models, Simulations and Integrated Support Plan*.

t) NASA will develop drawings and CAD models for all GFE. NASA will use **DRD CEV-T-003**, *CEV CAD Models*, and **DRD CEV-T-004**, *CEV Drawings*, as the template for development and delivery of these items.
u) NASA will develop models and simulations for all GFE. NASA will use **DRD CEV-T-001**, *Models, Simulations and Integrated Support Plans*, as the template for development and delivery of these items.
v) The Contractor shall use the following standards and requirements documents for developing all subsystems:
   – CXP 72385, CEV Government Furnished Data for Orion System Design and Analysis
w) The Contractor shall deliver and maintain integrated simulation for the Orion Test Labs in accordance with **DRD CEV-T-001**, *Models, Simulations and Integrated Support Plan*.

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-001: Models, Simulations and Integrated Support Plan**
- **DRD CEV-T-003: CEV CAD Models**
- **DRD CEV-T-004: CEV Drawings**
- **DRD CEV-T-008: CEV System Analysis Plan**
- **DRD CEV-T-009: CEV Analysis Reports**
- **DRD CEV-T-036: Margin Management Plan/Report**
- **DRD CEV-T-042: Mass Properties Control Plan**
- **DRD CEV-T-043: Mass Properties Reports**

2.5 SPACECRAFT CREW CABIN AND COCKPIT LAYOUT DESIGN REQUIREMENTS

a) NASA and the Contractor shall jointly participate in the development of detailed design requirements for the MPCV crew cabin, and cockpit layout and functionality.
b) Reserved
c) Reserved
d) The Contractor shall provide materials (e.g., layout schematics, computer 3-D models) to support a Crew Station Review. The Contractor shall conduct this Crew Station Review in support of CDR of the Contractor's CEV crew cabin internal layout design utilizing NASA-identified Crew Office representatives. After the Crew Station Review, the Contractor shall prepare and provide to NASA an impact assessment of quantifiable design issues arising from the review.
e) NASA will document the display format standards in CxP 72242, CEV Display Format Standards Document.
f) NASA and the Contractor shall jointly participate in prototyping the layout and behavior of the display formats, using CxP 72242, CEV Display Format Standards Document as an applicable document. The Contractor shall develop and maintain a Display Format Dictionary in accordance with **DRD CEV-T-048**, *Software Requirement Specification*. The Display Format Dictionary shall document the results of the proto-typing effort.
g) The Contractor shall develop and maintain **DRD CEV-T-048**, *Display & Control Software Requirements Specification* appendix for the Display Format Dictionary.
h) The contractor shall provide supplemental rapid-prototyping tool operators to augment the NASA provided tool-operators. (IDIQ)

2.6 CEV SYSTEMS INTEGRATION MANAGEMENT

MPCV Systems Integration Management consists of the discipline-specific efforts to manage the overall integrated MPCV system architecture definition and engineering functions including the interfaces with ESD elements. This includes the technical and management efforts of directing and controlling the integrated engineering effort for the MPCV spacecraft in all modes and configurations.

Systems Integration Management consists of the efforts to manage the Contractor's systems integration activities and to manage the Contractor's participation in NASA-led ESD systems integration activities in accordance with NASA requirements and the Contractor's documented plans.

a) The Contractor shall manage their systems integration activities consistent with MPCV-72008, Orion MPCV Program Plan.
b) The Contractor shall participate in MPCV Program and ESD systems integration activities in accordance with MPCV-72008, Orion MPCV Program Plan.
c) The Contractor shall implement plans for managing technical data products, processes and organizational roles and responsibilities used to accomplish their systems integration activities and document their plans in the Contractor's PMP (**DRD CEV-M-001**, *CEV Prime Project Management Plan*).
d) The Contractor shall perform requirements development, design, analysis and trade studies, assembly/production, integration, testing, verification, validation, qualification, certification, and delivery for all CEV Spacecraft subsystems to the component level. A small number of subsystems contain government furnished products. These NASA-provided products will be detailed in each subsystem section.
e) The Contractor shall hold subsystem or component design reviews prior to the system PDR and CDR.
f) The Contractor shall perform analyses, trade studies, and developmental testing to determine the spacecraft architecture and component design that meets all requirements and best balances performance, cost, schedule, and risk. The Contractor shall document this design information in each of the subsystem design and data books.
g) The Contractor shall demonstrate how the design maps to and complies with the CEV System-level and external interface requirements.
h) The Contractor shall support the documentation and delivery of the Master Verification Plan (**DRD CEV-T-015**). The Contractor shall document this information at the CEV Spacecraft system, module, subsystem, and component levels in the Spacecraft Master Verification Plan.
i) The Contractor shall specify, produce and deliver integration testing assemblies and flight test articles necessary to implement the Spacecraft Master Test Plan as provided in CEV-T-015, Master Verification Test Plan. The Contractor shall document this information at the CEV Spacecraft system, module levels (GSE, LAS), subsystem, and component certifications in **DRD CEV-T-017**, *Certification Data Package*. Note: Module, subsystem and component-level test and test documentation requirements are defined in Sections 6.1.5 CM Test, Verification, and Certification, 6.2.5 SM Test, Verification, and Certification, 6.4.5 LAS Test, Verification, and Certification and 6.5.4 CEV Software Test and Verification.
j) The Contractor shall perform acceptance testing at the integrated spacecraft level using **DRD CEV-T-039**, *Acceptance Test Plans and Procedures*, and document the results using **DRD CEV-T-040**, *Acceptance Data Package*.
k) NASA has identified subsystem-specific standards the Contractor shall follow during all design, development, and test activities. The standards are listed in Subsection sections within Sections 6.1.3 (CM Subsystems), 6.2.3 (SM/SA Subsystems) and 6.4.3 (LAS Subsystems). Crosscutting standards applying to all subsystems are covered in Section 2.8, Specialty Engineering, sections 2.9 (Aerosciences), and 2.4 (Integrated Analysis).

l) The Contractor shall use the following standards and requirements documents for developing all subsystems:
   - JPR 8080.5, JSC Design and Procedural Standards
   - MPCV-70024, MPCV Human Systems Integration Requirements (HSIR)

Deliverables
The following DRDs for the integrated vehicle are collected in the DRDs specified in Section10.
- **DRD CEV-T-015: Master Verification Plan**
- **DRD CEV-T-017 Certification Data Packages**
- **DRD CEV-T-039: Acceptance Test Plans and Procedures**
- **DRD CEV-T-040: Acceptance Data Package**

2.6.1 Avionics Integration

The contractor shall integrate the efforts to design, develop, test, certify, and deliver the software, computers, firmware, and other electrical and electronic equipment used for commanding, monitoring, and communicating with CEV subsystems.

Avionics Integration includes the integration of the hardware and software components in the areas of Flight Software, Command & Data Handling (C&DH), Instrumentation, Communications and Tracking (C&T), Displays & Controls (D&C), and all data/signal interfaces between these functions and other CEV Spacecraft systems, modules, subsystems, components, and external elements. This element also includes efforts to develop and implement an approach for modular open systems architecture in the design of the CEV System, and to define the collection and processing of vehicle transducer and sensor information and vehicle health monitoring data specified by other subsystems for use on the vehicle and ground.

a) The Contractor shall use a modular, multi-use open systems approach in the design of the CEV System making the impact to the overall modular, multi-use open systems architecture a primary consideration in the selection of equipment to meet the CEV design functionality. This approach shall be reflected in the architecture documented in the Architecture Design Document (**DRD CEV-T-033**).
b) The Contractor shall use a modular, multi-use open systems approach and analysis of long-term supportability, interoperability, and growth for future modifications in the final selection of CEV equipment and the integration approach for future ESD elements and equipment.
c) Reserved
d) The Contractor shall report the results of an open systems architecture analysis for modular, multi-use systems that extends beyond CEV to other ESD elements and equipment specified in the analysis cycle in accordance with **DRD CEV-T-009**, *CEV Analysis Reports*.
e) NASA will perform independent requirements validation and design certification in key areas. In these key areas NASA will establish design requirements teams intended to integrate the activities of NASA and the Contractor. The Contractor shall participate in and support these design requirements teams.
f) The Contractor shall define and implement an integrated plan for CEV Spacecraft instrumentation. The Contractor shall document this plan in **DRD CEV-T-041**, *CEV Instrumentation Plan*.
g) The Contractor shall define and document sensor range and calibration information in **DRD CEV-T-046**, *CEV Data and Command Dictionary*, using the standards and formats called out in MPCV 70022-4 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 4: Information Representation Specification.
h) Reserved

i) The Contractor shall perform certification testing of the avionics subsystem and document the results using **DRD CEV-T-017**, *Certification Data Package*.

j) The Contractor shall develop and maintain a sortable CEV Data and Command Dictionary (**DRD CEV-T-046**), which includes channelization information, calibration information, telemetry information, and command information required to define, manage and record all data elements that interface with the core avionics software and hardware, the subsystem specific software, and the ground systems, using the standards and formats called out in MPCV 70022-4 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 4: Information Representation Specification(and associated

k) The Contractor shall develop an Avionics Subsystem - Constellation C3I Interoperability Report (also see section 6.5.2) per **DRD CEV-T-047**, *Avionics Design and Data Book Volume V - Avionics Subsystem - Constellation C3I Interoperability Report*, to detail how the Contractor's design will adhere to MPCV-70022, MPCV Command, Control, Communication, and Information (C3I) Interoperability Standards Book, Volumes 1, 2, 4, 5 and 8.

l) The Contractor shall develop **DRD CEV-T-047**, *Avionics Design and Data Book Volume I - Avionics System-Level Data*, which contains avionics architecture diagrams, results of trade studies and performance analyses, block diagrams, schematics, prototyping results, design data, planned growth provisions/margins/scarring, and discussion of fault tolerance and effects of failures on performance.

m) The Contractor shall utilize open architecture designs and industry standards where feasible and cost-effective in the avionics subsystem hardware and software designs, taking into consideration long-term maintainability/availability and extensibility. The Contractor shall utilize modular hardware and common building blocks such as power supplies, chassis, processor cards, memory cards, network cards, etc. where feasible and cost-effective.

n) The Contractor shall utilize standard compilers, operating systems, and software development tools/environments throughout the CEV software design and development process where feasible and cost-effective.

o) Reserved

p) For each avionics LRU that requires active cooling, the Contractor shall determine the maximum time that the LRU can be operated without active cooling applied. The Contractor shall document this data in each volume of the avionic design and data book.

q) The Contractor shall use the following standards for designing the avionics subsystem:
   - MPCV 70022-1 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 1: Interoperability Specification (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)
   - MPCV 70022-2 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 2: Spectrum and Channel Plan
   - MPCV 70022-4 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 4: Information Representation Specification
   - CxP 70022-5 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 5: Data Exchange Protocol Specification
   - CxP 70022-8 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 8: Common Command and Control Functional Requirements

r) The Contractor shall design, develop, produce, integrate, verify, validate, certify, operate, maintain, and document, and deliver a backup flight control system (BFCS), which houses an independently developed subset of the primary flight software functions.

s) Reserved
t) Reserved
u) The Contractor shall develop an Avionics Subsystem - Constellation Functional Security Report per **DRD CEV-T-047**, *Avionics Design and Data Book Volume VI - Avionics Subsystem - Constellation Security Report*.
v) The Contractor shall develop and maintain **DRD-CEV-T-031**, *CEV <Subsystem> Requirements Specification for the Avionics Subsystem*
w) The Contractor shall develop and maintain **DRD CEV-T-029**, *CEV <Subsystem> Interface Control Documents* for the Avionics Subsystem interfaces to other subsystems.
x) Reserved
y) Contractor may reuse hardware between vehicles.

Deliverables

The Contractor shall deliver and maintain the following document(s):

-
- **DRD-CEV-T-029: Avionics Subsytem Interface Control Documents**
- **DRD-CEV-T-031: Avionics Subsystem Requirements Specification**
- **DRD CEV-T-041: CEV Instrumentation Plan**
- **DRD CEV-T-046: CEV Data and Command Dictionary**
- **DRD CEV-T-047: Avionics Design and Data Book Volume 1 Avionics, System-Level Data**
- **DRD CEV-T-047: Avionics Design and Data Book Volume VI, Avionics Subsystem-Constellation Security Report**

The following subsystem specific data is collected in the DRDs specified in Section 2.2:

- **DRD CEV-T-033: Architecture Design Document**

The following subsystem specific data is collected in the DRDs specified in Section 2.4:

- **DRD CEV-T-009: CEV Analysis Reports**

The following subsystem specific information is collected in the DRDs specified in Section 6.5.2:

- **DRD CEV-T-047: Avionics Design and Data Book Volume V, Avionics – Constellation C3I Interoperability Report**

The following subsystem specific data is collected in the DRDs specified in Sections 10.2:

- **DRD CEV-T-017: Certification Data Package**

2.6.2 Command and Data Handling (C&DH) Integration

C&DH hardware includes data processing and computing resources including processors, memory, input/output devices, data multiplexers/ demultiplexers, mass storage devices, inter-computer time-synchronization devices, and networking equipment

a) The contractor shall integrate the DDT&E efforts of the C&DH hardware.
b) The Contractor shall document the design integration for all C&DH hardware as specified in **DRD CEV-T-047**, *Avionics Design and Data Book Volume II - C&DH/Instrumentation Subsystem Data*.
c) Reserved
d) The Contractor shall develop and maintain **DRD CEV-T-031**, *CEV <Components> Requirements Specifications* for the C&DH components.

Deliverables

The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-031: Command and Data Handling Component Requirements Specifications**
- **DRD CEV-T-047: Avionics Design and Data Book Volume II C&DH/Instrumentation Subsystem Data**

2.6.3 Communications and Tracking

The Contractor shall integrate the DDT&E efforts of the space-to-ground and space-to-space communication links, RF/optical tracking devices (excluding navigational aids), audio and video/imagery.

a) The Contractor shall prepare, deliver, and maintain **DRD CEV-T-047**, *Avionics Design and Data Book Volume III - Communications and Tracking Subsystem Data*.
b) The Contractor shall participate in the development of ESD's integrated communications and tracking concepts, architecture, and requirements. The Contractor shall comply with the design of the communications architecture according to MPCV-70022 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books Volumes 1, 2, 4, 5 and 8.
c) Subsystems other than C&T may contain RF/optical devices (i.e., wireless sensors, GPS). The Contractor shall apply the standards in this section to those subsystems containing RF/optical devices. The Contractor shall provide the same documentation required in **DRD CEV-T-047**, *Avionics Design and Data Book Volume III - Communications and Tracking Subsystem Data*, for all subsystems containing RF/optical devices. The Contractor shall document this information in that subsystems design and data book.
d) The Contractor shall participate in the development of Radio Frequency/Optical ICDs and document the results in **DRD CEV-T-058**, *Radio Frequency/Optical ICDs*.
e) The Contractor shall use the following standards for designing the C&T subsystem:
   - 450-SNUG, Space Network Users' Guide
   - FIPS 140-2, Security Requirements for Cryptographic Module
   - FIPS-197, Advanced Encryption Standard
   - IS-GPS-200 , Navstar GPS Space Segment/Navigation User Interfaces
   - NTIA Manual, National Telecommunications and Information Administration (NTIA) Manual of Regulations & Procedures for Federal Radio Frequency Management (May 2003 Edition, May 2005 Revisions) Chapter 10
f) Reserved
g) The CEV Contractor shall participate with NASA and ESD in development of Radio Frequency (RF) spectrum management in compliance with the National Telecommunications and Information Administration (NTIA) Manual of Regulations & Procedures for Federal Radio Frequency Management (May 2003 Edition, May 2005 Revisions), Chapter 10. The Contractor shall provide RF spectrum management documentation in **DRD CEV-T-026**, *Spectrum Management Documents*

h) The Contractor shall develop and maintain **DRD CEV-T-031**, *CEV <Components> Requirements Specifications* for the C&T components.
i) The contractor shall perform C&T compatibility testing with Space Communications and Navigation (SCaN) post vehicle integrations (prior to DD250) for each unique Communication configuration on MPCV.
j) NASA will provide the facilities and equipment, (e.g., DSN's test trailer, Space Network's test van) necessary to support integration tests with SCaN.
k) The contractor may maximize use of regression testing in verification activities from previous vehicles.

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-026, Spectrum Management Documents**
- **DRD CEV-T-031: Communication & Tracking Components Requirements Specifications**
- **DRD CEV-T-047: Avionics Design and Data Book Volume III – Communications and Tracking Subsystem Data**
- **DRD CEV-T-058: Radio Frequency/Optical ICDs**

2.6.4 Displays & Controls Integration

The contractor shall integrate the DDT&E efforts of the crew interface with the on-board computer systems and the manual controls/feedbacks used by the crew to control the vehicle, interact with its subsystems, and monitor automated processes. This work is done in concert with Human Engineering activities under Section 2.8, Specialty Engineering, and 2.5, Spacecraft Crew Cabin and Cockpit Layout Design Requirements.
a) Reserved
b) The D&C subsystem shall utilize naming conventions as established in MPCV-72524, MPCV Operations Nomenclature Plan that comply with CxP-72242 Display Formats Standard.
c) The Contractor shall prepare, maintain, and deliver Avionics Design and Data Book Volume IV - Displays and Controls Subsystem Data per **DRD CEV-T-047**.
d) The Contractor shall develop and maintain **DRD CEV-T-031**, *CEV <Components> Requirements Specifications* for the Displays and Controls components.

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-031: Displays & Controls Components Requirements Specifications**
- **DRD CEV-T-047: Avionics Design and Data Book Volume IV – Displays and Controls Subsystem Data**

2.6.5 Electrical Power Subsystem (EPS) Integration

The contractor shall integrate the DDT&E efforts of the power generation, energy storage, electrical power distribution and control, and external/internal CEV lighting.

a) The Contractor shall participate with the MPCV in the development of **DRD CEV-T-060**, *Electrical Power Quality Specification Requirements Document*. The Contractor shall perform testing and analyses required to develop a power quality specification that will be compatible with the technology needed to generate, store, and distribute electrical power.
b) The Contractor shall document the design for the Electrical Power Subsystem as specified in **DRD CEV-T-059**, *Electrical Power System (EPS) Design and Data Book*
c) Reserved

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-059: Electrical Power System (EPS) Design and Data Book**
- **DRD CEV-T-060: Electrical Power Quality Specification Requirements Document**

2.6.6 Mechanisms Integration

The Contractor shall integrate the DDT&E efforts of any mechanical or electromechanical devices that control the movement of a mechanical part of the spacecraft relative to another part. These devices include latches, hatches, doors, and fasteners installed, removed, or adjusted during flight.

a) The Contractor shall design develop, and verify safety or mission critical mechanisms in accordance with the following standard:
   – NASA-STD-5017, Design and Development Requirements for Mechanisms, Sections 1-4
b) The Contractor shall document the design for all CEV mechanisms as specified in **DRD CEV-T-061**, *Mechanical Systems Design and Data Book*, and **DRD CEV-T-062**: *Stress Analysis Report*.
c) Reserved

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-061: Mechanical Systems Design and Data Book**
- **DRD CEV-T-062: Stress Analysis Report**

The following subsystem specific information is collected in the DRDs specified in Section 10.2

- **DRD CEV-T-015: Mechanisms Volume - Master Verification Plan**

2.6.7 Passive Thermal Control Integration

The Contractor shall integrate the DDT&E efforts of hardware, coatings, blankets, heaters, and other design accommodations that protect the vehicle, crew, and its constituent components from thermal environmental extremes during all mission phases.

a) The Contractor shall develop thermal analytical models to support integrated ESD vehicle analyses and MPCV thermal analyses.
b) The Contractor shall define environments for spacecraft design, development, test and flight, and document these environments in **DRD CEV-T-090**, *Environments Definition Document*.
c) The Contractor shall document the design for the Passive Thermal Control subsystem as specified in **DRD CEV-T-063**, *Passive Thermal Control Design and Data Book*.
d) The contractor shall deliver **DRD CEV-T-064**, *Passive Thermal Control Mathematical Models and Documentation*, which will deliver and describe the mathematical models used in the PTC analyses.

Deliverables

The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-063: Passive Thermal Control Design and Data Book (PTCDDB)**
- **DRD CEV-T-064: Passive Thermal Control Mathematical Models and Documentation**
- **DRD CEV-T-090: Environments Definition Document.**

2.6.8 Reserved

2.6.9 Structures Integration

The Contractor shall integrate the DDT&E efforts of the primary structure, secondary structure, and all structural components of vehicle equipment, including spacecraft and component loads, dynamics, and stress analysis.

a) The Contractor shall perform structural analysis on all spacecraft structures, including pressure vessels, to show that all elements of the design such as the strength, stiffness, structural stability, and life meet all specified criteria for the anticipated loads and environments
b) The Contractor shall perform loads and dynamics analyses and document the results in **DRD CEV-T-090**, *Environments Design Document*.
c) The Contractor shall perform stress and fatigue analyses and document the results in **DRD CEV-T-062**, *Stress Analysis Report* [Does not include ESM Stress Analysis].
d) The Contractor shall develop models to support integrated ESD vehicle analyses as well as CEV loads and stress analyses. The Contractor shall deliver **DRD CEV-T-068**, *Structures Mathematical Models and Documentation*, which will deliver and describe the mathematical models used in the CEV Spacecraft system, module, subsystem, and component loads and stress analyses.
e) The Contractor shall implement a fracture control program and identify fracture critical parts to protect against catastrophic structural hazards associated with flaw presence, fatigue crack propagation and fracture. The Contractor shall deliver and implement **DRD CEV-T-069**, *Fracture Control Plan*, and **DRD CEV-T-070**, *Fracture Control Summary Report*.
f) The Contractor shall use NASA-HDBK-7005, Dynamic Environmental Criteria, as an informational document to support the **DRD CEV-T-015**, *Master Verification Plan* DRD product development activity.
g) The Contractor shall use the following standards for designing and analyzing the structures subsystem:
   - CxP-72385, CEV Government Furnished Data for Orion System Design and Analysis
   - JSC-62550, Structural Design and Verification Criteria for Glass, Ceramics and Windows in Human Space Flight Applications
   - NASA-STD-(I)-5019, Fracture Control Requirements for Spaceflight Hardware as implemented by CEV-T-069
   - NSTS 08307, Space Shuttle Criteria for Preloaded Bolts
   - CxP-70135, Structural Design and Verification Requirements (SDVR)
h) The contractor shall produce engineering development Ground Test Articles (GTA) for use in environmental testing. The contractor shall perform environmental testing on these engineering development test articles. The contractor shall document the results of the engineering development structure testing in **DRD CEV-T-090**, *Environments Definition Document*, and **DRD CEV-T-068**, *Structures Mathematical Models and Documentation*. The contractor shall deliver (via 1149) the GTA 'as is' to NASA at the completion of the test program.
i) Reserved
j) Reserved
k) Reserved

l) The Contractor shall develop, implement, and maintain a Structures Master Verification Plan, per **DRD CEV-T-015**, that details the Contractor's plan for verifying, certifying, and acceptance of the Structures system.

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-062: Stress Analysis Report**
- **DRD CEV-T-068: Structures Mathematical Models and Documentation**
- **DRD CEV-T-069: Fracture Control Plan**
- **DRD CEV-T-070: Fracture Control Summary Report**
- **DRD CEV-T-090 Environments Definition Document**

The following subsystem specific data is collected in the DRD specified in Sections 10.2:

- **DRD CEV-T-015: Master Verification Plan**

2.6.10 Propulsion Integration

The Contractor shall integrate the DDT&E efforts of vehicle components that provide propulsive thrust used for trajectory insertion, orbital maneuvering, and translation and rotation reaction control.

a) The Contractor shall perform design, development, test, and certification of propulsion systems and develop propulsion related DRD products.

b) The Contractor shall develop, document, implement, execute and integrate comprehensive verification activities and associated processes for all propulsion systems in order to certify the propulsion systems for compliance with CEV vehicle-level requirements. The Contractor shall also design, fabricate and test integrated propulsion systems in order to evaluate and certify integrated propulsion system hot fire performance for each propulsion application. The Contractor shall also design, fabricate, and test integrated propulsion systems to evaluate and certify integrated propellant system storage and conditioning designs and capabilities in order to evaluate and certify propellant conditioning performances. The Contractor shall design and certify liquid propellant rocket engines for combustion stability, using CPIA 655, Guidelines for Combustion Stability Specifications and Verification Procedures for Liquid Propellant Rocket Engines.

c) Reserved.

d) The Contractor shall document the design for the Propulsion subsystem as specified in **DRD CEV-T-071**, *Propulsion Systems Design and Data Book*.

Deliverables
The Contractor shall deliver and maintain the following document(s):
- **DRD CEV-T-071: Propulsion Systems Design and Data Book**

2.6.11 Suits and Survival Crew Equipment Support Systems Integration

a) The Contractor shall integrate the DDT&E efforts of components that interface to Suits and Survival Crew Equipment Support Systems.
b) NASA will provide the MPCV Launch and Entry suits, umbilicals and support equipment (e.g. helmets, gloves, undergarments, and standard tools if applicable).
c) NASA will provide crew equipment systems and gear for emergency egress and survival, crew/personnel post landing tracking systems, and crew/personnel post landing communications systems. The NASA provided equipment is identified in Contract Attachment J-11, Government Furnished Property.
d) The Contractor shall perform requirements development, design, analysis and trade studies, assembly/production, integration, testing, verification, validation, qualification, certification, and delivery of the CEV interfaces for the NASA-provided suits, umbilicals, support equipment, and survival crew equipment.
e) The Contractor shall supply the vehicle resources to the NASA-provided suits with power, oxygen, water, cooling, contaminant control and communications as defined in **DRD CEV-T-031**: *ECLS and Suit Subsystem Requirements Specification* and the **DRD CEV-T-029** *Interface Control Documents*. The Contractor shall control/provide/analyze the vehicle side interface, and NASA will control/provide the umbilical/support systems hardware and the suit-side interface.
f) The Contractor shall use the human engineering standards listed in section 2.8.7., Human Engineering, to design all interfaces to suits and survival crew equipment systems.
g) The Contractor shall provide an IVA and suited operable CEV Spacecraft hatch and mechanisms.
h) RESERVED
i) Reserved
j) The Contractor shall document the design for the Suits, and Survival Crew Equipment Support Systems as specified in **DRD CEV-T-073**, *Environmental Control and Life Support and Suit Design and Data Book Design and Data Book* and **DRD CEV-T-074**, *Crew Health, Survival, Habitation Accommodations/Stowage and EVA Systems Design and Data Book*.

Deliverables
The Contractor shall deliver and maintain the following document(s):
- **DRD CEV-T-073: Environmental Control and Life Support and Suit Design and Data Book**

The following subsystem specific information is collected in the DRDs specified in Section 6.1.2:
- **DRD CEV-T-029 Interface Control Documents**
- **DRD CEV-T-031: ECLS Subsystem Requirements**

2.6.12 Environmental Control and Life Support (ECLS), Crew Health and Habitation Accommodations Integration

The Contractor shall integrate the DDT&E efforts of the spacecraft subsystems for Environmental Control and Life Support (ECLS), active thermal control, medical systems interfaces, and habitation accommodations.
a) The NASA provided ECLS Crew Health and Habitation Accommodation equipment is identified in Contract Attachment J-11, Government Furnished Property.
b) The Contractor shall design the interfaces for these NASA-provided items.
c) Reserved

d) Reserved

e) The Contractor shall use the following ECLS, crew health and habitation accommodations standards and the Human Engineering Standards listed in Section 2.8.7, Human Engineering, for designing this subsystem:
   - JSC 20584, Spacecraft Maximum Allowable Concentrations for Airborne Contaminants

f) The Contractor shall provide definition of the process to be used for cleanliness of components for use in oxygen, fuel, and pneumatic systems. The Contractor shall provide this information in **DRD CEV-T-073**, *Environmental Control and Life Support and Suit Design and Data Book*.

g) The Contractor shall identify the standard for test methods for environmental engineering in **DRD CEV-T-073**, *Environmental Control and Life Support and Suit Design and Data Book*.

h) Reserved

i) The Contractor shall document the design for the Habitation Accommodations as specified in **DRD CEV-T-074**, *Crew Health, Survival, Habitation Accommodations/Stowage Systems Design and Data Book*.

Deliverables

The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-073: Environmental Control and Life Support and Suit Design and Data Book**
- **DRD CEV-T-074: Crew Health, Survival, Habitation Accommodations/Stowage Systems Design and Data Book**

2.6.13 Pyrotechnics Integration

The Contractor shall integrate all CEV mounted devices and assemblies containing or operated/actuated/severed by, propellants and/or explosives.

a) NASA will supply the pyrotechnic initiators for all pyrotechnic events excluding mechanically initiated devices. NASA will supply interface and performance requirements for the system used to fire the initiators.

b) If the Contractor selects existing Shuttle pyrotechnic devices for the CEV Spacecraft, then NASA will supply those pyrotechnic devices

c) NASA will supply pyrotechnic reefing line cutters used in the CPAS.

d) The Contractor shall comply with all requirements in CxP 70199 Constellation Program Pyrotechnic Specification and JPR 8080.5 Standards P-1, E-1, G-2, G-12 and P-6.

e) The Contractor shall perform preliminary component design reviews and critical component design reviews for each pyrotechnic device not provided by NASA. The Contractor shall conduct development, qualification, and acceptance testing on all other pyrotechnic devices selected for the CEV Spacecraft. The Contractor shall conduct Phase I, Phase II, and Phase III technical reviews on all other pyrotechnic devices selected for the CEV Spacecraft per the requirements of CxP 70199, Constellation Program Pyrotechnic Specification.

f) The Contractor shall perform stress analysis and deliver stress analysis reports (**DRD CEV-T-062**, *Stress Analysis Report*) on all pyrotechnic devices selected for the CEV Spacecraft.

g) Reserved

h) Reserved

i) Reserved

j) The Contractor shall document the design for the Pyrotechnics Integration as specified in **DRD CEV-T-075**, *Pyrotechnics Subsystem Design and Data Book*.

Deliverables

The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-031: Pyrotechnics Subsystem Requirements Specification**
- **DRD CEV-T-062: Stress Analysis Report**
- **DRD CEV-T-075: Pyrotechnics Subsystem Design and Data Book**

2.6.14 Reserved

2.6.15 Guidance, Navigation, and Control (GN&C) Integration

The Contractor shall integrate the DDT&E efforts of the Guidance, Navigation, and Control (GN&C) subsystem including the Integrated CEV Flight Dynamics design.

a) The CEV GN&C requirements design and functional verification effort will be performed through the use of specialized Multi-Organizational Design Environment (MODE) teams. NASA and the Contractor will co-lead the development of detailed design requirements for the CEV GN&C flight system. The Contractor shall document the GN&C requirements in **DRD CEV-T-031**, *CEV GN&C Subsystem Requirements Specification*, and **DRD CEV-T-048**, *Software Requirements Specification*. The Contractor shall co-lead the following teams:
   - Ascent/Abort GN&C MODE Team
   - Entry GN&C MODE Team
   - On-Orbit GN&C MODE Team
   - Integrated GN&C MODE Team

b) NASA will perform independent requirements validation and design certification in key areas. In these key areas NASA will establish design requirements teams intended to integrate the activities of NASA and the Contractor. The Contractor shall participate in and support these design requirements teams for GN&C Flight Software

c) Reserved

d) The Contractor shall document the design for the GN&C subsystem as specified in **DRD CEV-T-078**, *GN&C Subsystem Design and Data Book*.

Deliverables

The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-078: GN&C Design and Data Book**

The following subsystem specific information is collected in the DRDs specified in Section 6.1.2

- **DRD CEV-T-031: GN&C <Subsystem > Requirements Specification**
- **DRD CEV-T-031: GN&C <Components> Requirements Specification**

The following subsystem specific information is collected in the DRD specified in Section 6.5.2

- **DRD CEV-T-048: Software Requirements Specification**

2.6.16 Wiring Integration

The Contractor shall integrate the DDT&E efforts of the wiring harnesses and optical cabling for both electrical and optical signals, including the following activities: provide the power, data, and command paths, connections, production breaks, and access points required to develop, assemble, test, operate, verify, certify, service and safeguard the CEV Spacecraft.

a) The Contractor shall develop the process for defining, fabricating, testing, routing, installing, verifying, and maintaining the MPCV wiring subsystem, including discrepancy resolution through vehicle delivery.

b) The Contractor shall develop wiring documentation that provides identification down to the level of pin-to-pin connectivity for all electrical harnesses and optical cables used on the MPCV to support ground, launch, flight, and recovery operations, including testing, verification, calibration, and maintenance through vehicle delivery. The Contractor shall provide access and identify location of the wiring documentation to NASA as defined in **DRD CEV-T-080**, *CEV Vehicle Wiring Configuration, Identification, and Definition Reports*.

c) Reserved

Deliverables

The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-080: CEV Vehicle Wiring Configuration, Identification and Definition Reports**

2.7 FLIGHT AND GROUND OPERATIONS INTEGRATION

CEV Operations is a NASA-led function with the Contractor providing the necessary data products, operational requirements, and support for NASA to develop the plans, processes, procedures, and tools to operate the CEV System. Operations includes the development and implementation of the processes, plans, system requirements, support and reference documents, training, procedures, and work associated with the preparation, launch and flight execution, and recovery of the CEV spacecraft. The scope of operations includes use of the CEV System hardware/software after delivery to NASA in support of the preparation and execution of the Exploration Flight Test-1, EM-1 and EM-2 flights.

The two principle areas of operations are ground operations and flight operations. Ground operations are activities associated with the processing of the flight hardware using ground systems for the launch and post-landing operations. These activities include the planning, pre-launch processing, launch, and post-landing operations. Flight operations are activities performed to support the spacecraft and crew to accomplish the mission objectives. The scope of flight operations includes the early preflight analyses and design, flight planning, flight product and procedure development, flight training, and flight execution by the crew and mission operations.

2.7.1 Operational Analysis Supporting Design

a) The Contractor shall participate with NASA Operations in the development of operations plans involving multiple systems across the exploration ESD enterprise.

b) The Contractor shall provide a concept of operations for the CEV in accordance with **DRD CEV-O-001**, *Contractor's CEV Concept of Operations*, using ANSI/AIAA-G043-1992, Guidance for the Preparation of Operational Concept Documents, paragraph 4.0 and Appendix A, as guidance documents.

c) The Contractor shall perform and update operational analyses using operations requirements analysis and operations assessment analysis processes for implementation per SOW Sections 2.4, Integrated Analysis, and 2.3 (a), CEV to ESD Element Integration, to ensure a balance of cost, schedule and risk between spacecraft design and ground and flight infrastructure needed to accomplish the operational mission. These operational analyses are intended to provide an "operational view" that describes how the system products serve the operators (e.g. flight crew, ground operations, and flight operations).

d) The Contractor shall provide operational analyses that establish lifecycle operation and support requirements for the system. These operational analyses shall be sufficient for use by NASA to determine how best to provide operational support, determine under what environmental conditions the system products may be used, and how well they may perform under anticipated conditions. The Contractor shall incorporate the applicable human-to-machine interface considerations for ground processing from the MPCV-70024, MPCV Human System Integration Requirements (HSIR). Example subjects for operational analyses include:

- Reduction and consolidation of flight-to-ground interface points in addition to flight-element to flight-element interfaces;
- Use of common/consistent fasteners, connectors, and consumables/propellants;
- Use of non-toxic consumables;
- Design of Line Replaceable Units (LRUs) that allows for removal, replacement and retest throughout the ground processing flow;
- Use of design that allows for limited in-space maintenance;
- Minimize operational constraints on vehicle in-space attitudes caused by design limitations in such systems as communications, thermal, or power system; and
- Design of flight software architecture for less costly maintenance and certification following updates.

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-O-001: Contractor's CEV Concept of Operations**

The following Operational Analysis specific data is collected in the DRD specified in Section 2.4

- **DRD CEV-T-009: CEV Analysis Report**

2.7.2 Ground Operations Integration

Ground Operations will be the responsibility of NASA; however, it is essential that the Contractor participate with NASA in the overall planning and implementation of ground operations.

Ground Operations Integration includes efforts required to provide (1) plans for CEV stand-alone ground operations where the activities involve the CEV system and (2) requirements for integrated ground operations where the activities involve the spacecraft with other ESD flight elements. It also includes tasks to develop concepts, requirements and plans for maintenance and logistics for CEV Project supportability for operations. These activities are generally performed in cooperation with the Ground Systems Development Office (GSDO).

a) The Contractor shall develop, implement and update **DRD CEV-T-011**, *Integrated Logistics Support Plan*.
b) The Contractor shall perform a Logistics Support Analysis (**DRD CEV-T-012**) in accordance with the **DRD CEV-T-011**, *Integrated Logistics Support Plan*.
c) The Contractor shall perform iterative design evaluations utilizing the results of on-going reliability, maintainability, and supportability assessments to identify logistics impacts and apply these evaluations to the design of the system in order to minimize the identified logistics impacts.
d) Reserved
e) The Contractor shall develop and maintain a launch site forecast of CEV propellants, fluids, and gases for the CEV Project life cycle per **DRD CEV-T-013**, *Launch Site CEV Propellants, Fluids, and Gases Forecast*.
f) The Contractor shall provide and maintain data to support a Logistics Management System (LMS) for the tracking and management of equipment, spares, repair parts, supplies, material, and shipping containers, and identify excess or obsolete assets and initiate disposal. The LMS applies to both ground-based and space-stored assets. (IDIQ)
g) The Contractor shall develop the capability within the CEV spacecraft to interface/utilize the LMS for on-board inventory management. (IDIQ)
h) The Contractor shall deliver all supportability data developed and acquired for the design and manufacturing of CEV spacecraft to support flight hardware and Ground Support Equipment (GSE)

reprocurement, remanufacturing, refurbishment, failure analysis, and repair in accordance with **DRD CEV-T-012**, *Logistics Support Analysis*.

i) Reserved

j) Reserved

k) Reserved

l) The Contractor shall support NASA ground operations in the development of a CEV ground operations plan addressing pre-launch processing, launch operations, and post-landing operations to ensure that ground operations activities are appropriately planned and implemented. Examples of Contractor support to NASA ground operations include: provide flight and ground design data, provide technical assistance to the system integrated testing approach, identify support requirements for vehicle processing, provide technical expertise during the operations reviews, and provide work force resource loading forecasts for ground operations activities involving Contractor-provided hardware and software. (IDIQ)

m) The Contractor shall develop and update the flight hardware/software operations and maintenance plans and requirements for ground operations in accordance with **DRD CEV-O-002**, *Flight Hardware/Software Operations and Maintenance Requirements Development Plan and Requirements Document*. The Contractor shall coordinate flight hardware/software operations and maintenance plans and requirements development with NASA.

n) The Contractor shall provide flight and ground hardware/software technical assistance during ground operations phases to support ground operations activities, ensure operations and maintenance requirements implementation, assist in element-to-element integrated testing, assist in flight hardware/software corrective action disposition, ensure consistent, clear communications between the Contractor and NASA ground operations, and provide an advocate between the ground operations organizations and the spacecraft designers. (IDIQ)

o) NASA will implement the requirements as defined in the **DRD CEV-O-002**, *Flight Hardware/Software Operations and Maintenance Requirements Development Plan and Requirements Document*, during ground operations. The Contractor shall assess and provide recommendations regarding changes to the NASA-developed ground operations procedures to assure that the changes are consistent with the CEV Spacecraft and GSE requirements, constraints, and capabilities. (IDIQ)

p) For work that is to be accomplished by the Contractor at either KSC or CCAFS, the Contractor shall develop and update the support requirements in accordance with **DRD CEV-O-003**, *Launch Site Support Requirements Documentation*.

Deliverables

The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-O-002: Flight Hardware/Software Operations and Maintenance Requirements Development Plan and Requirements Document**
- **DRD CEV-O-003: Launch Site Support Requirements Documentation**
- **DRD CEV-T-011: Integrated Logistics Support Plan**
- **DRD CEV-T-012: Logistics Support Analysis**
- **DRD CEV-T-012: Logistics Support Analysis (Recommended Spare Parts List). (IDIQ)**
- **DRD CEV-T-013: Launch Site CEV Propellants, Fluids, and Gases Forecast**

2.7.2.(a) Facilities and Facility Systems

The ground facilities and facility systems encompass NASA owned processing facilities, control rooms, landing and recovery facility systems and other monitoring systems.

a) The Contractor shall develop and update end item-level requirements in accordance with **DRD CEV-O-008**, *Ground Systems Requirements, Plans, Reports, and Design Data, Volume I, Ground Systems End Item Requirements Document and Report*.
b) The Contractor shall support NASA in the requirements development; and in the design, development, modification, and implementation activities for the facilities and facility systems that will be provided by NASA. Examples of Contractor support include: provide flight hardware/software interface design and data; participate in the design reviews, working groups, and technical interchange meetings; ensure Contractor requirements are implemented appropriately; and participate in the activation and verification of NASA provided facilities and facility systems. (IDIQ)

Deliverables
The Contractor shall deliver and maintain the following document(s):
- **DRD CEV-O-008: Ground Systems Requirements, Plans, Reports and Design Data**

2.7.2.(b) Storage
Ground Systems Storage includes the development of requirements for storage facilities for flight and ground systems and logistical spares provided by the CEV Contractor at a NASA Facility.
a) The Contractor shall develop the requirements for the storage of Contractor-provided flight hardware and logistical spares in accordance with **DRD CEV-O-002**, *Flight Hardware/Software Operations and Maintenance Requirements Development Plan and Requirements Document*.
b) The Contractor shall develop the requirements for the storage of Contractor-provided ground systems and logistical spares in accordance with **DRD CEV-O-008**, *Ground Systems Requirements, Plans, Reports, and Design Data, Volume I, Ground Systems End Item Requirements Document and Report*.

Deliverables
The Contractor shall deliver and maintain the following document(s):
- **DRD CEV-O-002: Flight Hardware/Software Operations and Maintenance Requirements Development Plan and Requirements Document**
- **DRD CEV-O-008: Ground Systems Requirements, Plans, Reports and Design Data Volume I, Ground Systems End Item Requirements Document and Report**

2.7.2.(c) Transportation
a) The Contractor shall perform the planning and implementation for government furnished transportation support of CEV spacecraft element or equipment other than that provided in Section 2.10. The Contractor shall work with the appropriate NASA Ground Operations organizations to coordinate the implementation of government furnished transportation of CEV elements and equipment. These plans shall be included in **DRD CEV-T-011**, *Integrated Logistics Support Plan*.
b) The Contractor shall develop and implement plans detailing the design and construction of all CEV transportation support equipment, and the plans for transportation of the CEV Spacecraft elements to and from Government Furnished transportation locations, test facility locations, processing sites, and/or launch/landing sites. These plans shall be included in **DRD CEV-T-011**, *Integrated Logistics Support Plan*.

2.7.2.(d) CEV Ground and Training Systems

Ground Systems include facilities, facility systems, and support equipment hardware and software required for ground and flight operations. NASA will provide all ground systems facilities, facility systems, and a portion of the support equipment.

Training Systems include facilities, hardware and software to support ground and flight operations training.

NASA operations will develop the training products and conduct the operations training and certification for ground and flight operations.

a) For ground operations, the Contractor shall provide support for NASA development of training materials. Examples of Contractor support include: provide technical assistance in flight hardware processing, handling, and safety considerations; and provide an advocate between the ground operations' training organization and the spacecraft designers. (IDIQ)

2.7.2.(e) Integrated Ground Support Equipment

Ground Support Equipment (GSE) includes hardware and software needed for ground operations.

a) The Contractor shall support NASA in developing the allocation list of GSE to be provided by the Contractor. The allocation list will include GSE end items required to support SOW Sections 6.5, CEV Software, 10.3 Integrated Test and Verification, 2.7.2, Ground Operations Integration, and 10.6, Flight Test. The Contractor shall identify all Contractor-provided GSE in Attachment J-9, Deliverable Items List. The NASA-provided GSE described in Attachment J-11, Government Furnished Property List, will be delivered to NASA ground operations for flight tests and operational flights. Contractor use of the NASA-provided equipment will be determined during the allocation list development. Examples of the types of GSE to be provided by the Contractor include:
   - Lifting Devices – Contractor to provide lifting slings and adapters from Hydra set down to spacecraft elements/components
   - Fluid and Gases Servicing Systems – Contractor to provide spacecraft interfacing connections
   - Electrical Ground Support Equipment – Contractor to provide EGSE in support to nominal processing activities post DD-250
   - Facility Infrastructure Systems – Contractor to provide spacecraft specialty systems (Spacecraft specific special electrical power supplies, data handling, etc.)
   - Access stands – Contractor to provide internal access equipment
   - Special tools – Contractor to provide spacecraft specific special tools and ancillary equipment (LRU installation and removal devices and tools, inspection tools,)
   - Special Test equipment – Contractor to provide special test equipment (Cabin Leak test equipment, Data bus test equipment, etc.)

b) The Contractor shall develop and update the GSE Specification in accordance with **DRD CEV-T-031**, *CEV <System> Requirements Specification*, for Contractor-provided GSE. The Contractor shall ensure that the GSE Specification is consistent with **DRD CEV-O-001**, *Contractor's CEV Concept of Operations* and balances performance, life-cycle cost, schedule, and risk. The Contractor shall develop and update the **DRD CEV-T-031**, *CEV <Level> Requirements Specification*, for all interfaces with flight hardware, NASA and Contractor-provided GSE, facility systems, and facilities. The Contractor shall develop and update the **DRD CEV-T-029**, *Interface Control Document*, for all interfaces with flight hardware, NASA and Contractor-provided GSE, facility systems, and facilities.

c) The Contractor shall develop and update the contractor provided GSE end item-level requirements in accordance with **DRD CEV-T-031**, *CEV <GSE Subsystem> Requirements Specifications and CEV <GSE Component> Requirements Specifications*. The Contractor shall use the following applicable documents:

  – CxP 72506, CEV Orion Standard for Design and Fabrication of: Ground Support Equipment

d) The Contractor shall develop and update the NASA provided GSE end item-level requirements in accordance with **DRD CEV-O-008**, *Ground Systems Requirements, Plans, Reports, and Design Data, Volume I, Ground Systems End Item Requirements Document and Report*. The Contractor shall use the following applicable documents:
  – CxP 72506, CEV Orion Standard for Design and Fabrication of: Ground Support Equipment

e) The Contractor shall design, develop, produce, integrate, verify, validate, certify, document, and deliver integrated CEV GSE in accordance with all requirements in MPCV-72000, MPCV Systems Requirements Document (MPCV SRD), and in this SOW, and in accordance with **DRD CEV-O-008**, *Ground Systems Requirements, Plans, Reports, and Design Data, Volume II, Ground Systems End Item Implementation Plan and Report*. The Contractor shall provide common GSE for use during multiple phases including manufacturing, transport, processing, operations, and integration. The Contractor shall provide a common CM handling and transportation fixture. The Contractor shall assess existing material equipment lists for existing programs for any GSE hardware items that can be used for CEV. The Contractor shall use the following applicable documents for design and development of Contractor-provided GSE:
  – CxP 72506, CEV Orion Standard for Design and Fabrication of: Ground Support Equipment

f) The Contractor shall support NASA in the requirements development, design, modification, and implementation activities for the GSE that will be provided by NASA. Examples of Contractor support include: provide flight hardware/software interface design and data; participate in design reviews, working groups, and technical interchange meetings; ensure Contractor requirements are implemented appropriately; and participate in the test and verification of the NASA-provided GSE. (IDIQ)

g) The Contractor shall develop and update ***DRD CEV-O-008***, *Ground Systems Requirements, Plans, Reports, and Design Data, Volume IV, Ground Systems Sustaining Engineering Plan, for the Contractor-provided GSE*.

h) NASA will perform the GSE sustaining engineering activities. The Contractor shall support NASA sustaining engineering activities. Examples of Contractor support include: provide engineering support for problem resolution including Material Review Board (MRB) items; provide engineering review and analysis of proposed upgrades and modifications; review FMEA-CIL and hazard analysis identified critical items for mitigation or elimination; and provide an advocate between the ground operations organizations and the GSE designers. (IDIQ)

i) The Contractor shall develop and deliver **DRD CEV-T-040**, *Acceptance Data Package, for each Contractor-provided GSE end item*.

j) The Contractor shall provide initial spares, concurrent with the delivery of the GSE end items and in accordance with the provisioning procedures in **DRD CEV-T-011**, Integrated Logistics Support Plan, and **DRD CEV-T-012**, *Logistics Support Analysis, for all Contractor-provided GSE*. (IDIQ)

k) Reserved

l) The Contractor shall develop and update 2-D and 3-D simulation models of the Contractor-provided spacecraft and Contractor-provided GSE to assess clearances, placement, conflicts and the moving of hardware in accordance with **DRD CEV-T-003**, *CEV CAD Models*. The Contractor shall develop and deliver these models in accordance with SOW Section 2.4.

m) Reserved

n) The Contractor shall develop and maintain **DRD CEV-T-032**, *CEV Specification and Drawing Trees for GSE*.

o) The Contractor shall support NASA in the requirements development, design, modification, and implementation activities for the GSE that will be provided by ESA. Examples of Contractor support include: provide flight hardware/software interface design and data; participate in design reviews, working groups, and technical interchange meetings; ensure Contractor requirements are implemented appropriately; and participate in the test and verification of the ESA-provided GSE.

Deliverables
The Contractor shall deliver and maintain the following document(s):
- **DRD CEV-O-008: Ground Systems Requirements, Plans, Reports, and Design Data**
- **DRD-CEV-T-029: GSE Interface Control Documents**
- **DRD-CEV-T-031: GSE <System> Requirements Specification**
- **DRD-CEV-T-031: GSE <Subsystem> Requirements Specification**
- **DRD-CEV-T-031: GSE <Component> Requirements Specification**
- **DRD CEV-T-032 GSE Specification and Drawing Tree**
- **DRD-CEV-T-040: Acceptance Data Package**

The following GSE data is incorporated in the DRD specified in Section 2.4:
- **DRD CEV-T-003: CEV CAD Models**

2.7.3 Flight Operations Integration
Flight Operations include the plans, processes, schedules, and products required to perform the flight design, analyses, and flight planning activities; flight products and procedure development; and execution of Orbital Flight Test, EM-1 and EM-2 operational flights. Flight operations will be the responsibility of NASA; however, it is essential that the Contractor provide the data and support to NASA for the development of the flight operations products to prepare for and execute the CEV missions.

2.7.3.(a) Flight Operations Preparation
Flight Operations Preparation is the development of the pre-flight plans, processes, schedules, flight design and analyses, flight plans, procedures, and support products necessary to prepare for the CEV mission execution. The culmination of these activities will produce a complete, integrated set of operations products and procedures necessary to execute a CEV mission.
A single authoritative source of vehicle design and performance data is required to develop, produce, and implement the flight design process, trade studies, analyses, simulations, and flight products and procedures.

a) The Contractor shall develop and update vehicle systems, flight design, and analysis data for the CEV spacecraft in accordance with **DRD CEV-O-004**, *CEV Operations Data Book*,
   - Volume I: CEV Spacecraft Systems Performance and Constraints Data
   - Volume II: CEV Spacecraft Systems Electrical Equipment List
   - Volume III: CEV Mission Mass Properties Data
   - Volume IV: CEV Spacecraft Systems Contingency Analysis Data
   - Volume V: CEV Aerodynamic and Astrodynamic Performance and Constraints Data
   - Volume VI: CEV Crew Module Landing and Emergency Rescue Data
   - Volume VII: CEV Flight Capability Envelopes
   - Volume VIII: CEV Ascent, Entry, and On-orbit Structural Envelopes

b) The Contractor shall develop the initial procedures inputs in accordance with **DRD CEV-O-005**, *Flight Operations Procedures Data*. These provide nominal operations, maintenance, and nominal/off-nominal time critical response CEV spacecraft procedure inputs.

c) The Contractor shall develop the CEV stowage procedures, and supporting documentation in accordance with **DRD CEV-O-006**, *CEV Stowage Capabilities and Services Handbook*.

d) The Contractor shall provide support to the NASA flight operation's systems, flight planning and cargo integration, and flight design and analysis disciplines. The Contractor shall ensure consistent, clear communications between the Contractor and NASA flight operations, and shall research and disseminate the necessary data and technical information from the spacecraft designers for NASA to develop its flight products. Examples of Contractor support to NASA flight operations include: provide technical assistance during NASA's development of the flight crew and flight controller procedures, flight rules, flight plans, system briefs, reference products, flight design and analysis tools, system analysis tools, telemetry parameter selection, displays necessary to prepare for and execute CEV flight operations, and provide an advocate between the flight operations organizations and the spacecraft designers. (IDIQ)

e) The Contractor shall assess and provide recommendations regarding flight rule change requests and procedures change requests to assure that changes are consistent with CEV spacecraft requirements, constraints, and capabilities. (IDIQ)

Deliverables

The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-O-004: CEV Operations Data Book**
- **DRD CEV-O-005: Flight Operations Procedures Data**
- **DRD CEV-O-006: CEV Stowage Capabilities and Services Handbook**

2.7.3.(b) Flight Operations Execution (IDIQ)

Flight Operations Execution encompasses real-time support for all phases of mission operations beginning with pre-launch activities through post-landing egress of the flight crew. It is the culmination of all of the earlier pre-flight flight design, mission planning, training, and ground operations activities.

a) The Contractor shall provide support during the execution of the CEV missions using the Contractor personnel supporting the NASA flight operation's systems, flight planning and cargo integration, flight design and analysis, and training disciplines.

b) The Contractor shall provide engineering support during flight execution to provide technical information, interpret systems health data, and perform in-depth analysis in response to anomalous spacecraft conditions. The Contractor shall support the NASA CEV sub-system managers.

2.7.4 Range Safety Integration

Test and operational flights of the MPCV from U.S. airspace and ranges will require interaction with the agency responsible for the range. Support to Range Safety includes the technical and management efforts to assemble the appropriate team; develop and prepare plans for compliance with range safety requirements during design, development, preparation and execution of MPCV test and operational flights; support meetings and reviews with range safety personnel and the MPCV subsystems personnel; coordinate with operations personnel; and obtain range safety support to hazardous activities at the launch, launch operations, and hazards analysis for the launch/ascent and the descent/landing phases.

a) The Contractor shall coordinate with the ESD elements and provide technical expertise, supporting analysis, and requirements review for the NASA-led tailoring process of the AFSPCMAN 91-710, Range Safety User Requirements Manual (all Volumes), and the NPR 8715.5A, Range Flight Safety Program.

b) The Contractor shall coordinate with the ESD elements and provide technical expertise, supporting data, and analyses for the NASA-led integrated range safety products that must be delivered to the Range and reviewed by NASA for flight plan approval in accordance with **DRD CEV-O-007**, *Range Safety Requirements Documents*.

c) The Contractor shall coordinate with the MPCV Program and ESD to develop and implement operational range safety requirements, system safety plans, hazard analyses, procedures, and check lists including mission rules and flight commit criteria, pertaining to Range Safety aspects of the MPCV, in accordance with **DRD CEV-O-007**, *Range Safety Requirements Document*.

d) The Contractor shall incorporate the requirements set developed in accordance with **DRD CEV-O-007** into the appropriate CEV Spacecraft and GSE specifications delivered in **DRD CEV-T-031**, *CEV <System > System Requirements Specification* and **DRD CEV-T-031**, *CEV <GSE> System Requirements Specification*.
e) The Contractor shall use the following applicable standards for **DRD CEV-O-007**, *Range Safety Requirements Documents*:
   - AFSPCMAN 91-710: Range Safety User Requirements Manual
   - NPR 8715.5, Range Safety Program

Deliverables
The Contractor shall deliver and maintain the following document(s):
- **DRD CEV-O-007: Range Safety Requirements Documents**

The following GSE related Range Safety data is collected in the DRD specified in Section 2.7.2
- **DRD CEV-T-031: CEV <System> System Specification**
- **DRD CEV-T-031: CEV <GSE> System Specification**

2.7.5 Training Systems (IDIQ)
NASA will provide the Training Systems necessary to prepare the crew, ground, and flight operations personnel for successful execution of CEV missions. Some Training Systems may rely on contractor-provided simulation models and flight software products which NASA will modify.
a) For ground operations training systems, the Contractor shall support NASA in the implementation of the training systems requirements. Examples of the support include: provide flight hardware interface design and data; participate in the design reviews, working groups, and technical interchange meetings; and participate in the test and verification of the NASA-provided training systems.
b) The Contractor shall support NASA's development of the CEV simulators and mockups used for crew and flight controller training, procedure verification, real-time support, and control center testing. Examples of Contractor support include: provide flight hardware interface design and data; participate in the design reviews, working groups, and technical interchange meetings; provide technical support in the modification of vehicle subsystem models to include fault/malfunction capabilities; and participation in the integration, test and verification of the NASA training systems using contractor-provided simulation and flight software products (examples include Orion Sims, vehicle recon data, ARINC/Linux, FSW partition code and SOCRRATES).

2.7.6 Training
NASA operations will develop the training products and conduct the operations training and certification for ground and flight operations.
a) The Contractor shall provide NASA operations access to all data products produced by the Contractor, its subcontractors, and its vendors for the purpose of their in-house training and familiarization of the CEV System and its subsystems. The Contractor shall provide access, via Projectlink to the data products.
b) For ground operations, the Contractor shall provide support for NASA development of training materials. Examples of Contractor support include: provide technical assistance in flight hardware processing, handling, and safety considerations; and provide an advocate between the ground operations' training organization and the spacecraft designers. (IDIQ)
c) For flight operations, the CEV Contractor shall provide support to the NASA training organization. The Contractor shall ensure consistent, clear communications between the Contractor and the NASA training organization, and shall provide technical assistance during NASA's development of the

training materials necessary to prepare the flight crew, flight controllers, and other flight operations personnel for CEV missions. Examples of Contractor support include: research and dissemination of the necessary vehicle systems data and technical information from the spacecraft designers for NASA to develop its training products; provide preliminary vehicle design and test data, vehicle design rationale and drivers, and clarify vehicle requirements, design, and interfaces; and provide an advocate between the flight operations' training organization and the spacecraft designers. (IDIQ)

d) NASA will support the Contractor in "Test Participation" training and familiarization of Crew members for Contractor led Verifications. NASA will provide the Crew Operational Procedures.

2.8 SPECIALTY ENGINEERING

Specialty Engineering applies the crosscutting specialty engineering disciplines of human engineering, materials and processes, electromagnetic compatibility, Electrical, Electronic, and Electromechanical (EEE) parts, and environments to the CEV System.

a) The Contractor shall apply specialty engineering throughout the life cycle of the CEV System.
b) The Contractor's approach to incorporating the engineering specialties into the systems engineering process and the technical effort required shall be documented in **DRD CEV-M-001**, *CEV Prime Project Management Plan*.
c) The Contractor shall integrate ESM-provided data, where applicable, into the deliverables defined in this section.

Deliverables
The following Specialty Engineering data is collected in the DRD specified in Section 1.1

- **DRD CEV-M-001: CEV Prime Program Management Plan**

2.8.1 Natural and Induced Environments

a) The Contractor shall design the CEV System for the specific natural environments and induced environments that the CEV System must operate within and for which the CEV System must be qualified, encompassing all phases of CEV System production, testing and operation in all modes through disposal in accordance with SLS-SPEC-159 Cross-Program DSNE. The Contractor shall use the applicable requirements CxP-72385, CEV Government Furnished Data for Orion System Design and Analysis.
b) The Contractor shall derive, control and validate environment data and analysis models for the design, certification, and operation of the CEV System, subsystems, and components.
c) The Contractor shall define environments for spacecraft design, development, test and flight ,and document these environments in **DRD CEV-T-090**, *Environments Definition Document*.

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-090: Environments Definition Document**

2.8.2 Micrometeoroid and Orbital Debris (MM/OD) Environments

a) The Contractor shall assess MMOD risk for loss of vehicle/crew and loss of mission based on the design MMOD environments derived from SLS-SPEC-159 Cross-Program DSNE.
b) In performing the analysis and providing the protection hardware, the Contractor shall comply with the following standards:

- NASA TP-2003-210788, Meteoroid/Debris Shielding, 2003, Section 2 for describing the MMOD risk assessment process using Bumper code
- JPR 8080.5 M/S-11, JSC Design and Procedural Standards, Section M/S-11, Meteoroid and Orbital Debris Protection Levels for Structures

c) The contractor shall submit an MMOD Analysis Report in accordance CEV-T-044

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-044: CEV MMOD Analysis Report**

2.8.3 Radiation Environments for Crew Exposure

a) The Contractor shall use radiation analyses, including crew radiation exposure analysis (using analytical tools integrated to structural models), to certify that the spacecraft meets the CEV radiation requirements for the space radiation environments described in SLS-SPEC-159 Cross-Program DSNE. The Contractor shall document the certification results in **DRD CEV-T-045**, *CEV Space Radiation Analysis and Certification Report.*

b) The Contractor shall use the following radiation protection requirements and applicable document(s) in the design of the CEV Spacecraft:
- MPCV-70024, MPCV Human Systems Integration Requirements (HSIR), Section 3.2.7 per the HSIR allocation matrix in Appendix J.
- OSHA Standards 29 CFR, Supplementary Standards 1960.18
- National Council on Radiation Protection and Measurements Report No. 132: Radiation Protection Guidance for Activities in Low-Earth Orbit

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-045: CEV Space Radiation Analysis and Certification Report**

2.8.4 Materials and Processes

a) The Contractor shall ensure materials are selected, controlled, implemented and verified to be consistent with their intended usage environments.
b) The Contractor shall select, treat, fabricate, inspect, test, and analyze materials of construction to ensure the safety and success of the CEV System.
c) The Contractor shall develop and implement **DRD CEV-T-019**, *Materials and Processes Selection, Implementation, and Control Plan* that tailors the requirements and applicable documents of NASA-STD-(I)-6016, Standard Materials and Processes for Requirements for Spacecraft indicating the degree of conformance and method of implementation for each requirement as well as providing rationale for any requirements altered or not implemented.
d) RESERVED
e) The Contractor shall use the following applicable standards for Materials and Processes or demonstrate use of an equivalent standard:
   - JPR 8080.5, E-6, JSC Design and Procedural Standard E-6, Corona Suppression
   - JPR 8080.5, E-14, JSC Design and Procedural Standard, E-14, Electrical Wire Harness Acceptance Testing
   - JPR 8080.5, E-24, JSC Design and Procedural Standard, E-24, Electrical Wire and Cable Acceptance Test
   - NASA-STD-(I)-6016, Standard Requirements for Materials and Processes for Spacecraft.
f) The Contractor shall develop and implement **DRD CEV-T-020**, *Materials Usage Agreements (MUA)*; **DRD CEV-T-021**, *Contamination Control Plan (CCP)*; **DRD CEV-T-022**, *Materials Identification and Usage List (MUIL)*; **DRD CEV-T-023**, *Nondestructive Evaluation Plan*.

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-019: Materials and Processes Selection, Implementation, and Control Plan**
- **DRD CEV-T-020: Materials Usage Agreements (MUA)**
- **DRD CEV-T-021: Contamination Control Plan (CCP)**
- **DRD CEV-T-022: Materials Identification and Usage List (MIUL)**
- **DRD CEV-T-023: Non destructive Evaluation Plan**
- **DRD CEV-T-024: Corona Design Criteria**

2.8.5 EMI/EMC

a) The Contractor shall design, develop, verify and deliver a CEV System that is electromagnetically compatible with internally generated electromagnetic energy, external electromagnetic energy environments, and the other elements of ESD throughout its life cycle.
b) The Contractor shall develop and implement **DRD CEV-T-025**, *CEV Electromagnetic Compatibility (EMC) Control and Verification Document* to define the plans, processes, procedures, and test data that the Contractor will use to design, construct, and verify the CEV System electromagnetic compatibility requirements.
c) The Contractor shall tailor MIL-STD-461E, Requirements for the Control of Electromagnetic Interference (EMI) Characteristics of Subsystems and Equipment and MIL-STD-464A, Electromagnetic Environmental Effects Requirements for Systems, to assist in establishing the Contractor's documented requirements to meet the overall EMC requirements for CEV. This tailoring shall be documented in **DRD CEV-T-025**, *CEV Electromagnetic Compatibility Control and Verification Document*.

d) The Contractor shall develop and design the CEV System to control and mitigate hardware malfunction and damage throughout its life cycle that can be caused by lightning. The Contractor's CEV lightning protection effort shall include the Lightning Protection Plan, the Lightning Verification Plan, and the Lightning Protection Verification Report information requested in **DRD CEV-T-025**, *CEV Electromagnetic Compatibility Control and Verification Document*.
e) The Contractor shall develop and implement an Electrostatic Discharge control program. The Contractor's electrostatic discharge control program and processes shall be documented in **DRD CEV-T-025**, *CEV Electromagnetic Compatibility (EMC) Control and Verification Document*. The CEV System shall be constructed and delivered in accordance with these ESD processes.
f) The Contractor shall design and deliver a CEV System which complies with the requirements of NASA-STD-4003, Electrical Bonding for NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment. The Contractor's processes for implementing electrical bonding requirements shall be documented in **DRD CEV-T-025**, *CEV Electromagnetic Compatibility (EMC) Control and Verification Document*.
g) The Contractor shall tailor ML0303-0014, Electrical Wire Harnesses and Coaxial Cables, Installation Requirements for Electromagnetic Compatibility; SSP 30240, Space Station Grounding Requirements; and SSP 30242, Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility to establish the Contractor's documented requirements to meet the overall EMC requirements for the CEV System. This tailoring shall be documented in **DRD CEV-T-025**, *CEV Electromagnetic Compatibility Control and Verification Document*. The CEV System shall be designed, constructed, and delivered in accordance with the Contractor's wire/harness/cable installation processes.
h) The Contractor shall participate with NASA and the ESD elements through the E3 Control Working Group. CxP 70141, Appendix A is provided for information to coordinate and ensure CEV meets overall Electromagnetic Compatibility. The Contractor support to this working group will be tailored to support the functions defined in sections 4.2 and 4.3 of CxP 70141 and documented in **DRD CEV-T-025**, *CEV Electromagnetic Compatibility (EMC) Control and Verification Document*.
i) The Contractor shall develop and implement corona design criteria as guided by MSFC-STD-531, High Voltage Design Criteria and JPR 8080.5, E-6, JSC Design and Procedural Standard E-6, Corona Suppression. The contractor shall document and implement **DRD CEV-T-024**, *Corona Design Criteria*.

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-024: Corona Design Criteria**
- **DRD CEV-T-025: CEV Electromagnetic Compatibility Control and Verification Document**

2.8.6 Electrical, Electronic, and Electromechanical (EEE) Parts

a) The Contractor shall develop, update, and implement **DRD CEV-T-027**, *Electrical, Electronic, and Electromechanical Parts Management and Implementation Plan* for the CEV System.
b) The contractor shall incorporate a control plan for ionizing radiation effects for all CEV electronics hardware as part of **DRD CEV-T-027**, *Electrical, Electronics, and Electromechanical Parts Management and Implementation Plan*.
c) The Contractor shall use the following standards as guidance for EEE Parts:
   – JPR 8080.5, E-7, JSC Design and Procedural Standards, Section E-7, Electrical Components – Restrictions on Use
   – JPR 8080.5, E-22, JSC Design and Procedural Standards, Section E-22, Ionizing Radiation Effects
d) The Contractor shall develop and maintain **DRD CEV-T-028**, *As-built EEE Parts List*.
e) The Contractor will review and perform gap analyses on ESA provided EEE processes and plans

Deliverables
The Contractor shall deliver and maintain the following document(s):
- **DRD CEV-T-027: Electrical, Electronic, and Electromechanical Parts Management and Implementation Plan**
- **DRD CEV-T-028: As-Built EEE Parts List**

2.8.7 Human Engineering

a) The Contractor shall participate with NASA in the human engineering of the CEV System as specified in Section 2 Vehicle Integration, Section 6, CEV Spacecraft Development and Section 2.7.2, Ground and Training Systems. This includes supporting the NASA-led Cockpit Working group. Human engineering processes will be used to ensure crew and ground personnel safety, and enhance performance, efficiency, productivity, and cost effectiveness throughout the system's expected life cycle for onboard crew, ground operators, and maintainers.
b) The Contractor shall perform all human engineering in accordance with MPCV-70024, MPCV Human Systems Integration Requirements (HSIR). The Contractor shall convert analysis data, information on human capabilities and limitations, and system requirements into (a) detail design, and (b) development plans to create human system integration concepts that operate within human capabilities, and accomplish mission objectives.
c) The Contractor shall ensure Human Engineering personnel are integrated into the CEV development process, verify requirements for all human system interfaces, participate in each Integrated Product Team, concur on drawings and specifications involving human system interfaces, and support risk and engineering review boards involving human system interfaces.
d) The Contractor shall use the following applicable standards for **DRD CEV-T-089**, *Orion Crew Interface Label Map*:
   - MPCV 70024, MPCV Human Systems Integration Requirements (HSIR)
   - CxP 70152, Constellation Program Crew Interface Labeling Standard

Deliverables
The Contractor shall deliver and maintain the following document(s):
- **DRD CEV-T-089, Orion Crew Interface Label Map**

2.9 AEROSCIENCES

a) NASA will develop, update, and implement aerothermal and aerodynamic databases as part of the design and development of the CEV Spacecraft. NASA will maintain the CEV aerothermal and aerodynamic databases for the duration of contract performance.
b) NASA will define the initial Crew Module OML shape, including any flight control surfaces that might be required.
c) The Contractor will control all changes to the configuration of the Crew Module OML shape through a Crew Module OML Panel in coordination with NASA.
d) NASA will document the development of the CEV databases with an explanation of the methodologies used to develop, populate, validate, and utilize the databases, including the following:
   - Documentation of experimental testing, including descriptions of the model, instrumentation, facilities, test conditions, and results.
   - Computational tool documentation describing the application of Computational Fluid Dynamics (CFD) codes and engineering tools used to populate the databases including code descriptions,

gas dynamic modeling assumptions, best practices followed in grid refinement and result validation.
- Electronic files detailing solid model geometries, computational grids, and flow field solutions used in creating the databases with complete descriptions of file formats and content.
- Assumptions and extrapolations used to incorporate experimental and computational data into the database.
- Specification of aerodynamic and heating uncertainties and corresponding justification.
- Definition of constants, variables, functions, and engineering units.
- Documentation of aerodynamic and aerothermodynamic verification analysis.

e) The Contractor shall be responsible for using the aerothermal and aerodynamic databases for implementing the spacecraft design.
f) The Contractor shall participate in an aerodynamic technical panel, which will coordinate the development, implementation, maintenance, and delivery of the aerodynamic database.
g) The Contractor shall participate in an aerothermodynamic technical panel, which will coordinate the development, implementation, maintenance, and delivery of the aerothermodynamic database.
h) Reserved
i) The Contractor shall be responsible for developing all CAD models of the OML.

2.10 CEV ASSEMBLY, INTEGRATION, AND PRODUCTION

CEV Assembly, Integration, and Production consists of all activities needed to plan for the production of an integrated, verified, and validated vehicle and for the coordination of the accepted vehicle and all deliverable hardware, software, and documentation products. CEV AI&P includes integrated CEV-level imagery and imagery archiving for the CEV Project.

a) The Contractor shall integrate, assemble, certify, acceptance test, and deliver flight spacecraft meeting the requirements for the configurations identified in Sections 2.3, 6.1.6, 6.2.6, and 6.4.6 for Spacecraft, CM, SM/SA, and LAS, respectively.
b) The Contractor shall be responsible for post-flight disposal of non-reusable flight hardware. (IDIQ)
c) The Contractor shall provide to NASA test equipment, facilities, tooling or fixtures required for producing and testing mission-cycle flight articles.
d) The Contractor shall develop and implement an imagery plan to provide imagery (e. g., still photo, motion picture, digital imagery, or video) of the CEV Spacecraft system, modules, subsystems, and components during manufacturing, assembly, test, integration, and close-out to document the hardware configuration. The Contractor shall include the plan and imagery in **DRD CEV-T-088**, *CEV Imagery Plan/Imagery Deliverables*.
e) The Contractor's delivery plans shall include the planned method of manufacturing (including the Contractor's plans for design for manufacturability) and assembly of the flight articles(s) and associated unique tooling, fixtures and support and test equipment in accordance with **DRD CEV-T-086**, *Manufacturing and Assembly Plan*.
f) Reserved
g) The Contractor shall deliver 1 production CEV for EM-1 (uncrewed mission) and 1 production CEV for EM-2 (Crewed Mission).
h) The Contractor shall provide and maintain the non-standard Agency Consolidated End-user Services (ACES) hardware and software required for production activities.
i) The Contractor shall perform facility modifications and/or upgrades as required to support production operations in the Industrial Operating Zones (IOZs) at the Kennedy Space Center Operations and Checkout (O&C) Building M7-0355 and LAS Facility (LASF) Building M7-0777. (IDIQ)

j) The Contractor shall perform operations, maintenance, sustaining, engineering, user responsibilities (OMEU), configuration/data management and logistics support for the following facility/systems/equipment (FSE) located at the O&C and LASF IOZs as required to support its Assembly, Integration and Production (AI&P) activities:

O&C Building (M7-0355)

1.	K61-1616	Door, M7-0355 O&C High Bay East, Powered Vertical
2.	K61-1616-01	Door, M7-355 O&C High Bay West, Powered Vertical
3.	K61-1616-02	Air Lock Door
4.	K61-1616-03	Horizontal Power Doors (Flight Inventory RM 1480)
5.	K61-1616-04	Horizontal Power Doors (S&R Interior RM 1471)
6.	K61-1616-05	Horizontal Power Doors (S&R Exterior RM 1475)
7.	K62-5113	25 Ton Overhead Crane
8.	K62-5111	1 Ton Overhead Hoist
9.	PMN (TBD)	30 Ton Overhead Crane

LASF (M7-0777)

1.	K61-3214	Door, Overhead Coil, High Bay
2.	K61-3278	Bi-Parting Doors
3.	H70-1386	Crane, M7-0777, 1 Ton Bridge
4.	K61-3020	Crane, 100/10 Ton Bridge, Ccrf
5.	K62-5055	Door, M7-0777 Transporter/Canister, Pwrd (RM 1010)
6.	K62-5055	Door, M7-0777 Transporter/Canister, Pwrd (RM 1015)

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-086: Manufacturing and Assembly Plan**
- **DRD CEV-T-088: CEV Imagery Plan/Imagery Deliverables**

3 SAFETY, RELIABILITY, AND QUALITY ASSURANCE

Safety Reliability and Quality Assurance (SR&QA) is the performance of system safety, environmental safety, industrial safety, processing and launch site safety, range safety, reliability, maintainability, hardware quality assurance and software assurance across the MPCV lifecycle for production DDT&E and Flight Test Article DDT&E. The Contractor shall integrate ESM-provided data, where applicable, into the deliverables defined in this section. Integration of the ESM-provided data includes Contractor participation in technical interchange meetings and reviews where ESM safety, reliability and quality assurance products are presented, such as safety reviews, Program Material Review Boards, and acceptance data package reviews.

3.1 SR&QA MANAGEMENT AND ADMINISTRATION

The requirements in this section are applicable to all flights, including flight tests, unless otherwise specified in the MPCV 70059 Appendix C, Prime Contractor Flight Applicability Matrix, the DRDs, or this SOW.

a) The Contractor shall demonstrate and document compliance with requirements stated in the MPCV-70059, MPCV Program Integrated Safety, Reliability and Quality Assurance Requirements for safety, reliability, maintainability, hardware and software quality assurance, industrial safety, and environmental safety for all aspects of the MPCV System as implemented by **DRD CEV-S-001**.
b) The Contractor shall develop, implement and maintain a Safety and Mission Assurance (S&MA) Plan in accordance with (**DRD CEV-S-001**). The S&MA Plan encompasses the System Safety Plan, Industrial, Environmental and Range Safety Plan, Reliability, and Maintainability Plan, Quality Assurance Plan and the Software Assurance Plan. Each of these plans shall define the key processes and describe the methodology for accomplishment of and adherence to these processes. Where the DDT&E processes, methodologies, standards and requirements employed for EFT-1, differ from production, the S&MA Plan shall fully describe the different approach. For EFT-1 hardware that is common with production DDT&E, the Contractor shall address extensibility to production processes.
c) The Contractor shall incorporate and maintain in the Integrated Master Schedule all MPCV Safety Engineering Review Panel (MSERP) and Technical Interchange Meetings (TIMs) where MPCV hazard analyses are addressed. The Contractor shall also incorporate the S&MA DRD deliveries, including the interim deliveries of Probabilistic Risk Assessment models, hazard reports and FMEA/CILs.
d) The Contractor shall support concurrent engineering by providing S&MA representation at program technical and management meetings, milestones and reviews (e.g., technical interchange meetings, integration meetings, review boards, safety review panels, and change control boards) and provide positions, analysis results and decision support.
e) The Contractor shall provide S&MA representation for MPCV Safety Engineering Review Panel (MSERP) meetings and TIMs where MPCV flight, ground, or integrated hazards are addressed.
f) The Contractor shall provide an S&MA evaluation of flight rules, change requests, procedures, and contingency operations for both ground and flight operations.
g) The Contractor shall provide S&MA support for the MPCV System integrated risk assessments.
h) The Contractor shall generate, document, analyze and incorporate lessons learned for incorporation into NASA's Lessons Learned database.
i) The Contractor shall provide an S&MA evaluation of all waivers, deviations, and changes with an emphasis on impacts to safety and mission success.

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-S-001: Safety and Mission Assurance (S&MA) Plan**

3.2 SYSTEM SAFETY

The requirements in this section are applicable to all flights, including flight tests, unless otherwise specified in the MPCV 70059 Appendix C, Prime Contractor Flight Applicability Matrix, the DRDs, or this SOW.

a) The Contractor shall develop and maintain the hazard reports in accordance with MPCV 70059, MPCV Program Integrated SR&QA Requirements. (Upload into a database will be addressed in MPCV 70038.)
b) The Contractor shall deliver flight safety data packages per **DRD CEV-S-003**, *Flight System Safety Hazard Analyses*, (which include the flight operations Hazard Analysis, mitigations and controls, design drawings, schematics, systems descriptions and system analysis) at all flight phased safety reviews in accordance with the Program schedule and MPCV 70059, MPCV Program Integrated SR&QA Requirements.
c) The Contractor shall deliver ground safety packages per **DRD CEV-S-005**, *Ground System Safety Hazard Analysis*, (which include the ground operations Hazard Analysis, mitigations and controls, design drawings, schematics, systems descriptions, hazardous operations descriptions, and launch site processing plans and procedures) at all ground phased safety reviews in accordance with the Program schedule, and MPCV 70059, MPCV Program Integrated SR&QA Requirements.
d) Reserved
e) Reserved.
f) Reserved.
g) The Contractor shall perform an orbital debris assessment on the MPCV system per **DRD CEV-S-007**, *Orbital Debris Assessment*, to determine the amount of orbital debris that may be generated both in nominal and malfunction operations and for collisions in orbit.

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-S-003: Flight System Safety Hazard Analysis**
- **DRD CEV-S-005: Ground System Safety Hazard Analysis**
- **DRD CEV-S-007: Orbital Debris Assessment**

3.3 INDUSTRIAL, ENVIRONMENTAL, AND HEALTH

The requirements in this section are applicable to all flights, including flight tests, unless otherwise specified in the MPCV 70059 Appendix C, Prime Contractor Flight Applicability Matrix, the DRDs, or this SOW.

a) The Contractor shall develop and deliver a mishap prevention plan per **DRD CEV-S-004**, *Mishap Plan and Safety Statistics* that meets or exceeds NPR 8621.1, NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping and MPCV 72223, MPCV Mishap Response and Contingency Action Plan.
b) Reserved
c) Reserved
d) Reserved

e) The Contractor safety organization shall actively participate in Test Readiness Reviews to ensure personnel and hardware safety.
f) Reserved
g) Reserved
h) Reserved
i) Reserved
j) Reserved
k) Reserved
l) Reserved
m) The Contractor shall provide a safety and health program which identifies, eliminates, mitigates and controls hazards and risks in all Contractor activities and document the plan in **DRD CEV-S-008**, *Safety and Health Plan*.
n) The Contractor and their subcontractors (if any) shall follow applicable OSHA, NASA, and CEV safety and health requirements. The Contractor and their subcontractors shall document this "flow down" of safety and health responsibility in the Safety and Health Plan (**DRD CEV-S-008**).
o) Reserved
p) Reserved
q) Reserved

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-S-004: Mishap Plan and Safety Statistics**
- **DRD CEV-S-007: Orbital Debris Assessment**
- **DRD CEV-S-008: Safety and Health Plan**

3.4 RELIABILITY AND MAINTAINABILITY

The requirements in this section are applicable to all flights, including flight tests, unless otherwise specified in the MPCV 70059 Appendix C, Prime Contractor Flight Applicability Matrix, the DRDs, or this SOW.

a) The Contractor shall develop, implement, and maintain an RMS Plan per **DRD CEV-S-001**, *Safety and Mission Assurance (S&MA) Plan*, which defines the implementation of RMS within their organization including processes, required skills, tasks and products for the MPCV System.
b) The Contractor shall perform Failure Modes Effects Analyses /Critical Items Lists (FMEA/CIL) per MPCV-70059, MPCV Program Integrated SR&QA Requirements and document the results per **DRD CEV-S-009**, *Failure Mode and Effects Analysis & Critical Items List (FMEA/CIL)*.
c) The Contractor shall perform MPCV System Probabilistic Risk Assessments per MPCV 70059, MPCV Program Integrated SR&QA Requirements and document the results in **DRD CEV-S-010**, *Probabilistic Risk Assessment Results*. The Contractor shall also perform focused PRAs to support necessary design trade studies or hazard analyses.
d) The Contractor shall perform Reliability and Maintainability analyses per the reliability and maintainability requirements in MPCV 70059, MPCV Program Integrated SR&QA Requirements and document the results per the **DRD CEV-S-011**, *Reliability and Maintainability Integrated Report*.
e) Reserved
f) Reserved
g) Reserved

Deliverables

The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-S-009: Failure Modes Effects Analysis & Critical Items List (FMEA/CIL)**
- **DRD CEV-S-010: Probabilistic Risk Assessment Results**
- **DRD CEV-S-011: Reliability) and Maintainability Integrated Report**

3.5 HARDWARE QUALITY ASSURANCE

The requirements in this section are applicable to all flights, including flight tests, unless otherwise specified in the MPCV 70059 Appendix C, Prime Contractor Flight Applicability Matrix, the DRDs, or this SOW.

a) The Contractor shall develop, implement and maintain a quality management system and Quality Assurance Plan per **DRD CEV-S-001**, *Safety and Mission Assurance (S&MA) Plan*. For EM-1, EM-2 the quality management system shall be in accordance with MPCV-70059, MPCV Program Integrated Safety, Reliability & Quality Assurance (SR&QA) Requirements. For EFT-1 and AA-2, the Contractor shall maintain an AS9100B compliant quality management system. The Quality Assurance Plan shall define their Quality Assurance organization including processes, required skills, tasks and products for the MPCV.

b) The Contractor shall provide all reportable problems, their status, and corrective actions, for both hardware and software maximizing use of batch processing data transfer in accordance with MPCV 70068, MPCV Program Problem Reporting, Analysis and Corrective Action (PRACA) Requirements.

c) Reserved

d) The Contractor shall perform internal and subcontractor audits per the Safety and Mission Assurance (S&MA) Plan (**DRD CEV-S-001**). The Contractor shall document the findings and results of the internal and subcontractor audits in accordance with Contractor processes.

e) The Contractor's S&MA organization shall review design specifications and designs to determine compliance with required materials specifications.

f) The Contractor's S&MA organization shall review Materials and Special Processes activities in the MPCV Spacecraft Manufacturing process, to ensure compliance with materials and process control specifications (including welding and brazing assurance, and NDE expertise to assure proper methods, techniques and standards are being used in the performance of NDE upon the hardware).

g) The Contractor's S&MA organization shall participate in the Fracture Control Board for the MPCV System to evaluate fracture-critical hardware.

h) The Contractor shall document the controls that they shall use for those manufacturing processes where uniform high quality cannot be ensured by inspection or test alone and the failure would be of a critical nature. These production processes and their controls shall be documented in **DRD CEV-S-015**, *Critical Processes*.

i) The Contractor shall develop, implement, and document a Mechanical Parts Assurance Plan for flight and critical ground support equipment hardware per **DRD CEV-S-016**, *Mechanical Parts Management and Implementation Plan*.

j) The Contractor shall document its workmanship standards/specifications to ensure that they meet or exceed applicable NASA and Program Standards per **DRD CEV-T-019**, *Materials and Processes Program Plan*.

k) The Contractor shall participate in the GIDEP and NASA Alerts process employing **DRD CEV-S-012**, *Government-Industry Data Exchange Program and NASA Advisories/Alerts*.

Deliverables

The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-S-012: Government-Industry Data Exchange Program and NASA Advisories/ALERTS**

- **DRD CEV-S-015: Critical Processes**
- **DRD CEV-S-016: Mechanical Parts Management and Implementation Plan**
- **DRD CEV-T-019: Materials and Processes Program Plan**

The Quality Assurance Plan specific data is collected in the following DRD specified in Section 3.1:

- **DRD CEV-S-001: Safety and Mission Assurance Plan**

3.6 SOFTWARE SAFETY AND ASSURANCE

The requirements in this section are applicable to all flights, including flight tests, unless otherwise specified in the MPCV 70059 Appendix C, Prime Contractor Flight Applicability Matrix, the DRDs, or this SOW.

a) The Contractor shall develop, implement, and maintain a Software Assurance Plan per **DRD CEV-S-001**, *Safety and Mission Assurance (S&MA) Plan*.
b) The Contractor shall demonstrate and document software assurance functions for all software in the MPCV System in accordance with MPCV 70059, MPCV Program Integrated SR&QA Requirements.
c) The Contractor shall audit its own and any software supplier's internal software assurance activities to allow evaluation of both the progress and effectiveness of software assurance tasks and the need for adjustments or changes and document the results in accordance with Contractor processes.
d) The Contractor shall implement a systematic approach to software safety as an integral part of the Program's overall system safety program, per MPCV 70059, MPCV Program Integrated SR&QA Requirements and MPCV 70038, MPCV Hazard Analyses Requirements.

Deliverables

The software safety approach and Software Assurance Plan is collected in the following DRD specified in Section 3.1:

- **DRD CEV-S-001: Safety and Mission Assurance Plan**

4 RESERVED

5 RESERVED

6 CEV SPACECRAFT DEVELOPMENT

Spacecraft development includes the tasks required for the design, development, production, assembly, test, and certification efforts to deliver the completed Spacecraft for integration with the launch vehicle and other mission elements.

6.1 CREW MODULE

The Crew Module includes the tasks required for the design, development, production, assembly, test, and certification of the Crew Module (CM) and efforts to deliver the completed Crew Module for Spacecraft integration.

6.1.1 CM Management and Administration

CM Management and Administration includes the efforts for planning, organizing, directing, coordinating, controlling, and approval processes used to accomplish Crew Module Development objectives.

a) NASA will maintain oversight of all Crew Module design activities. The Contractor shall maintain responsibility for delivery of a design that meets the requirements. The detailed process discussion to accomplish this can be found in MPCV-72008, MPCV Orion Program Plan. The Contractor shall include NASA personnel on all design teams established by the Contractor.

6.1.2 CM System Engineering and Integration

CM Systems Engineering and Integration consists of the efforts to lead the Crew Module's overall system architecture definition and engineering functions. This includes the technical and management efforts of directing and controlling the integrated engineering effort for the CM. This also includes the effort to coordinate CM integration with the CEV integration functions described in Section 2.

a) The Contractor shall define the modules, subsystems, components, and software units that make up the Crew Module per the requirements and deliverables included in this section.
b) The Contractor shall develop, maintain, and deliver all drawings and technical Computer Aided Design (CAD) models of the Crew Module system, subsystems and components. The Contractor shall use **DRD CEV-T-003**, *CEV CAD Models*, and **DRD CEV-T-004**, *CEV Drawings*, as the template for development and delivery of these items.
c) The Contractor shall develop and maintain analysis, models and test bed simulations for the Crew Module system, subsystems, and components using **DRD CEV-T-001**, *Models, Simulations and Integrated Support Plan*.
d) The Contractor shall document ICD(s) where required for the government furnished hardware provided on contract attachment J-11, in accordance with **DRD CEV-T-029** *Interface Control Documents* and **DRD CEV-O-006**, *CEV Stowage Capabilities and Services Handbook*.
e) The Contractor shall document Crew Module subsystem requirements and interface requirements using **DRD CEV-T-031**, *CEV <Subsystem> Requirements Specifications*.
f) The Contractor shall document component-level requirements within the Crew Module using **DRD CEV-T-031**, *CEV <Component> Requirements Specifications*.
g) Reserved

h) The Contractor shall develop and maintain the Crew Module portion of the CEV Specification and Drawing Trees, **DRD-CEV-T-032**. The top drawing shall be incorporated into the CEV System Drawing Tree identified in Section 2.2.
i) The contractor shall provide a CEV stowage interface design document in accordance with **DRD CEV-T-029**.
j) The contractor shall document Crew Module internal subsystem interface design details using **DRD CEV-T-029**, *Interface Control Documents*.

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-029: Crew Module Internal Interface Control Documents**
- **DRD CEV-T-029: Crew Module Internal<Subsystem> Interface Control Documents**
- **DRD CEV-T-029: Crew Module Internal Stowage Interface Control Documents**

The following Module specific data is collected in the DRD specified in Section 2.2

- **DRD CEV-T-031: Crew Module <Subsystem> Requirements Specifications**
- **DRD CEV-T-031: Crew Module <Component> Requirements Specifications**
- **DRD CEV-T-032: CEV Specification and Drawing Tree for the Crew Module**

The following Module specific data is collected in the DRDs specified in Section 2.4

- **DRD CEV-T-001 Models, Simulations and Integrated Support Plan**

The following deliverables are separate Module deliverables and are integrated by reference into the System level submittal in 2.4.

- **DRD CEV-T-003: CM CAD Models**
- **DRD CEV-T-004: CM Drawings**

6.1.3 CM Subsystems

This Section includes the work required to design, develop, produce, and test through certification and acceptance all Crew Module subsystems required to meet CEV module-level and interface requirements.

a) The Contractor shall design, develop, test, certify, and deliver Crew Module subsystem hardware complying with all requirements allocated from MPCV-72000, MPCV Systems Requirements Document (MPCV SRD).
b) Reserved
c) The Contractor shall provide system and module level design definition data in the **DRD CEV-T-033**, *Architectural Design Document* and design definition and data down to the component level in the Subsystem Design and Data Books. (See Section 2.2)
d) The Contractor shall hold subsystem or component design reviews prior to the system PDR and CDR.
e) The Contractor shall test and deliver flight spares for the Crew Module subsystems. (IDIQ) The Contractor shall provide a spare parts list as part of **DRD CEV-T-012**, *Logistics Support Analysis* (Recommended Spare Parts List). (IDIQ)
f) The Contractor shall deliver two (2) Flight Spacecraft Crew Modules for EM-1 and EM-2. The Contractor may reuse hardware from EM-1 to EM-2.
g) The Contractor shall deliver one ship set of Crew Module flight spares (i.e., 1 copy of every line replaceable unit) (IDIQ)
h) The Contractor shall use the following standards and requirements documents for developing all CM subsystems:
   - JPR 8080.5, JSC Design and Procedural Standards
   - MPCV-70024, MPCV Human Systems Integration Requirements (HSIR)
i) The Contractor shall use the following standards for developing all CM subsystems:

- AIAA-S-080, AIAA Standard for Space Systems – Metallic Pressure Vessels Pressurized Structures, and Pressure Components
- ANSI/AIAA-S-081A-2006, AIAA Standard for Space Systems – Composite Overwrapped Pressure Vessels

Deliverables

The following module specific information is collected in the DRDs specified in Section 2.7.2

- **DRD CEV-T-012: Logistics Support Analysis**

The following module specific information is collected in the DRDs specified in Section 2.2

- **DRD CEV-T-033: Architecture Design Document**

6.1.3.1 Reserved

6.1.3.2 CM Command & Data Handling

a) For the Crew Module, the Contractor shall prepare, deliver and maintain **DRD CEV-T-047**, *Avionics Design and Data Book Volume II - C&DH/Instrumentation Subsystem Data*.

b) Reserved

Deliverables

The following module specific information is collected in the DRDs specified in Section 2.6.1

- **DRD CEV-T-047: Avionics Design and Data Book, Volume II – C&DH/Instrumentation Subsystem Data**

6.1.3.3 CM Communications & Tracking

a) For the Crew Module, the Contractor shall prepare, deliver, and maintain **DRD CEV-T-047**, *Avionics Design and Data Book Volume III - Communications and Tracking Subsystem Data*.

b) Reserved

c) Reserved

d) Reserved

Deliverables

The following module specific information is collected in the DRDs specified in Section 2.6.3

- **DRD CEV-T-047: Avionics Design and Data Book, Volume III – Communications and Tracking Subsystem Data Book**

6.1.3.4 CM Displays and Controls

a) For the Crew Module, the Contractor shall prepare, deliver and maintain **DRD CEV-T-047**, *Avionics Design and Data Book Volume IV - Displays and Controls Subsystem Data*.

b) Reserved

Deliverables
The following module specific information is collected in the DRDs specified in Section 2.6.4

- **DRD CEV-T-047: Avionics Design and Data Book, Volume III – Displays and Controls Subsystem Data Book**

6.1.3.5 CM Electrical Power System

a) For the Crew Module, the Contractor shall prepare, deliver and maintain **DRD CEV-T-059**, *Electrical Power System (EPS) Design and Data Book*
b) The Contractor shall participate with ESD in the development of **DRD CEV-T-060**, *Electrical Power Quality Specification Requirements Document*.

Deliverables
The following module specific information is collected in the DRDs specified in Section 2.6.5

- **DRD CEV-T-059: CM Electrical Power System (EPS) Design and Data Book**
- **DRD CEV-T-060: CM Electrical Power Quality Specification Requirements Document**

6.1.3.6 CM Mechanisms

a) For the Crew Module, the Contractor shall prepare, deliver, and maintain **DRD CEV-T-061**, *Mechanical Systems Design and Data Book,* and **DRD CEV-T-062***: Stress Analysis Report*

Deliverables
The following module specific information is collected in the DRDs specified in Section 2.6.6

- **DRD CEV-T-061: CM Mechanical Systems Design and Data Book**
- **DRD CEV-T-062: CM Stress Analysis Report**

6.1.3.7 CM Passive Thermal Control

a) The Contractor shall develop thermal analytical models to support Crew Module thermal analyses.
b) For the Crew Module, the Contractor shall prepare, deliver and maintain **DRD CEV-T-063**, *PTC Systems Design and Data Book*, and **DRD-CEV-T-064**, *Passive thermal Control Mathematical Models and Documentation*

Deliverables
The following module specific information is collected in the DRDs specified in Section 2.6.7

- **DRD CEV-T-063: CM Passive Thermal Control Design and Data Book (PTCDDB)**
- **DRD CEV-T-064: CM Passive Thermal Control Mathematical Models and Documentation**

6.1.3.8 CM Thermal Protection System

a) NASA will perform advanced development of two designs for the TPS forebody heat shield component through the Orion PDR. The forebody heat shield component includes both the TPS materials or material system, the underlying support structure to which the TPS material is mounted, and the attachment or bonding agents or system. These two advanced development design options are as follows:
   - Primary Lunar Return capable
   - Alternate Lunar Return capable
b) NASA will produce the following subsystem products for PDR:

- TPS Component (Forebody Heat shield) Requirements Specification (**DRD CEV-T-031**)
- TPS Component (Forebody Heat shield) section of the Thermal Protection System Design and Data Book (TPSDDB) (**DRD CEV-T-065**)
- TPS Component (Forebody Heat shield) Math Models as part of Thermal Protection System Mathematical Models and Documentation (**DRD CEV-T-066**) and CEV CAD Models (**DRD CEV-T-003**)
- Inputs to integrated Contractor products

c) The contractor shall produce the following subsystem products post-transition:
   - TPS Component (Forebody Heat shield) Requirements Specification (**DRD CEV-T-031**)
   - TPS Component (Forebody Heat shield) section of the Thermal Protection System Design and Data Book (TPSDDB) (**DRD CEV-T-065**)
   - TPS Component (Forebody Heat shield) Math Models as part of Thermal Protection System Mathematical Models and Documentation (**DRD CEV-T-066**) and CEV CAD Models (**DRD CEV-T-003**)

d) The Contractor shall participate in advanced development activities to the extent necessary to execute the efforts described in this SOW.
e) The Contractor shall produce all remaining subsystem PDR products not produced by NASA.
f) The Contractor shall integrate the DDT&E efforts of components that interface to the Heatshield DFI
g) NASA will provide the Heatshield DFI inserts for EFT-1 and EM-1
h) Following the TPS subsystem design review that occurs prior to Orion PDR, the Contractor shall perform detailed design, test, and analysis of the two TPS heat shield designs
i) The Contractor shall establish a milestone for selecting one of the two TPS heat shield designs based on test and evaluation of the two designs. The Contractor shall recommend the TPS heat shield design to be used for final implementation at this milestone. The Contractor shall document this milestone in the Integrated Master Plan (IMP). NASA will select the final TPS heat shield design.
j) The Contractor shall develop engineering development units (EDU) for the selected heat shield design for use in Contractor and NASA testing.
k) The Contractor shall complete design, development, test, certification, and delivery of the selected TPS heat shield and all post-PDR DRD products.
l) The Contractor shall design, develop, test, certify, and deliver all other CEV Spacecraft TPS components and DRD products.
m) The Contractor shall develop thermal analytical models to support integrated ESD systems vehicle analyses and CEV thermal analyses.
n) NASA will lead, and the Contractor shall participate in, joint advanced development activities for the CEV thermal protection system through the Preliminary Design Review (PDR). The Contractor shall develop and implement plans, which detail the transition from development to insertion into the primary design path, for these advanced technologies. The Contractor shall document these plans in the design and data books for each subsystem.
o) The Contractor may reuse the heat shield from STA to perform heat shield qualification.

Deliverables

The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-065: Thermal Protection System Design and Data Book (TPSDDB)**
- **DRD CEV-T-066: Thermal Protection System Mathematical Models and Documentation**

The following subsystem documentation is collected in the DRDs specified in Section 6.1.2, Post PDR

- **DRD CEV-T-031:CM Thermal Protection System <Subsystem> Requirements Specification**
- **DRD CEV-T-031: CM Thermal Protection System <Components> Requirements Specification**

The following module specific information is collected in the DRDs specified in Section 2.4, Post PDR

- **DRD CEV-T-001: Models, Simulations and Integrated Support Plan**
- **DRD CEV-T-003: CM TPS CAD Models**
- **DRD CEV-T-004: CM TPS Drawings**

6.1.3.9 CM Structures

a) The Contractor shall perform structural analysis on all Crew Module structures, including pressure vessels, to show that all elements of the design such as the strength, stiffness, structural stability, and life meet all specified criteria for the anticipated loads and environments.
b) The Contractor shall perform Crew Module loads and dynamics analyses and document the results and structural environments in **DRD CEV-T-090**, *Environments Design Document*.
c) The Contractor shall perform Crew Module stress and fatigue analyses and document the results in **DRD CEV-T-062**, *Stress Analysis Report*.
d) The Contractor shall develop Crew Module models to support ESD vehicle analyses as well as CEV loads and stress analyses. The Contractor shall deliver **DRD CEV-T-068**, *Structures Mathematical Models and Documentation*, which will deliver and describe the mathematical models used in the Crew Module system, subsystem, and component loads and stress analyses.
e) The Contractor shall implement a fracture control program and identify fracture critical parts to protect against catastrophic structural hazards associated with flaw presence, fatigue crack propagation and fracture. The Contractor shall deliver and implement **DRD CEV-T-069**, *Fracture Control Plan*, and **DRD CEV-T-070**, *Fracture Control Summary Report*.
f) The Contractor shall use NASA-HDBK-7005, Dynamic Environmental Criteria, as an informational document to support the **DRD CEV-T-015**, *Master Verification Plan* DRD product development activity.
g) The Contractor shall use the following standards for designing and analyzing the Crew Module structures subsystem:
   - CxP-72385, CEV Government Furnished Data for Orion System Design and Analysis
   - JSC-62550, Structural Design and Verification Criteria for Glass, Ceramics and Windows in Human Space Flight Applications
   - NASA-STD-5002, Loads Analyses of Spacecraft and Payloads
   - NASA STD-(I)-5019, Fracture Control Requirements for Space Flight Hardware
h) Reserved
i) Reserved

Deliverables
The following module specific information is collected in the DRDs specified in Section 2.6.9

- **DRD CEV-T-015 Master Verification Plan**
- **DRD CEV-T-062: CM Stress Analysis Report**
- **DRD CEV-T-068: CM Structures Mathematical Models and Documentation**
- **DRD CEV-T-070: CM Fracture Control Summary Report**
- **DRD CEV-T-090: Environments Definition Document**

6.1.3.10 Crew Module Propulsion

a) The Contractor shall perform design, development, test and certification of all Crew Module propulsion systems.
b) The Contractor shall certify the propulsion systems for compliance with CEV component, subsystem, module, Spacecraft system, and vehicle-level requirements. The Contractor shall design, fabricate and test integrated Crew Module propulsion systems in order to evaluate and certify integrated propulsion system hot fire performance for each propulsion application. The Contractor shall design, fabricate, and test integrated Crew Module propulsion systems to evaluate and certify integrated propellant system storage and conditioning designs. (See Section 2.6.10)

c) For the Crew Module, the Contractor shall prepare, deliver and maintain **DRD CEV-T-071**, *Propulsion Systems Design and Data Book*.

Deliverables
The following module specific information is collected in the DRDs specified in Section 2.6.10

- **DRD CEV-T-071: CM Propulsion Systems Design and Data Book**

6.1.3.11 Suits and Survival Crew Equipment Support Systems

a) NASA will provide the MPCV Launch and Entry suits per **DRD CEV-T-031**: *ECLS and Suits Subsystem Requirements Specification* (e.g. helmets, gloves, undergarments, and standard EVA tools if applicable).
b) NASA will provide portable crew equipment systems and gear as defined in Contract Attachment J-11, Government Furnished Property for emergency egress and survival, crew/personnel post landing tracking systems, and crew/personnel post landing communications systems.
c) The Contractor shall design and document the Crew Module interfaces for these NASA-provided items.
d) The Contractor shall perform requirements development, and design, to support integration of NASA-provided suits, support equipment, and survival crew equipment. The contractor shall conduct testing, verification, validation, qualification, and certification of the Crew Module with those NASA provided items included.
d) Reserved
e) The Contractor shall use the human engineering standards listed in section 2.8.7, Human Engineering, to design all interfaces to suits, , and survival crew equipment systems.
f) Reserved
g) Reserved

Deliverables
The following module specific information is collected in the DRDs specified in Section 2.6.11

- **DRD CEV-T-073: Environmental Control and Life Support, and Suit Design and Data Book**

6.1.3.12 Crew Module Environmental Control and Life Support (ECLS), Crew Health and Habitation Accommodations

The Contractor shall integrate the DDT&E efforts of the spacecraft subsystems for Environmental Control and Life Support (ECLS), active thermal control, medial systems interfaces, and habitation accommodations.

a) NASA will provide ECLS Crew Health and Habitation Accommodation equipment as identified in Contract Attachment J-11, Government Furnished Property.
b) The Contractor shall design the Crew Module interfaces for these NASA-provided items.
c) Reserved
d) Reserved
e) The Contractor shall use the following ECLS, crew health and habitation accommodations standards and the Human Engineering Standards listed in section 2.8.7, Human Engineering, for designing this subsystem:
   – JSC 20584, Spacecraft Maximum Allowable Concentrations for Airborne Contaminants
f) The Contractor shall provide definition of the process to be used for cleanliness of components for use in oxygen, fuel, and pneumatic systems. The Contractor shall provide this information in **DRD CEV-T-073**, *Environmental Control and Life Support and Suit Design and Data Book*.

g) The Contractor shall identify the standard for test methods for environmental engineering in **DRD CEV-T-073**, *Environmental Control and Life Support and Suit Design and Data Book*.

Deliverables
The following module specific information is collected in the DRDs specified in Section 2.6.12
- **DRD CEV-T-073: CM Environmental Control and Life Support and Suit Design and Data Book**
- **DRD CEV-T-074: Crew Health, Survival Habitation Accommodations/Stowage and EVA Systems Design and Data Book**

6.1.3.13 CM Pyrotechnics

a) The Contractor shall perform device level preliminary design reviews and critical design reviews for each Crew Module pyrotechnic devices not provided by NASA. The Contractor shall conduct development, qualification, and acceptance testing on all other pyrotechnic devices selected for the Crew Module. The Contractor shall conduct Phase I, Phase II, and Phase III technical reviews on all other pyrotechnic devices selected for the Crew Module per the requirements of CxP 70199, Constellation Program Pyrotechnic Specification and JPR 8080.5 Standards P-1, E-1, G-2, G-12, P-6.
b) Crew Module specific stress analysis reports will be collected in the DRD (**DRD CEV-T-062**, *Stress Analysis Report*) specified in Section 2.6.13 for all pyrotechnic devices selected for the Crew Module.
c) The Contractor shall document the design for the Crew Module pyrotechnic subsystem as specified in **DRD CEV-T-075**, *Pyrotechnic Subsystem Design and Data Book*
d) NASA will supply pyrotechnic hardware in accordance with Contract Attachment J-11.

Deliverables
The following module specific information is collected in the DRDs specified in Section 2.6.13
- **DRD CEV-T-062: CM Stress Analysis Report**
- **DRD CEV-T-075: CM Pyrotechnic Subsystem Design and Data Book**

The following Module specific data is collected in the DRD specified in Section 2.2.
- **DRD CEV-T-031: Pyrotechnics Subsystem Requirements Specification**
- **DRD CEV-T-031: CM Pyrotechnics Component Requirements Specifications**

6.1.3.14 Landing and Recovery Systems

a) NASA will provide the parachute system, except for the drogue parachute mortars and pilot and FBC parachute mortars that are being provide by the contractor.
b) The contractor shall provide the pyrotechnic devices and select Parachute Test Vehicle hardware (Parachute Bays) as defined in J-9 with the exception of the reefing line cutters, in support of the parachute system.
c) NASA will perform advanced development of the landing attenuation system leading up to the landing attenuation subsystem design review.
d) NASA will produce the following landing attenuation system PDR products that are derived from Landing and Recovery System Subsystem Requirements Specification (**DRD CEV-T-031**):
   - Landing Attenuation System Subsystem Requirements Specification (**DRD CEV-T-031**, *CEV <Subsystem> Requirements Specification*)
   - Landing Attenuation System Component Requirements Specification (**DRD CEV-T-031**, *CEV <Component> Requirements Specification*)
   - Input to **DRD CEV-T-076**, *Recovery Systems Design and Data Book*
   - Input to **DRD CEV-T-077**, *Recovery Systems Simulation Models and Documentation*

e) The Contractor shall participate in the advanced development activities to the extent necessary to execute the efforts described in this SOW.

f) The Contractor shall produce all remaining PDR products not produced by NASA.
g) The Contractor shall complete design, development, test, certification, and delivery of the selected landing attenuation system and all post-PDR DRD products.
   – Landing Attenuation System Subsystem Requirements Specification (**DRD CEV-T-031**, *CEV <Subsystem> Requirements Specification*)
   – Landing Attenuation System Component Requirements Specification (**DRD CEV-T-031**, *CEV <Component> Requirements Specification*)
   – **DRD CEV-T-076**, *Recovery Systems Design and Data Book*
   – **DRD CEV-T-077**, *Recovery Systems Simulation Models and Documentation*
h) The Contractor shall perform the requirements development, trade studies, design, analysis, production, assembly, integration, testing, verification, validation, qualification, certification, and maintenance for Contractor-provided CEV recovery hardware as specified by the CEV Project.
i) The Contractor shall develop analysis, models and test bed simulations for Contractor-provided hardware and integrate with the models and simulations for the NASA-provided hardware to support recovery systems development (**DRD CEV-T-077**, *Recovery System Simulation Models and Documentation*).
j) NASA will lead, and the Contractor shall participate in, joint advanced development activities for the CEV landing attenuation through the system Preliminary Design Review (PDR). The Contractor shall develop and implement plans, which detail the transition from development to insertion into the primary design path, for these advanced technologies. The Contractor shall document these plans in the design and data books for each subsystem.
k) The Contractor shall develop, implement, and maintain an Landing and recovery Systems Detailed Test Plan, that details the Contractor's plan for verifying, certifying, and acceptance of the Landing and Recovery System.

Deliverables
The Contractor shall deliver and maintain the following document(s):
- ***DRD* CEV-T-076: CM Recovery Systems Design and Data Book**
- **DRD CEV-T-077: CM Recovery Systems Simulation Models and Documentation**

The following subsystem documentation is collected in the DRDs specified in Section 6.1.2, Post PDR
- **DRD CEV-T-031: CM Landing Attenuation System <Subsystem> Requirements Specification**
- **DRD CEV-T-031: CM Landing Attenuation System <Components> Requirements Specification**

The following module specific information is collected in the DRDs specified in Section 10.2, Post PDR
- **DRD CEV-T-015: CM Recovery Systems Volume – Master Verification Plan**

6.1.3.15 Crew Module Guidance, Navigation, and Control (GN&C)

a) The Crew Module GN&C requirements design and functional verification effort will be performed through the use of specialized MODE teams. NASA will co-lead with the Contractor the development of detailed design requirements for the Crew Module GN&C flight system. The Contractor shall document the Crew Module GN&C requirements in **DRD CEV-T-031**, *CEV GN&C Subsystem Requirements Specification*, and **DRD CEV-T-048**, *Software Requirements Specification*. The Contractor shall co-lead the following teams:
   – CEV Ascent/Abort MODE Team
   – Entry GN&C MODE Team
   – On-Orbit GN&C MODE Team
   – Flight Mechanics/Mission Design MODE Team
b) The Contractor shall document the design for the Crew Module GN&C subsystem as specified in **DRD CEV-T-078**, *GN&C Systems Design and Data Book*.

Deliverables
The following module specific information is collected in the DRDs specified in Section 6.1.2

- **DRD CEV-T-031:CM GN&C <Subsystem > Requirements Specification**
- **DRD CEV-T-031 CM GN&C <Components> Requirements Specification**

The following module specific information is collected in the DRDs specified in Section 6.5.2

- **DRD CEV-T-048: Software Requirements Specification**

The following module specific information is collected in the DRDs specified in Section 2.6.15

- **DRD CEV-T-078: CM GN&C Design and Data Book**

6.1.3.16 CM Wiring

a) The Contractor shall develop wiring documentation that provides definition down to the level of pin-to-pin connectivity for all electrical harnesses and optical cables used on the Crew Module to support ground, launch, flight, and recovery operations including testing, verification, calibration, and maintenance through the vehicle delivery. The Contractor shall deliver the wiring documentation to NASA as **DRD CEV-T-080**, *CEV Vehicle Wiring Configuration, Identification and Definition Reports*. The Contractor shall provide a hierarchical path/signal structure which links the wiring documentation to **DRD CEV-T-046**, *CEV Data and Command Dictionary*.

b) The Contractor shall develop, manufacture/fabricate, test, install, and certify all Crew Module wiring in accordance with **DRD CEV-T-080**, *CEV Vehicle Wiring Configuration, Identification and Definition Reports*.

Deliverables
The following module specific information is collected in the DRDs specified in Section 2.6.1

- **DRD CEV-T-046: CEV Data and Command Dictionary**

The following module specific information is collected in the DRDs specified in Section 2.6.16

- **DRD CEV-T-080: CEV Vehicle Wiring Configuration, Identification and Definition Reports**

6.1.4 Reserved

6.1.5 CM Test, Verification, and Certification

a) The Contractor shall include Crew Module, subsystems, and components verification, qualification, certification, and acceptance activities as part of the Master Verification Plan, CEV-T-015.

b) The Contractor shall perform Crew Module qualification tests using **DRD CEV-T-037**, *Qualification Test Procedures,* and document the test results in **DRD CEV-T-038**, *Qualification Test Report*, and **DRD CEV-T-017**, *Certification Data Package*. The Contractor shall perform qualification testing at component, CM and intermediate levels of assembly as necessary to accumulate the data necessary for certification.

c) The Contractor shall produce a Certification Data Package for the component, each subsystem in the Crew Module, the Crew Module, and the Spacecraft as required to meet certification for individual mission or certification to meet requirements of CxP-72000 SRD. Note: Software test documentation is handled in SOW section 6.5, CEV Software.

d) The Contractor shall perform acceptance testing at the Crew Module and CM components using DRD CEV-T-039, Acceptance Test Plans and Procedures, and document the results using **DRD CEV-T-040,** *Acceptance Data Package*.

e) The Contractor shall hold Test Readiness Reviews (TRRs) before Crew Module Level formal verification activities. The Contractor shall make subsystem or component test procedures available to NASA. The Contractor shall invite NASA, to all formal verification activities, including TRRs and test executions.

f) The Contractor shall conduct verification activities for all interfaces and requirements within the Crew Module (between subsystems, and between components).
g) If the Contractor utilizes analysis, modeling and test bed simulation to conduct analysis in support of verification, the Contractor shall comply with **DRD CEV-T-001**, *Models, Simulations and Integrated Support Plan*.
h) The Contractor shall provide the integration, test, & verification facilities or utilize Government provided facilities with capabilities necessary to test and certify the Crew Module and all CM subsystems and components. The Contractor shall invite NASA to all subsystem facility design reviews, test, verification, and certification activities.
i) The Contractor shall provide the Integration, Test, & Verification (IT&V) facilities required to complete integrated verification of the Crew Module. The requirements for the certification for test in the IT&V facilities shall be derived from the products developed under Section 10.1, Test, Verification Management and Administration.
j) Reserved
k) The Contractor shall provide support in order to conduct verification testing of all interface designs and requirements within the CM Module for those verification activities that are NASA led in NASA facilities.

Deliverables

The Contractor shall deliver the following DRDs for the Qualification documenting all lower level element Qualification data. These DRDs will be also documented into the DRD specified in Sections 10.2 and 10.3 for the integrated CEV.

- **DRD CEV-T-017 Certification Data Package**
- **DRD CEV-T-037: Qualification Test Procedures**
- **DRD CEV-T-038: Qualification Test Report**

The Contractor shall deliver the following DRDs for the Production Vehicle CM, documenting all lower level element acceptance data. These DRDs will be also documented into the DRD specified in Sections 10.2 and 10.3 for the integrated CEV.

- **DRD CEV-T-039: Acceptance Test Procedures**
- **DRD CEV-T-040: Acceptance Data Package**

6.1.6 CM Assembly, Integration, and Production (AI&P)

a) The Contractor shall integrate, assemble, certify, acceptance test, and deliver flight Crew Modules meeting the requirements for the configurations below.
b) The Contractor shall develop and implement an imagery plan to provide imagery (e. g., still photo, motion picture, digital imagery, or video) of the Crew Module, subsystems, and components during manufacturing, assembly, test, integration, and close-out to document the hardware configuration. The Contractor shall include the plan and imagery in **DRD CEV-T-088**, *CEV Imagery Plan/Imagery Deliverables*.
c) The Contractor shall develop and implement plans detailing the design and construction of all Crew Module transportation support equipment, and the plans for transportation of the Crew Module to the processing and/or launch sites. These plans shall be included in **DRD CEV-T-011**, *Integrated Logistics Support Plan*.

Deliverables

The following module specific information is collected in the DRDs specified in Section 2.7.2:

- **DRD CEV-T-011: Integrated Logistics Support Plan**

The following module specific information is collected in the DRDs specified in Section 2.10:

- **DRD CEV-T-088: CEV Imagery Plan/Imagery Deliverables**

6.1.6.1 CM Flight Hardware AI&P

a) Reserved
b) Reserved
c) The Contractor shall deliver a production CM for EM-1 and EM-2.
d) The Contractor shall be responsible for post-flight refurbishment of any reusable items delivered under Schedule A. (IDIQ)
e) The Contractor shall design, develop, produce, integrate, verify, validate, certify, document, and deliver Crew Module GSE in accordance with all requirements allocated from CXP-72000, Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD), and in this SOW, and in accordance with **DRD CEV-O-008**, Ground Systems Requirements, Plans, Reports, and Design Data, Volume II, Ground Systems End Item Implementation Plan and Report. The Contractor shall plan for and deliver the GSE end items in accordance with Attachment J-9. The Contractor shall use the following applicable documents for design and development of Contractor-provided GSE:
   – CxP 72506 CEV Orion Standard for Design and Fabrication of: Ground Support Equipment
f) The Contractor shall develop and update **DRD CEV-O-008**, *Ground Systems Requirements, Plans, Reports, and Design Data, Volume III, Systems Operations and Maintenance Plan and Requirements Documentation*, for the ground support equipment provided for the Crew Module excluding government-provided GSE.
g) The Contractor shall develop, maintain and deliver all technical models and drawings of the GSE associated with the Crew Module, excluding government-provided GSE in accordance with **DRD CEV-T-003**, *CEV CAD Models*, and **DRD CEV-T-004**, *CEV Drawings*.
h) The Contractor shall develop and update 2-D and 3-D simulation models of the Contractor-provided Crew Module and Contractor-provided Crew Module GSE to assess clearances, placement, conflicts and the moving of hardware in accordance with **DRD CEV-T-003**, *CEV CAD Models*. The Contractor shall develop and deliver these models in accordance with SOW Section 2.4.
i) The Contractor shall develop and deliver **DRD CEV-T-040**, *Acceptance Data Package*, for each Contractor-provided Crew Module GSE end item.
j) The Contractor shall provide initial spares, concurrent with the delivery of the GSE end items and in accordance with the provisioning procedures in DRD CEV-T-011, Integrated Logistics Support Plan, and **DRD CEV-T-012**, *Logistics Support Analysis*, for all Contractor-provided Crew Module GSE. (IDIQ)
k) Reserved
l) Reserved
m) Reserved
n) For EFT-1, and EM-1, the Contractor shall provide and install a Developmental Flight Instrumentation (DFI) system and installation engineering.

Deliverables

The following CM GSE data is incorporated in the DRD specified in Section 2.4:

- **DRD CEV-T-003: CEV CAD Models**
- **DRD CEV-T-004: CEV Drawings**

The following CM GSE data is incorporated in the DRD specified in Section 2.7.2:

- **DRD CEV-O-008: Ground Systems Requirements, Plans, Reports, and Design Data**
- **DRD CEV-T-040: Acceptance Data Package**
- **DRD CEV-T-011: Integrated Logistics Support Plan**

6.1.6.2 Test Article Design and Production

a) The CM primary structure for PA1 will be provided by NASA
b) For PA1, the Contractor shall design, develop, procure, build, assemble, integrate, and verify the CM avionics and mechanisms kits per the requirements and specifications developed in Section 10.6.4, Flight Test Article (FTA) DDT&E.
c) RESERVED
d) For AA2, the Contractor shall certify the crew module test article (new fabrication or reuse) to meet the system, module, sub-system, and component level requirements and specifications developed in section 10.6.4, Flight Test Article (FTA) DDT&E as defined by the mission requirements and flight objectives in CxP-72465.
e) Reserved
f) For AA2, the Contractor shall certify AA-2 in accordance with **DRD CEV-T-007**, *Certification Data Package*. The contractor shall perform acceptance testing at the Crew Module level and document the results using **DRD CEV-T-040**, *Acceptance Data Package* as tailored for content for the Flight Test Program.
g) For AA2, the Contractor shall deliver one (1) CM per contract attachment J-9.
h) RESERVED
i) The Contractor shall provide CM GSE in accordance with the criteria established in section 2.7.2 necessary to test the CM, as well as test the integrated AA-2 vehicle, deliver it to the launch facility, conduct pad, launch, mission, retrieval, and post-flight data retrieval and de-servicing.
j) The Contractor may maximize the reuse of EFT-1 assets to support AA-2 Flight Test.

Deliverables
The following Module specific information is collected in the DRDs specified in Section 10.6:

- **DRD CEV-T-031: CEV <Level> Requirements Specification, for the Flight Test Articles**
- **DRD CEV-T-040: Acceptance Data Package – Flight Test Program**

6.2 SERVICE MODULE

Service Module includes the tasks required for the design, development, production, assembly, test, and certification of the Service Module, and efforts to deliver the completed Service Module for Spacecraft integration.
The Service Module includes the following:

- European Service Module (ESM)
- Crew Module Adapter (CMA)
- Spacecraft Adapter (SA)
- Spacecraft Adapter Jettisonable (SAJ)

The Contractor is responsible for DDT&E of the CMA, SA and SAJ, as well as integration of the ESM, to produce the SM. The Contractor is also responsible for hardware items to be part of the ESM as defined in the J-9 Table 2. NASA will provide the integrated ESM as defined in the J11.2. Unless otherwise excluded, the following requirements apply to the integrated Service Module as defined above. The Contractor shall integrate ESM-provided data, where applicable, into the deliverables defined in this section.

6.2.1 SM Management and Administration

SM Management and Administration includes the efforts for planning, organizing, directing, coordinating, controlling, and approval processes used to accomplish Service Module development objectives, including the ESM integration effort.

a) NASA will maintain oversight of all of the Service Module design activities. The Contractor shall maintain responsibility for delivery of a design that meets the requirements. The detailed process discussion to accomplish this can be found in MPCV-72008, MPCV Orion Project Plan. The Contractor shall invite NASA personnel on all design teams established by the Contractor.
b) In addition, the Contractor will work with ESM personnel on DDT&E activities to accomplish integration of the ESM into the SM.

6.2.2 SM System Engineering and Integration

SM Systems Engineering and Integration consist of the efforts to lead the Service Module's overall system architecture definition and engineering functions. This includes the technical and management efforts of directing and controlling the integrated engineering effort for the SM. This also includes the effort to coordinate SM integration with the CEV integration functions described in Section 2.

a) Reserved
b) The Contractor shall define and develop the subsystems, components, and software units that make up the Service Module, excluding the ESM, per the requirements and deliverables included in this section.
c) The Contractor shall develop, maintain, and deliver all drawings and technical Computer Aided Design (CAD) models of the Service Module system, subsystems and components, and integrate the government provided ESM models and simulations. The Contractor shall use **DRD CEV-T-003**, *CEV CAD Models*, and **DRD CEV-T-004**, *CEV Drawings*, as the template for development and delivery of these items.
d) The Contractor shall develop and maintain analysis, models and test bed simulations for the Service Module system, subsystems, and components, and integrate the government provided ESM models and simulations, using **DRD CEV-T-001**, *Models, Simulations and Integrated Support Plan*.
e) The Contractor shall document and maintain ICD(s) where required for the government furnished hardware provided on contract attachment J-11, including the ESM, in accordance with **DRD CEV-T-029** *Interface Control Documents* and **DRD CEV-O-006**, *CEV Stowage Capabilities and Services Handbook*
f) The Contractor shall document Service Module subsystem- level requirements and interface requirements using **DRD CEV-T-031**, *CEV <Subsystem> Requirements Specifications*.
g) The Contractor shall document component-level requirements within the Service Module using **DRD CEV-T-031**, *CEV <Component> Requirements Specifications*.
h) Reserved
i) The Contractor shall develop and maintain the Service Module portion of the CEV Specification and Drawing Trees, **DRD-CEV-T-032**. The top drawing shall be incorporated into the CEV System Drawing Tree identified in Section 2.2
j) The contractor shall document Service Module internal subsystem interface design details, including the CMA to ESM interfaces, using **DRD CEV-T-029**, *Interface Control Documents*.
k) The Contractor shall integrate the Government-provided ESM and components into the SM, including the engineering, test, verification, certification, assembly, and production.
l) NASA will provide the ESM system, subsystem and component specifications and documents as defined in the Attachment J11.2.
m) The contractor shall incorporate ESM government furnished data documented the Attachment J11.4 into the DRDs where applicable.

n) The contractor shall identify and provide inputs to NASA on ESA deliverables required to support integration of the ESM, for inclusion by NASA into the ESM bilateral documents below
   - MPCV 72526 (Bilateral Data Exchange Agreements List and Schedules)
   - MPCV 72527 (Bilateral Hardware and Software Exchange List and Schedules)
   - MPCV 72513 (Bilateral Integrated Verification Plan)

Deliverables
The Contractor shall deliver and maintain the following document(s):
- **DRD-CEV-T-029: Service Module Internal Interface Control Documents**
- **DRD CEV-T-031: Service Module <Subsystem> Requirements Specifications (excluding ESM subsystems)**
- **DRD-CEV-T-031: Service Module <Component> Requirements Specifications (excluding ESM components)**
- **DRD CEV-T-032: CEV Specification and Drawing Tree for the Service Module**

The following Module specific data is collected in the DRDs specified in Section 2.4 3
- **DRD CEV-T-001: Models, Simulations and Integrated Support Plan**

The following deliverables are separate Module deliverables and are integrated by reference into the System level submittal in 2.3.
- **DRD CEV-T-003: SM CAD Models**
- **DRD CEV-T-004: SM Drawings**

6.2.3 SM Subsystems

This section includes the work required to design, develop, produce, and test through certification and acceptance all Service Module subsystems required to meet CEV spacecraft and interface requirements. This section also includes the work required to deliver hardware to be used on the ESM, identified J-9 Table 2.

a) The Contractor shall design, develop, test, certify, and deliver Service Module subsystem hardware, excluding the ESM subsystems, complying with all requirements allocated from MPCV-72000, MPCV Systems Requirements Document (MPCV SRD).
b) The Contractor shall design, develop, test, certify and deliver hardware to be provided and used in the ESM as identified in the J-9 Table 2.
c) Reserved
d) The Contractor shall provide system and module level design definition data in the **DRD CEV-T-033**, *Architectural Design Document* and design definition and data down to the component level in the Subsystem Design and Data Books.
e) The Contractor shall hold subsystem or component design reviews prior to the system PDR and CDR and participate in ESM reviews to facilitate vehicle integration.
f) The Contractor shall test and deliver flight spares for the Service Module subsystems (IDIQ). The Contractor shall provide a spare parts list as part of the **DRD CEV-T-012**, *Logistics Support Analysis* (Recommended Spare Parts List). (IDIQ)
g) The Contractor shall deliver 2 Flight Spacecraft Service Modules for EM-1 and EM-2.
h) The Contractor shall deliver one ship set of Service Module flight spares (i.e., 1 copy of every line replaceable unit) (IDIQ)
i) The Contractor shall use the following standards and requirements documents for developing all SM subsystems:
   – JPR 8080.5, JSC Design and Procedural Standards
   – MPCV-70024, MPCV Human Systems Integration Requirements (HSIR)
j) The Contractor shall use the following standards for developing all SM subsystems:

- AIAA-S-080, AIAA Standard for Space Systems – Metallic Pressure Vessels Pressurized Structures, and Pressure Components
- ANSI/AIAA-S-081A-2006, AIAA Standard for Space Systems – Composite Overwrapped Pressure Vessels

Deliverables

The following module specific information is collected in the DRDs specified in Section 2.7.2

- **DRD CEV-T-012: Logistics Support Analysis**

The following module specific information is collected in the DRDs specified in Section 2.2

- **DRD CEV-T-033: Architecture Design Document**

6.2.3.1 Reserved

6.2.3.2 SM Command and Data Handling (C&DH)

a) For the Service Module the Contractor shall prepare, deliver and maintain **DRD CEV-T-047**, *Avionics Design and Data Book Volume II - C&DH/Instrumentation Subsystem Data*.

Deliverables

The Contractor shall deliver and maintain the following document(s) as applicable:

- **DRD CEV-T-047: Avionics Design and Data Book, Volume II – C&DH/Instrumentation Subsystem Data**

6.2.3.3 SM Communications and Tracking (C&T)

a) For the Service Module, the Contractor shall prepare, deliver, and maintain **DRD CEV-T-047**, *Avionics Design and Data Book Volume III - Communications and Tracking Subsystem Data*.

Deliverables

The following module specific information is collected in the DRDs specified in Section 2.6.3

- **DRD CEV-T-047: Avionics Design and Data Book, Volume III – Communications and Tracking Subsystem Data Book**

6.2.3.4 Reserved

6.2.3.5 SM Electrical Power System

a) For the Service Module, the Contractor shall prepare, deliver and maintain **DRD CEV-T-059**, *Electrical Power System (EPS) Design and Data Book*
b) The Contractor shall participate with ESD in the development of **DRD CEV-T-060**, *Electrical Power Quality Specification Requirements Document*.

Deliverables

The following module specific information is collected in the DRDs specified in Section 2.6.5

- **DRD CEV-T-059: SM Electrical Power System (EPS) Design and Data Book**
- **DRD CEV-T-060: SM Electrical Power Quality Specification Requirements Document**

6.2.3.6 SM Mechanisms

a) For the Service Module, the Contractor shall prepare, deliver and maintain **DRD CEV-T-061**, *Mechanical Systems Design and Data Book*, and **DRD CEV-T-062**: *Stress Analysis Report*

Deliverables

The following module specific information is collected in the DRDs specified in Section 2.6.6

- **DRD CEV-T-061: SM Mechanical Systems Design and Data Book**
- **DRD CEV-T-062: SM Stress Analysis Report**

6.2.3.7 SM Passive Thermal Control

a) The Contractor shall develop thermal analysis models of the SAJ, SA, CMA and integrate the provided ESM thermal model into the Service Module, supporting the Service Module thermal analysis.

b) For the SAJ, SA, and CMA, the Contractor shall prepare, deliver and maintain **DRD CEV-T-063**, *PTC Systems Design and Data Book*, and **DRD CEV-T-064**, *Passive Thermal Control Mathematical Models and Documentation*. The ESM will be incorporated into the appendix.

Deliverables

The following module specific information is collected in the DRDs specified in Section 2.6.7

- **DRD CEV-T-063: SM Passive Thermal Control Design and Data Book (PTCDDB)**
- **DRD CEV-T-064: SM Passive Thermal Control Mathematical Models and Documentation**

6.2.3.8 Reserved

6.2.3.9 SM Structures

a) The Contractor shall perform structural analysis on all contractor-provided Service Module structures, including pressure vessels, and integrate the ESM structural analysis, to show that all elements of the design such as the strength, stiffness, structural stability, and life meet all specified criteria for the anticipated loads and environments.

b) The Contractor shall perform Service Module loads and dynamics analyses and document the results and structural environments in **DRD CEV-T-090**, *Environments Design Document*.

c) The Contractor shall perform Service Module stress and fatigue analyses and document the results in **DRD CEV-T-062**, *Stress Analysis Report*.

d) The Contractor shall develop Service Module models to support ESD vehicle analyses as well as CEV loads and stress analyses. The Contractor shall deliver **DRD CEV-T-068**, *Structures Mathematical Models and Documentation*, which will deliver and describe the mathematical models used in the Service Module system, subsystem, and component loads and stress analyses.

e) The Contractor shall implement a fracture control program and identify fracture critical parts to protect against catastrophic structural hazards associated with flaw presence, fatigue crack propagation and fracture. The Contractor shall deliver and implement **DRD CEV-T-069**, *Fracture Control Plan*, and **DRD CEV-T-070**, *Fracture Control Summary Report*.

f) The Contractor shall use NASA-HDBK-7005, Dynamic Environmental Criteria, as an informational document to support the **DRD CEV-T-015**, *Master Verification Plan* DRD product development activity.

g) The Contractor shall use the following standards for designing and analyzing the Service Module structures subsystem:

- CxP-72385, CEV Government Furnished Data for Orion System Design and Analysis
- JSC-62550, Structural Design and Verification Criteria for Glass, Ceramics and Windows in Human Space Flight Applications
- NASA-STD-5002, Loads Analyses of Spacecraft and Payloads
- NASA STD-(I)-5019, Fracture Control Requirements for Space Flight Hardware

h) RESERVED
i) Reserved

Deliverables
The following module specific information is collected in the DRDs specified in Section 2.6.9

- **DRD CEV-T-062: SM Stress Analysis Report**
- **DRD CEV-T-068: SM Structures Mathematical Models and Documentation**
- **DRD CEV-T-070: SM Fracture Control Summary Report**
- **DRD CEV-T-015: Structures Subsystem Volume Master Verification Plan**
- **DRD CEV-T-090 Environments Definition Document**

6.2.3.10 SM Propulsion

a) The Contractor shall provide OMS-E DDT&E, test and certification support. (IDIQ)
b) Reserved
c) The Contractor shall perform design, development, test, certification and delivery of propulsion hardware in the CMA necessary to interface to the ESM, and develop propulsion related DRD products.
d) Reserved
e) Reserved
f) The Contractor shall document the design for Service Module propulsion as specified in **DRD CEV-T-071**, *Propulsion Systems Design and Data Book*.

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-071: SM Propulsion Systems Design and Data Book**

6.2.3.11 Suits, EVA, and Survival Crew Equipment Support Systems

a) Reserved

6.2.3.12 Service Module and Spacecraft Adapter Environmental Control and Life Support (ECLS), Crew Health and Habitation Accommodations

a) The Contractor shall use the following ECLS, standards and the Human Engineering Standards listed in section 2.8.7, Human Engineering, for designing this subsystem:
   - JSC 20584, Spacecraft Maximum Allowable Concentrations for Airborne Contaminants

b) The Contractor shall provide definition of the process to be used for cleanliness of components for use in oxygen, fuel, and pneumatic systems. The Contractor shall provide this information in **DRD CEV-T-073**, *Environmental Control and Life Support and Suit Design and Data Book*.
c) The Contractor shall identify the standard for test methods for environmental engineering in **DRD CEV-T-073**, *Environmental Control and Life Support and Suit Design and Data Book*. This standard shall meet or exceed the following standard:
   - ***Reserved***

Deliverables

- **The following module specific information is collected in the DRDs specified in Section 2.6.12:**
- **DRD CEV-T-073: Environmental Control and Life Support and Suit Design and Data Book**

6.2.3.13 SM Pyrotechnics

a) The Contractor shall perform device level preliminary design reviews and critical design reviews for each Service Module pyrotechnic device not provided by the Government.

b) The Contractor shall conduct development, qualification, and acceptance testing on all other pyrotechnic devices selected for the Service Module, excluding the devices selected for the ESM. The Contractor shall conduct Phase I, Phase II, and Phase III technical reviews on all other pyrotechnic devices selected for the Service Module, excluding the devices selected for the ESM, per the requirements of CxP 70199, Constellation Program, Pyrotechnic Specification and JPR 8080.5 Standards P-1, E-1, G-2, G-12, P-6.

c) Service Module specific stress analysis reports will be collected in the DRD (**DRD CEV-T-062**, *Stress Analysis Report*) specified in Section 2.6.13 for all pyrotechnic devices selected for the Service Module.

d) The Contractor shall document the design for the Service Module pyrotechnic subsystem as specified in **DRD CEV-T-075**, *Pyrotechnic Subsystem Design and Data Book*

Deliverables

The following module specific information is collected in the DRDs specified in Section 2.6.13

- **DRD CEV-T-062: SM Stress Analysis Report**
- **DRD CEV-T-075: SM Pyrotechnic Subsystem Design and Data Book**

6.2.3.14 Reserved

6.2.3.15 SM Guidance, Navigation, and Control (GN&C)

a) The Service Module GN&C requirements design and functional verification effort will be performed through the use of specialized MODE teams. NASA will co-lead with the Contractor the development of detailed design requirements for the Service Module GN&C flight system. The Contractor shall document the Service Module and Spacecraft Adapter GN&C requirements in **DRD CEV-T-031**, *CEV GN&C Subsystem Requirements Specification*, and **DRD CEV-T-048**, *Software Requirements Specification*. The Contractor shall co-lead the following teams:
   - CEV Ascent/Abort MODE Team
   - Entry GN&C MODE Team
   - On-Orbit GN&C MODE Team
   - Flight Mechanics/Mission Design MODE Team

b) The Contractor shall document the design for the Service Module GN&C subsystem as specified in **DRD CEV-T-078**, *GN&C Systems Design and Data Book*.

Deliverables

The following module specific information is collected in the DRDs specified in Section 6.1.2:

- **DRD CEV-T-031: SM GN&C <Subsystem > Requirements Specification**
- **DRD CEV-T-031 SM GN&C <Components> Requirements Specification**

The following module specific information is collected in the DRDs specified in Section 6.5.2:

- **DRD CEV-T-048: Software Requirements Specification**

The following module specific information is collected in the DRDs specified in Section 2.6.15:

- **DRD CEV-T-078: SM GN&C Design and Data Book**

6.2.3.16 SM Wiring

a) The Contractor shall develop wiring documentation that provides definition down to the level of pin-to-pin connectivity for all electrical harnesses and optical cables used on the Service Module, up to the interfaces to the ESM, to support ground, launch, flight, including testing, verification, calibration, and maintenance through vehicle delivery. The Contractor shall provide access to the wiring documentation to NASA as **DRD CEV-T-080**, *CEV Vehicle Wiring Configuration Identification, and Definition Reports*. The Contractor shall provide a hierarchical path/signal structure which links the wiring documentation to **DRD CEV-T-046**, *CEV Data and Command Dictionary*.

b) The Contractor shall develop, manufacture/fabricate, test, install, and certify all Service Module wiring, excluding ESM, in accordance with **DRD CEV-T-080**, *CEV Vehicle Wiring Configuration, Identification and Definition Reports*. Note: The Contractor will provide selected harnesses that go inside the ESM (e.g. Gyro) and harnesses that go through the ESM to interface with the launch vehicle per the Attachment J-9.

Deliverables

The following module specific information is collected in the DRDs specified in Section 2.6.1

- **DRD CEV-T-046: CEV Data and Command Dictionary**

The following module specific information is collected in the DRDs specified in Section 2.6.16

- **DRD CEV-T-080: CEV Vehicle Wiring Configuration, Identification and Definition Reports**

6.2.4 Reserved

6.2.5 SM Test, Verification, and Certification

a) The Contractor shall execute the Master Verification Plan process for the verification, qualification, certification, and acceptance of the Service Module, subsystems, and components, including the ESM.

b) The Contractor shall support integrated and joint verification for the ESM as defined in MPCV 72513 Bilateral Integrated Verification Plan (BIVP)

c) The Contractor shall perform qualification tests using **DRD CEV-T-037**, *Qualification Test Procedures*, and document the test results in **DRD CEV-T-038**, *Qualification Test Report* and **DRD CEV-T-017**, *Certification Data Package* for the Service Module. The Contractor shall perform qualification testing at component, SM and intermediate levels of assembly as necessary to accumulate the data necessary for Service Module certification. The Contractor shall produce a Certification Data Package for the component, each subsystem in the Service Module, the Service Module, and the Spacecraft as required to meet certification for individual mission or certification to meet requirements of CxP-72000 SRD.

d) The Contractor shall perform acceptance testing of the components, subsystems and integrated Service Module using **DRD CEV-T-039**, *Acceptance Test Procedures*, and document the results using **DRD CEV-T-040**, *Acceptance Data Package*.

e) The Contractor shall hold Test Readiness Reviews (TRRs) before Service Module verification activities. The Contractor shall make subsystem or component test procedures available to NASA, excluding ESM subsystems and components. The Contractor shall invite NASA to all formal verification activities, including TRRs and test executions.

f) The Contractor shall conduct verification activities of interface requirements within the Service Module (between subsystems, between components, and up to the ESM interface).

g) If the Contractor utilizes analysis, modeling and test bed simulation to conduct analysis in support of verification, the Contractor shall comply with **DRD CEV-T-001**, *Models, Simulations and Integrated Support Plan*.
h) The Contractor shall provide the Test, & Verification facilities or utilize Government provided facilities with capabilities necessary to test and certify the Service Module subsystems and components, excluding ESM subsystems and components. The Contractor shall invite NASA to all subsystem facility design reviews and certification activities.
i) The Contractor shall provide the Integration, Test, & Verification (IT&V) facilities or utilize Government provided facilities required to complete integrated verification of the Service Module. The requirements for the certification for test in the IT&V facilities shall be derived from the products developed under Section 10.1, Test, Verification Management and Administration.
j) Reserved

Deliverables
The Contractor shall deliver the following DRDs documenting all lower level element Qualification data. These DRDs will be also documented into the DRD specified in Sections 10.2 and 10.3 for the integrated CEV.

- **DRD CEV-T-017: Certification Data Package**
- **DRD CEV-T-037: Qualification Test Procedures**
- **DRD CEV-T-038: Qualification Test Report**

The Contractor shall deliver the following DRDs for the Production Vehicle SM documenting all lower level element acceptance data. These DRDs will be also documented into the DRD specified in Sections 10.2 and 10.3 for the integrated CEV.

- **DRD CEV-T-039: Acceptance Test Procedures**
- **DRD CEV-T-040: Acceptance Data Package**

6.2.6 SM Assembly, Integration, and Production

a) The Contractor shall integrate, assemble, certify, acceptance test, and deliver the flight Service Modules.
b) The Contractor shall develop and implement an imagery plan to provide imagery (e. g., still photo, motion picture, digital imagery, or video) of the integrated Service Module, subsystems, and components, excluding ESM subsystems and components during manufacturing, assembly, test, integration, and close-out to document the hardware configuration. The Contractor shall include the plan and imagery in **DRD CEV-T-088**, *CEV Imagery Plan/Imagery Deliverables*.
c) The Contractor shall develop and implement plans detailing the design and construction of all Service Module transportation support equipment, and the plans for transportation of the Service Module and Spacecraft Adapter to the processing and/or launch sites. These plans shall be included in **DRD CEV-T-011**, *Integrated Logistics Support Plan*.

Deliverables
The following module specific information is collected in the DRDs specified in Section 2.7.2:

- **DRD CEV-T-011: Integrated Logistics Support Plan**

The following module specific information is collected in the DRDs specified in Section 2.10

- **DRD CEV-T-086: Manufacturing and Assembly Plan**
- **DRD CEV-T-088: CEV Imagery Plan/Imagery Deliverables**

6.2.6.1 SM Flight Hardware AIP

a) The Contractor shall integrate, assemble, certify, acceptance test, and deliver flight Service Modules.

b) Reserved
c) The Contractor shall deliver 1 production SM certified for EM-1 and 1 production SM certified and qualified for EM-2.
d) The Contractor shall design, develop, produce, integrate, verify, validate, certify, document, and deliver Service Module GSE, excluding Government-provided GSE, in accordance with all requirements allocated from CXP-72000, Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD), and in this SOW, and in accordance with **DRD CEV-O-008**, *Ground Systems Requirements, Plans, Reports, and Design Data, Volume II, Ground Systems End Item Implementation Plan and Report*. The Contractor shall plan for and deliver the GSE end items in accordance with Attachment J-9. The Contractor shall use the following applicable documents for design and development of Contractor-provided GSE:
   – MPCV 72506 CEV Orion Standard for Design and Fabrication of: Ground Support Equipment
e) The Contractor shall develop and update **DRD CEV-O-008**, *Ground Systems Requirements, Plans, Reports, and Design Data, Volume III, Systems Operations and Maintenance Plan and Requirements Documentation*, for the ground support equipment provided for the Service Module, excluding Government-provided GSE.
f) The Contractor shall develop, maintain and deliver all technical models and drawings of the GSE associated with the Service Module, excluding Government-provided GSE, in accordance with **DRD CEV-T-003**, *CEV CAD Models*, and **DRD CEV-T-004**, *CEV Drawings*.
g) The Contractor shall develop and update 2-D and 3-D simulation models of the Contractor-provided Service Module and Contractor-provided Service Module GSE to assess clearances, placement, conflicts and the moving of hardware in accordance with **DRD CEV-T-003**, *CEV CAD Models*. The Contractor shall develop and deliver these models in accordance with SOW Section 2.4.
h) The Contractor shall develop and deliver **DRD CEV-T-040**, *Acceptance Data Package*, for each Contractor-provided Service Module GSE end item.
i) The Contractor shall provide initial spares, concurrent with the delivery of the GSE end items and in accordance with the provisioning procedures in **DRD CEV-T-011**, *Integrated Logistics Support Plan*, and **DRD CEV-T-012**, *Logistics Support Analysis*, for all Contractor-provided Service Module GSE. (IDIQ)
j) The Contractor shall deliver the Contractor-provided Service Module GSE to the NASA-designated facilities per the contract attachment J-9.
k) For EFT-1 and EM-1 the Contractor shall provide and install a Developmental Flight Instrumentation (DFI) system and installation engineering.

Deliverables
The following SM GSE data is incorporated in the DRD specified in Section 2.4:
- **DRD CEV-T-003: CEV CAD Models**
- **DRD CEV-T-004: CEV Drawings**

The following SM GSE data is incorporated in the DRD specified in Section 2.7.2:
- **DRD CEV-O-008: Ground Systems Requirements, Plans, Reports, and Design Data**
- **DRD CEV-T-040: Acceptance Data Package**
- **DRD CEV-T-011: Integrated Logistics Support Plan**

6.2.6.2 SM Test Article Design and Production
For PA1, and AA2, the government will provide the Separation Ring (SR) that performs the CM/SM Retention and Release (R&R) function and is the interface to the Abort Test Booster. The following requirements only apply to contractor provided SR components, SMs and SAs.

a) For and AA2, the Contractor shall design, develop, and procure, build, verify, and deliver one (1) set of CM/SM R&R Mechanisms Kits in accordance with the requirements and specifications developed in section 10.6.4, Flight Test Article (FTA) DDT&E, documented in **DRD CEV-T-061**, *Mechanical System Design and Data Book*.
b) For AA2 the Contractor shall design, develop, and procure, build, verify and deliver one (1) CM/SM Umbilical Mechanism Kits in accordance with the requirements and specifications developed in section 10.6.4, Flight Test Article (FTE) DDT&E, and documented in **DRD CEV-T-061**, *Mechanical System Design and Data Book*.
c) For AA2, the Contractor shall validate, verify and perform acceptance testing of the mechanisms kits in accordance with section 10.6.4, FTA DDT&E and document the results using **DRD CEV-T-040**, *Acceptance Data Package* as tailored for content for the Flight Test Program.
d) For AA2 the Contractor shall deliver one (1) each of the flight and ground sides of the T-0 Ground Interface Plate and the Pyro Test Panel Mechanism Kits in accordance with the requirements and specifications documented in **DRD CEV-T-061**, *Mechanical System Design and Data Book*
e) For AA2, the Contractor shall design, develop, procure, and build a harness kits between the T-0 interface, and Contractor-provided mechanisms kit with the requirements and specifications developed in section 10.6.4 FTA DDT&E; documented in **DRD CEV-T-004**, *CEV Drawings*.
f) RESERVED
g) The Contractor shall design, develop, produce, integrate, verify, validate, certify, document, and deliver SM FTA Unique GSE in accordance with all requirements allocated from CxP 72000, Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD), and in this SOW, and in accordance with **DRD CEV-O-008**, *Ground Systems Requirements, Plans, Reports, and Design Data, Volume II, Ground Systems End Item Implementation Plan and Report*. The Contractor shall use the following applicable documents for design and development of Contractor-provided GSE:
   – CxP 72506 CEV Orion Standard for Design and Fabrication of: Ground Support Equipment
h) The Contractor shall provide SM GSE in accordance with the criteria established in Section 2.7.2 necessary to produce the SM and deliver it to the launch facility.

Deliverables
The Contractor shall deliver and maintain the following document(s):
- **DRD CEV-T-061: Mechanical Systems Design and Data Book**
- **DRD CEV-T-004: CEV Drawings**

The following Module specific information is documented in the DRDs specified in Section 10.6.4:
- **DRD CEV-T-031: CEV <Level> Requirements Specification, for the Flight Test Article.**
- **DRD CEV-T-040: Acceptance Data Package**

6.3 RESERVED

6.4 LAUNCH ABORT SYSTEM

Launch Abort System includes the tasks required for the design, development, production, assembly, test, and certification of the Launch Abort System (LAS) and efforts to deliver the completed LAS for Spacecraft integration. Development of unique launch abort system components and integration of all other subsystem components that make up the abort system is the responsibility of the Contractor.

6.4.1 LAS Management and Administration

LAS Management and Administration includes the efforts for planning, organizing, directing, coordinating, controlling, and approval processes used to accomplish Launch Abort System Development objectives.

a) NASA will maintain oversight of all Launch Abort System design activities. The Contractor shall maintain responsibility for delivery of a design that meets the requirements. The detailed process discussion to accomplish this can be found in MPCV-72008, MPCV Orion Project Plan. The Contractor shall invite NASA personnel on all design teams established by the Contractor.

6.4.2 LAS System Engineering and Integration

LAS Systems Engineering and Integration consists of the efforts to lead the Launch Abort System overall system architecture definition and engineering functions. This includes the technical and management efforts of directing and controlling the integrated engineering effort for the LAS. This also includes the effort to coordinate LAS integration with the CEV integration functions described in Section 2.

a) The Contractor shall define the subsystems, components, and software units that make up the Launch Abort System per the requirements and deliverables included in this section.
b) The Contractor shall develop, maintain, and deliver all drawings and technical Computer Aided Design (CAD) models of the Launch Abort System, subsystems and components. The Contractor shall use **DRD CEV-T-003**, *CEV CAD Models*, and **DRD CEV-T-004**, *CEV Drawings*, as the template for development and delivery of these items.
c) The Contractor shall develop and maintain analysis, models and test bed simulations for the Launch Abort System, subsystems, and components using **DRD CEV-T-001**, *Models, Simulations and Integrated Support Plan*.
d) The Contractor shall document and maintain interfaced requirements for the government furnished hardware provided on contract attachment J-11, in accordance with **DRD CEV-T-029** *Interface Control Documents*.
e) Reserved
f) The Contractor shall document Launch Abort System subsystem-level requirements using **DRD CEV-T-031**, *CEV <Subsystem> Requirements Specifications*.
g) The Contractor shall document component-level requirements within the Launch Abort System using **DRD CEV-T-031**, *CEV <Component> Requirements Specifications*.
h) The Contractor shall develop and use integrated models with sufficient fidelity to allow accurate trades to be performed for the design and development of the launch abort system to meet the requirements specified by the CEV Project.
i) Reserved
j) The contractor shall develop **DRD CEV-T-081** *Launch Abort System Design and Data Book* which contains detailed design descriptions for the LAS module, subsystems and major components, subsystem definitions, requirements analyses, operational analyses, as well as maintainability and testing data.
k) The Contractor shall develop and maintain the Launch Abort System portion of the *CEV Specification and Drawing Trees*, **DRD-CEV-T-032**. The top drawing shall be incorporated into the CEV System Drawing Tree identified in Section 2.2

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-031: Launch Abort System <Subsystem> Requirements Specification**
- **DRD-CEV-T-031: LAS <Component> Requirements Specifications**

- **DRD CEV-T-032: CEV Specification and Drawing Tree for the Service Module and Spacecraft Adapter**
- **DRD CEV-T-081: LAS Design and Data Book**

The following Module specific information is collected in the DRDs specified in Section 2.4 3

- **DRD CEV-T-001: Models, Simulations and Integrated Support Plan**
- **DRD-CEV-T-032: LAS Specification and Drawing Trees**

The following deliverables are separate Module deliverables and are integrated by reference into the System level submittal in 2.3.

- **DRD CEV-T-003:LAS CAD Models**
- **DRD CEV-T-004: LAS Drawings**

6.4.3 LAS Subsystems

This Section includes the work required to design, develop, produce, and test through certification and acceptance all Launch Abort System subsystems required to meet CEV module-level and interface requirements.

a) The Contractor shall design, develop, test, certify, and deliver Launch Abort System subsystem hardware complying with all requirements allocated from MPCV-72000, MPCV Systems Requirements Document (MPCV SRD).
b) Reserved
c) The Contractor shall provide system and LAS-level design definition data in the **DRD CEV-T-033**, *Architectural Design Document* and design definition and data down to the component level in the Subsystem Design and Data Books.
d) The Contractor shall hold subsystem or component design reviews prior to the LAS system PDR and CDR.
e) The Contractor shall test and deliver flight spares for the Launch Abort System subsystems (IDIQ). The Contractor shall provide a spare parts list as part of the **DRD CEV-T-012**, *Logistics Support Analysis* (Recommended Spare Parts List). (IDIQ)
f) The Contractor shall deliver one ship set of Launch Abort System flight spares (i.e., 1 copy of every line replaceable unit) (IDIQ)
g) The Contractor shall deliver one (1) Flight Test LAS for AA2, one (1) production LAS without abort functions for EM-1, and one (1) production LAS for EM-2.
h) The Contractor shall use the following standards and requirements documents for developing all LAS subsystems:
   - JPR 8080.5, JSC Design and Procedural Standards
i) Reserved

Deliverables

The following module specific information is collected in the DRDs specified in Section 2.7.2

- **DRD CEV-T-012: Logistics Support Analysis**

The following module specific information is collected in the DRDs specified in Section 2.2

- **DRD CEV-T-033: Architecture Design Document**

6.4.3.1 Reserved

6.4.3.2 LAS Command & Data Handling (C&DH)

a) The Contractor shall document the design for all Launch Abort System C&DH hardware as specified in **DRD CEV-T-047**, *Avionics Design and Data Book Volume II - C&DH/Instrumentation Subsystem Data*.

Deliverables

The following module specific information is collected in the DRDs specified in Section 2.6.1

- **DRD CEV-T-047: Avionics Design and Data Book, Volume II – C&DH/Instrumentation Subsystem Data**

6.4.3.3 LAS Communications and Tracking (C&T)

a) For the LAS, the Contractor shall prepare, deliver, and maintain **DRD CEV-T-047**, *Avionics Design and Data Book Volume III - Communications and Tracking Subsystem Data*.

Deliverables

The following module specific information is collected in the DRDs specified in Section 2.6.1

- **DRD CEV-T-047: Avionics Design and Data Book, Volume III – Communications and Tracking Subsystem Data Book**

6.4.3.4 Reserved

6.4.3.5 LAS Electrical Power System

a) For the LAS the Contractor shall prepare, deliver and maintain **DRD CEV-T-059**, *Electrical Power System (EPS) Design and Data Book*
b) The Contractor shall participate with the ESD in the development of **DRD CEV-T-060**, *Electrical Power Quality Specification Requirements Document*.

Deliverables

The following module specific information is collected in the DRDs specified in Section 2.6.5

- **DRD CEV-T-059: LAS Electrical Power System (EPS) Design and Data Book**
- **DRD CEV-T-060: LAS Electrical Power Quality Specification Requirements Document**

6.4.3.6 LAS Mechanisms

a) For the LAS, the Contractor shall prepare, deliver and maintain **DRD CEV-T-061**, *Mechanical Systems Design and Data Book*, and **DRD CEV-T-062**, *Stress Analysis Report*.

Deliverables

The following module specific information is collected in the DRDs specified in Section 2.6.6

- **DRD CEV-T-061: LAS Mechanical Systems Design and Data Book**
- **DRD CEV-T-062: LAS Stress Analysis Report**

6.4.3.7 LAS Passive Thermal Control

a) The Contractor shall develop thermal analytical models to support Launch Abort System thermal analyses.
b) For the LAS the Contractor shall prepare, deliver and maintain **DRD CEV-T-063**, *PTC Systems Design and Data Book*, and **DRD-CEV-T-064**, *Passive thermal Control Mathematical Models and Documentation*

Deliverables

The following module specific information is collected in the DRDs specified in Section 2.6.7

- **DRD CEV-T-063: LAS Passive Thermal Control Design and Data Book (PTCDDB)**
- **DRD CEV-T-064: LAS Passive Thermal Control Mathematical Models and Documentation**

6.4.3.8 Reserved

6.4.3.9 LAS Structures

a) The Contractor shall perform structural analysis on all Launch Abort System structures, including pressure vessels, to show that all elements of the design such as the strength, stiffness, structural stability, and life meet all specified criteria for the anticipated loads and environments.
b) The Contractor shall perform Launch Abort System loads and dynamics analyses and document the results in **DRD CEV-T-090**, *Environments Design Document*.
c) The Contractor shall perform Launch Abort System stress and fatigue analyses and document the results in **DRD CEV-T-062**, *Stress Analysis Report*.
d) The Contractor shall develop Launch Abort System models to support ESD vehicle analyses as well as CEV loads and stress analyses. The Contractor shall deliver **DRD CEV-T-068**, *Structures Mathematical Models and Documentation*, which will deliver and describe the mathematical models used in the Launch Abort System subsystem, and component loads and stress analyses.
e) The Contractor shall implement a fracture control program and identify fracture critical parts to protect against catastrophic structural hazards associated with flaw presence, fatigue crack propagation and fracture. The Contractor shall deliver and implement **DRD CEV-T-069**, *Fracture Control Plan*, and **DRD CEV-T-070**, *Fracture Control Summary Report*.
f) The Contractor shall use NASA-HDBK-7005, Dynamic Environmental Criteria, as a guidance document to support the **DRD CEV-T-015**, *Master Verification Plan* DRD product development activity.
g) The Contractor shall use the following standards for designing and analyzing the Launch Abort System structures subsystem:
   - CxP-72385, CEV Government Furnished Data for Orion System Design and Analysis
   - JSC-62550, Structural Design and Verification Criteria for Glass, Ceramics and Windows in Human Space Flight Applications
   - NASA-STD-5002, Loads Analyses of Spacecraft and Payloads
   - NASA STD-(I)-5019, Fracture Control Requirements for Space Flight Hardware

h) Reserved

Deliverables

The following module specific information is collected in the DRDs specified in Section 2.6.9

- **DRD CEV-T-062: LAS Stress Analysis Report**
- **DRD CEV-T-068: LAS Structures Mathematical Models and Documentation**
- **DRD CEV-T-070: LAS Fracture Control Summary Report**
- **DRD CEV-T-015 Structures Subsystem Volume Master Verification Plan**
- **DRD CEV-T-090 Environments Definition Document**

6.4.3.10 LAS Propulsion

a) The Contractor shall perform design, development, test, certification and delivery of all Launch Abort System propulsion systems.
b) The Contractor shall certify the propulsion systems for compliance with CEV component, subsystem, module, Spacecraft system, and vehicle-level requirements. The Contractor shall design and fabricate integrated Launch Abort System propulsion systems to evaluate and certify integrated propellant system storage and conditioning designs and capabilities in order to evaluate and certify propellant conditioning performances. (See Section 2.6.10)

c) The Contractor shall document the design for all LAS propulsion as specified in **DRD CEV-T-071**, *Propulsion Systems Design and Data Book*.

Deliverables

The following module specific information is collected in the DRDs specified in Section 2.6.10

- **DRD CEV-T-071: LAS Propulsion Systems Design and Data Book**

6.4.3.11 Reserved

6.4.3.12 Reserved

6.4.3.13 Pyrotechnics

a) The Contractor shall perform device level preliminary design reviews and critical design reviews for each Launch Abort System pyrotechnic device not provided by NASA. The Contractor shall conduct development, qualification, and acceptance testing on all other pyrotechnic devices selected for the Launch Abort System. The Contractor shall conduct Phase I, Phase II, and Phase III technical reviews on all other pyrotechnic devices selected for the Launch Abort System per the requirements of CxP 70199, Constellation Program, Pyrotechnic Specification and JPR 8080.5 Standards P-1, E-1, G-2, G-12, P-6
b) Launch Abort System specific stress analysis reports will be collected in the DRD (**DRD CEV-T-062**, *Stress Analysis Report*) specified in Section 2.6.13 for all pyrotechnic devices selected for the Launch Abort System.
c) The Contractor shall document the design for the Launch Abort System Module pyrotechnic subsystem as specified in **DRD CEV-T-075**, *Pyrotechnic Subsystem Design and Data Book*.

Deliverables
The following module specific information is collected in the DRDs specified in Section 2.6.13

- **DRD CEV-T-062: Stress Analysis Report**
- **DRD CEV-T-075: Pyrotechnic Subsystem Design and Data Book**

6.4.3.14 Reserved

6.4.3.15 LAS Guidance, Navigation, and Control (GN&C)

a) The Launch Abort System GN&C requirements design and functional verification effort will be performed through the use of specialized MODE teams. NASA will co-lead with the Contractor in the development of detailed design requirements for the Launch Abort System GN&C flight system. The Contractor shall document the Launch Abort System GN&C requirements in **DRD CEV-T-031**, *CEV GN&C Subsystem Requirements Specification*, and **DRD CEV-T-048**, *Software Requirements Specification*. The Contractor shall co-lead the following teams:
   – CEV Ascent/Abort MODE Team
   – Flight Mechanics/Mission Design MODE Team
b) The Contractor shall document the design for the LAS propulsion subsystem as specified in **DRD CEV-T-078**, *GN&C Systems Design and Data Book*.

Deliverables
The following module specific information is collected in the DRDs specified in Section 6.1.2

- **DRD CEV-T-031:LAS GN&C <Subsystem > Requirements Specification**

- **DRD CEV-T-031 LAS GN&C <Components> Requirements Specification**

The following module specific information is collected in the DRDs specified in Section 6.5.2

- **DRD CEV-T-048 Software Requirements Specification**

The following module specific information is collected in the DRDs specified in Section 2.6.15

- **DRD CEV-T-078: LAS GN&C Design and Data Book**

6.4.3.16 LAS Wiring

a) The Contractor shall develop wiring documentation that provides definition down to the level of pin-to-pin connectivity for all electrical harnesses and optical cables used on the Launch Abort System. The Contractor shall provide access to the wiring documentation to NASA as **DRD CEV-T-080**, *CEV Vehicle Wiring Configuration, Identification, and Definition Reports*. The Contractor shall provide a hierarchical path/signal structure which links the wiring documentation to **DRD CEV-T-046**, *CEV Data and Command Dictionary*.

b) The Contractor shall develop, manufacture/fabricate, test, install, and certify all Launch Abort System wiring in accordance with **DRD CEV-T-080**, *CEV Wiring Configuration, Identification, and Definition Reports*.

Deliverables

The following module specific information is collected in the DRDs specified in Section 2.6.1

- **DRD CEV-T-046: CEV Data and Command Dictionary**

The following module specific information is collected in the DRDs specified in Section 2.6.16

- **DRD CEV-T-080: LAS Wiring Configuration, Identification, and Definition Reports**

6.4.4 Reserved

6.4.5 LAS Test, Verification, and Certification

a) The Contractor shall execute the Master Verification Plan process for the verification, qualification, certification, and acceptance of the Launch Abort System, subsystems, and components.

b) The Contractor shall perform qualification tests using **DRD CEV-T-037**, *Qualification Test Procedures*, and document the test results in **DRD CEV-T-038**, *Qualification Test Report, for the LAS Abort Motor, Jettison Motor, and Attitude Control Motor*. The contractor shall develop a **DRD CEV-T-017**, *Certification Data Package* for the LAS system. The Contractor shall perform qualification testing at component, LAS structures, and LAS motors as necessary to accumulate the data necessary for Launch Abort System certification. The Contractor shall produce a Certification Data Package for each component and each subsystem in the Launch Abort System, the Launch Abort System, and the Spacecraft required to meet certification for individual mission or certification requirements of CxP-72000 SRD.

c) The Contractor shall perform acceptance testing of the LAS Abort Motor, Jettison Motor, and Attitude Control Motor using **DRD CEV-T-039**, *Acceptance Test Procedures*, and document the results using **DRD CEV-T-040**, *Acceptance Data Package*.

d) The Contractor shall hold Test Readiness Reviews (TRRs) before all formal verification activities. The Contractor shall make subsystem and module test procedures available to NASA two weeks prior to each TRR. The Contractor shall invite NASA to all formal verification activities, including TRRs and test executions.

e) The Contractor shall conduct verification activities for interface requirements within the Launch Abort System (between modules, between subsystems, and between components).

f) If the Contractor utilizes analysis, modeling and test bed simulation to conduct analysis in support of verification, the Contractor shall comply with **DRD CEV-T-001**, *Models, Simulations and Integrated Support Plan*.
g) The Contractor shall provide the integration, test, & verification facilities or utilize Government provided facilities with capabilities necessary to test and certify the Launch Abort System and all LAS subsystems and components. The Contractor shall invite NASA to all subsystem facility design reviews, test, verification, and certification activities.
h) The Contractor shall provide the Integration, Test, & Verification (IT&V) facilities required to complete integrated verification of the Launch Abort System. The requirements for certification for test in the IT&V facilities shall be derived from the products developed under Section 10.1, Spacecraft Test, Verification and Certification.

Deliverables
The following module specific information is collected in the DRDs specified in Section 10.2
- **DRD-CEV-T-015: LAS Volume Master Verification Plan**

The Contractor shall deliver the following DRDs for the LAS Motors test qualification activity, documenting all lower level element Qualification data. These DRDs will be also documented into the DRD specified in Sections 10.2 and 10.3 for the integrated CEV.
- **DRD CEV-T-017 Certification Data Package**
- **DRD CEV-T-037: Qualification Test Procedures**
- **DRD CEV-T-038: Qualification Test Report**

The Contractor shall deliver the following DRDs for the Production Vehicle LAS, documenting all lower level element acceptance data. These DRDs will be also documented into the DRD specified in Sections 10.2 and 10.3 for the integrated CEV.
- **DRD CEV-T-039: Acceptance Test Procedures**
- **DRD CEV-T-040: Acceptance Data Package**

6.4.6 LAS Assembly, Integration, and Production (AIP)
a) The Contractor shall integrate, assemble, certify, acceptance test, and deliver flight Launch Abort System meeting the requirements configurations below.
b) The Contractor shall develop and implement an imagery plan to provide imagery (e. g., still photo, motion picture, digital imagery, or video) of the Launch Abort System, and components during manufacturing, assembly, test, integration, and close-out to document the hardware configuration. The Contractor shall include the plan and imagery in **DRD CEV-T-088**, *CEV Imagery Plan/Imagery Deliverables*.
c) Reserved
d) The Contractor shall deliver one (1) prototype LAS for PA1, one (1) Flight Test LAS for AA2, one (1) jettison only capability LAS with a production structure for EM-1,and one (1) production LAS for EM-2.

Deliverables

The following module specific information is collected in the DRDs specified in Section 2.7.2:
- **DRD CEV-T-011: Integrated Logistics Support Plan**

The following module specific information is collected in the DRDs specified in Section 2.10
- **DRD CEV-T-088: CEV Imagery Plan/Imagery Deliverables**

6.4.6.1 LAS Flight Hardware AI&P

a) The Contractor shall integrate, assemble, certify, acceptance test, and deliver flight Launch Abort Systems meeting the requirements for the configurations below.
b) The Contractor shall develop and implement plans detailing the design and construction of all Launch Abort System transportation support equipment, and the plans for transportation of the Launch Abort System to the processing and/or launch sites. These plans shall be included in **DRD CEV-T-011** *Integrated Logistics Support Plan*.
c) The Contractor shall deliver one (1) jettison only capability LAS with a production structure for EM-1, and one (1) production LAS for EM-2.
d) The Contractor shall design, develop, produce, integrate, verify, validate, certify, document, and deliver Launch Abort System GSE in accordance with all requirements allocated from CXP-72000, Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD), and in this SOW, and in accordance with **DRD CEV-O-008**, *Ground Systems Requirements, Plans, Reports, and Design Data, Volume II, Ground Systems End Item Implementation Plan and Report*. The Contractor shall plan for and deliver the GSE end items in accordance with Attachment J-9. The Contractor shall use the following applicable documents for design and development of Contractor-provided GSE:
   – CxP 72506 CEV Orion Standard for Design and Fabrication of: Ground Support Equipment
e) The Contractor shall develop and update **DRD CEV-O-008**, *Ground Systems Requirements, Plans, Reports, and Design Data, Volume III, Systems Operations and Maintenance Plan and Requirements Documentation*, for the ground support equipment provided for the Launch Abort System excluding Government provided GSE.
f) The Contractor shall develop, maintain and deliver all technical models and drawings of the GSE associated with the Launch Abort System in accordance with **DRD CEV-T-003**, *CEV CAD Models*, and **DRD CEV-T-004**, *CEV Drawings*.
g) The Contractor shall develop and update 2-D and 3-D simulation models of the Contractor-provided Launch Abort System and Contractor-provided LAS GSE to assess clearances, placement, conflicts and the moving of hardware in accordance with **DRD CEV-T-003**, *CEV CAD Models*. The Contractor shall develop and deliver these models in accordance with SOW Section 2.4.
h) The Contractor shall develop and deliver **DRD CEV-T-040**, *Acceptance Data Package*, for each Contractor-provided Launch Abort System GSE end item.
i) The Contractor shall provide initial spares, concurrent with the delivery of the GSE end items and in accordance with the provisioning procedures in **DRD CEV-T-011**, *Integrated Logistics Support Plan*, and **DRD CEV-T-012**, *Logistics Support Analysis*, for all Contractor-provided Service Module GSE. (IDIQ)
j) For EFT-1, AA-2 and EM-1, the Contractor shall provide and install a Development Flight Instrumentation (DFI) system and installation engineering.
k) The Contractor shall complete the DD-250 for the Contractor-provided Launch Abort System GSE and deliver the Contractor-provided LAS GSE in accordance with Attachment J-9.

Deliverables
The following LAS GSE data is incorporated in the DRD specified in Section 2.4:
- **DRD CEV-T-003: CEV CAD Models**
- **DRD CEV-T-004: CEV Drawings**

The following LAS GSE data is incorporated in the DRD specified in Section 2.7.2:
- **DRD CEV-O-008: Ground Systems Requirements, Plans, Reports, and Design Data**
- **DRD CEV-T-040: Acceptance Data Package**
- **DRD CEV-T-011: Integrated Logistics Support Plan**

6.4.6.2 LAS Test Article Design and Production

a) For PA1, the Contractor shall design and develop the developmental LAS using the system, module, sub-system, and component level requirements and specifications developed in Section 10.6.4, Flight Test Article (FTA) DDT&E; documented in **DRD CEV-D-002**, *Flight Test Article <Level> Specification*
b) For PA1 the Contractor shall deliver one (1) prototype LAS.
c) For AA2, the Contractor shall design and develop the Flight Test LAS using the system, module, sub-system, and component level requirements and specifications developed in Section 10.6.4, Flight Test Article (FTA) DDT&E; documented in **DRD CEV-T-031**, *CEV <Level> Requirements Specification*.
d) For AA2, the Contractor shall deliver one (1) Flight Test LAS.
e) For PA1 the Contractor shall provide the installation design, associated hardware and installation of NASA provided LAS Development Flight Instrumentation (DFI) elements.
f) For AA2, the Contractor shall provide the installation design, associated hardware and installation of the LAS Development Flight Instrumentation (DFI) elements. The AA-2 DFI system shall be designed to integrate into existing vehicle architecture.
g) The Contractor shall provide LAS GSE in accordance with the criteria established in 2.7.2 necessary to produce the LAS and deliver it to the launch facility
h) The Contractor shall provide the LAS side of a LAS to CM mechanical interface simulator (MIS) to be used for LAS/CM Retention and Release (R&R) mechanism fit checks, and functional tests.
i) The Contractor shall provide LAS propulsion data and LAS OML data in the post-jettison configuration for the test range flight safety office to determine the nominal LAS impact area.
j) The Contractor shall perform/support a structural calibration test of the LAS/CM R&R structural interface.
k) Reserved
l) The Contractor shall perform acceptance testing at the LAS Module, LAS Subsystem and/or LAS component level. The contractor shall document the LAS Module level results using **DRD CEV-T-040**, Acceptance *Data Package* as tailored for content for Flight Test Article Units.

Deliverables
The following Module specific information is collected in the DRDs specified in Section 10.6.4:

- **DRD CEV-D-002: Flight Test Article <Level> Specification for Pad Abort FTAs**
- **DRD CEV-T-017: Certification Data Package for Flight Test Articles**
- **DRD CEV-T-031: CEV <Level> Requirements Specification, for the Flight Test Article**
- **DRD CEV-T-040: Acceptance Data Package for Flight Test Article Units**

6.5 CEV SOFTWARE

CEV Software includes the tasks required for the design, development, production, sustainment, assembly, test, and certification efforts to deliver the completed software for Spacecraft integration. This element includes all aspects of software production from the early stages of system specification through maintenance of the system in the field.

6.5.1 CEV Software Management and Administration

a) The Contractor shall design, develop, produce, integrate, verify, validate, certify, operate, maintain, document, and deliver CEV flight and accompanying ground and test/simulation software in accordance with all requirements and in this SOW.

6.5.2 CEV Software System Engineering

a) The Contractor shall define, design, develop, test, qualify, integrate, verify, validate, deliver, and maintain all CEV software. The plans for accomplishing this work shall be documented in **DRD CEV-T-005**, *Software Development Plan*.
b) The Contractor shall document the reuse of existing software, modification of existing software, and the development of new software in **DRD CEV-T-005**, *Software Development Plan*.
c) The Contractor shall, under CEV Project direction, participate in coordinating with the NASA IV&V Facility in accordance with NASA-STD-8739.8, NASA Software Assurance (Chapter 6 and 7)(IDIQ).
d) The Contractor and its subcontractors' organizations associated with CEV software development responsibilities shall be at Software Engineering Institute Software Capability Maturity Model Integration (CMMI) - SE/SW/IPPD Maturity Level III (Staged Representation) or higher prior to the CEV Preliminary Design Review. This requirement does not apply to commercial-off-the-shelf software procured for the CEV Project.
e) The Contractor shall develop, update, and maintain all software and software development tools under configuration management in accordance with the **DRD CEV-T-006**, *Software Configuration Management Plan*.
f) The Contractor shall develop and maintain electronic Software Development Folders for all flight, ground, and test software per **DRD CEV-T-007**, *Software Development Folder*.
g) The Contractor shall develop and maintain the Display Software Requirements Specification, using CxP 72242, Display Format Standards, and the CEV Display Format Dictionary, as applicable documents. This requirement specification shall be developed in accordance with **DRD CEV-T-048**, *Software Requirements Specification*. The display format dictionary shall be documented as an Appendix to DRD CEV-T-048, Software Requirements Specification.
h) The Contractor shall use the following standards for designing, developing, and testing all software:
   - NPR 7150.2 NASA Software Engineering Requirements
   - NASA-STD-8739.8, NASA Software Assurance Standard (chapters 6 and 7)
i) The Contractor shall allocate CEV Spacecraft requirements (section 2.2, Requirements Definition and Management) to the Computer Software Configuration Item (CSCI) level for the design of flight software and flight test software and maintain the allocations/requirements through Schedule A. The contractor shall maintain allocations/requirements over the life of the system as development transitions to production (Schedule B) and sustaining engineering (Schedule C)(IDIQ). The Contractor shall produce a Software Requirements Specification (SRS) for each CSCI, using **DRD CEV-T-048**, *Software Requirements Specification*.
j) The Contractor shall allocate the requirements of each CSCI to the Computer Software Components (CSCs) and Computer Software Units (CSUs) levels. This design breakdown shall be documented in the *Interface Control Documents* (**DRD CEV-T-029**) and *Software Design Description* (**DRD CEV-T-050**) documents.
k) The Contractor shall plan, execute and document trade studies to identify criteria and provide resolution data for flight software issues related to the selection of software, software tools, and hardware/software architectures (e.g., operating system selections and bus architectures). Trade study reports shall be documented per the requirements captured in **DRD CEV-T-009**, *CEV Analysis Reports*.
l) The Contractor shall perform configuration management of the flight and flight support software within their configuration management system and provide access to all software development folders, source code, and documentation which shall be updated on a minimum of weekly basis.
m) The Contractor shall develop a flight software mission reconfiguration process that details the Contractor's plan for flight-to-flight reconfiguration of the flight software and ground facility software to meet mission-specific requirements. The Contractor's process shall address the

changing of software parameters to account for vehicle modifications, vehicle differences, or to specify values for mission-specific requirements. The Contractor shall document the reconfiguration process plans, requirements, and design in **DRD CEV-T-005**, *Software Development Plan*, **DRD CEV-T-048**, *Software Requirements Specification*, and **DRD CEV-T-050**, *Software Design Description*. The Contractor shall develop tools to support the reconfiguration process.

n) The Contractor shall design, develop, produce, integrate, verify, validate, certify, operate, maintain, document, and deliver a space-time partitioned real time operating system as part of the contractor's flight software implementation.

o) The Contractor shall use a modular software architecture that evolves with the vehicle's capabilities. The Contractor's flight software architecture shall be designed to support system evolution through incremental enhancements. Each incremental enhancement shall add supplemental functional capabilities including selectable autonomy, mission management, and systems management in a time frame compatible with the increasing maturity of requirements and mission needs.

p) The Contractor shall ensure that ground systems software complies with Software Engineering standards identified within this section and those required for contractor developed ground test requirements. For ground operations, the Contractor shall develop and update the software and interface requirements specifications for Contractor-provided ground systems software in accordance with **DRD CEV-T-048**, *Software Requirements Specification*, and implement the design processes and plans documented in the **DRD CEV-T-005**, *Software Development Plan*.

q) The Contractor shall allocate the requirements of each Computer Software Configuration Item (CSCI) to the Computer Software Components (CSCs) and Computer Software Units (CSUs) levels for Contractor-provided GSE. The Contractor shall document the software design breakdown in accordance with the **DRD CEV-T-029**, *Interface Control Documents*, and **DRD CEV-T-050**, *Software Design Description*.

r) For FTA efforts, the Contractor shall develop and update the software and interface requirements for Contractor-provided flight support software in accordance with the specifications developed in 10.6.4: **DRD CEV-D-002**, *Flight Test Article (FTA) Specifications* or **DRD CEV-T-048**, *CEV Software Requirements Specification*.

s) For FTA Efforts, the Contractor shall allocate the requirements of each Computer Software Configuration Item (CSCI) to the Computer Software Components (CSCs) and Computer Software Units (CSUs) levels for FTA software. Engineering Design Data Book defined in Section 10.6.4, FTA DDT&E or **DRD CEV-T-050**, *Software Design Document*.

t) The contractor shall perform software build planning for each identified build and shall document the build planning results in accordance with **DRD CEV-T-005**, *Software Development Plan, Volume 6 Software Build Plan*

u) The Contractor shall develop, maintain, and deliver **DRD CEV-T-049**, *Software Metrics Report*.

v) The Contractor shall develop, maintain, and deliver **DRD CEV-T-056**, *Software User Manual*.

w) The contractor shall provide and maintain connectivity to Kedalion for gaining access to and/or distributing SW products (FSW, EGSE SW, SIM SW, Data, Automation Framework/eLab, Problem Reporting, etc. and test data.

x) The Contractor shall support development, test, and implementation of ground systems software necessary to support NASA conducted secondary usage in prelaunch, launch, mission, and recovery operations. (IDIQ)

Deliverables

The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-005 : Software Development Plan**
- **DRD CEV-T-006: Software Configuration Management Plan**

- **DRD CEV-T-007: Software Development Folder**
- **DRD CEV-T-009: CEV Analysis Reports**
- **DRD CEV-T-029: Interface Control Documents**
- **DRD CEV-T-048: Software Requirements Specifications**
- **DRD CEV-T-049: Software Metrics Report**
- **DRD CEV-T-050: Software Design Description**
- **DRD CEV-T-056: Software User Manual**

The following software specific information is collected in the DRDs specified in Section 10.6.4:

- **DRD CEV-D-002: Flight Test Article (FTA)**

6.5.3 CEV Software Production

a) The Contractor shall develop all flight and ground support equipment software following the plans, processes, and standards outlined in **DRD CEV-T-005**, *Software Development Plan*, and section 6.5.2, Software System Engineering.

b) The Contractor shall develop and deliver the FTA software and accompanying test software (source code, executables, build procedures, and graphical models/block diagrams from Computer Aided Software Engineering Tools) per NPR 7150.2, NASA Software Engineering Requirements using class C and class D definitions and requirements for this software.

c) The Contractor shall maintain the FTA software and accompanying test software until the completion of FTA testing as determined by the FTA configuration defined in Table 10.2 Abort Flight Test Matrix.

d) The Contractor shall deliver Flight software (source code, executables, graphical models, block diagrams from Computer-Aided Software Engineering tools, and build procedures). Flight software deliveries shall start occurring at CDR and occur at a frequency defined in **DRD CEV-T-005**, *Software Development Plan; Vol. 6 Build Plan*

e) The Contractor shall develop, maintain and deliver **DRD CEV-T-007**, *Software Development Folder*; **DRD CEV-T-050**, *Software Design Description*; **DRD CEV-T-055**, *Software Maintenance Plan*, and **DRD CEV-T-057**, *Version Description Document* in support of the CEV Software production and delivery.

f) In support of the Flight Test Program unique software, the Contractor shall maintain electronic Software Development Folders for all flight, ground, and test software per **DRD CEV-T-007**, *Software Development Folder*.

g) The Contractor shall use the following standards for developing software products and associated software data products.
   - NIST FIPS PUB, Secure Hash Signature Standard (SHS) (FIPS PUB 180-2)

h) The AA-2 software suite will utilize the EFT-1 software process since AA-2 software is derived from the EFT-1 Software suite

Deliverables

The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-007: Software Development Folder**
- **DRD CEV-T-050: Software Design Description**
- **DRD CEV-T-055: Software Maintenance Plan**
- **DRD CEV-T-056: Software User Manual**
- **DRD CEV-T-057: Version Description Document**

6.5.4 CEV Software T&V

a) The Contractor shall perform unit testing of the flight software. Unit test procedures (CSU-level), CSU-to-CSU interface, CSC-level, and CSC-to-CSC interface tests will not be a deliverable to NASA; however, they shall be made available to NASA upon request via **DRD CEV-T-007**, *Software Development Folders*. The Contractor's software test plan shall be documented in **DRD CEV-T-052**, *Software test Plan*. All CSCI-level test procedures shall be documented in **DRD CEV-T-053**, *Software Test Description*. The Contractor shall document test results in **DRD CEV-T-054**, *Software Test Report*. The Contractor shall develop and deliver **DRD CEV-T-017**, *Certification Data Package* for each CSCI and for the integrated flight software. The Contractor shall develop and deliver **DRD CEV-T-040**, *Acceptance Data Package* for each flight software deliverable as defined in contract attachment J-9.

b) The Contractor shall perform unit testing of the Flight Support software. Unit test procedures (CSU-level), CSU-to-CSU interface, CSC-level, and CSC-to-CSC interface tests will not be a deliverable to NASA; however, they shall be made available to NASA upon request via **DRD CEV-T-007**, *Software Development Folders*. The Contractor's software test plan shall be documented in **DRD CEV-T-052**, *Software test Plan*. All CSCI-level test procedures shall be documented in **DRD CEV-T-053**, *Software Test Description*. The Contractor shall document test results in **DRD CEV-T-054**, *Software Test Report*. **DRD CEV-T-048**, *Software Requirements Specification* does not require verification for Simulation/EGSE for any flight. The Contractor shall develop and deliver **DRD CEV-T-017**, *Certification Data Package* for each GSE software CSCI and the integrated GSE software, and the ground software development and test tools. The Contractor shall develop and deliver **DRD CEV-T-040**, *Acceptance Data Package*, for each GSE software deliverable as defined in contract attachment J-9.

c) The Contractor shall perform unit testing of the FTA software. Unit test procedures (CSU-level), CSU-to-CSU interface, CSC-level, and CSC-to-CSC interface tests will not be a deliverable to NASA; however, they shall be made available to NASA upon request via **DRD CEV-T-007**, *Software Development Folders*.

d) The Contractor shall develop and maintain **DRD CEV-T-057**, *Software Version Description Document*.

e) In support of the Flight Test Program, the Contractor shall develop and deliver in accordance with Flight Test Program tailored **DRD CEV-T-040**, *Acceptance Data Package*, for each Flight Test software deliverable as defined in contract attachment J-9.

f) EGSE and simulation software will conduct verification at a Software System Specification level (SW Systems = EGSE SW, SSW), 1 level above CSCIs Software Requirements Specifications).

Deliverables

The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-007: Software Development Folder**
- **DRD CEV-T-040, Acceptance Data Package**
- **DRD CEV-T-052: Software Test Plan**
- **DRD CEV-T-053: Software Test Description**
- **DRD CEV-T-054: Software Test Report**
- **DRD CEV-T-057 Version Description Document**

The following software specific information is collected in the DRDs identified in Section 10.2

- **DRD CEV-T-017: Certification Data Package**

6.5.5 Independent Validation and Verification

Reserved

7 RESERVED

8 RESERVED

9 RESERVED

10 MPCV TEST AND VERIFICATION

Test and Verification includes the activities, hardware, and software required to manage the CEV Project verification, certification, and acceptance processes and execute the integrated spacecraft and multi-system testing and verification, including flight testing. Planning and execution (including the hardware and software used for execution) of testing and verification at the integrated spacecraft, the module, subsystem and component levels is contained in Sections 2 and 6.

10.1 TEST AND VERIFICATION MANAGEMENT AND ADMINISTRATION

CEV Test and Verification Management and Administration includes the efforts for planning, organizing, directing, coordinating, controlling, and approval processes used to accomplish CEV Test and Verification objectives.

a) The Contractor shall provide information and technical data to support NASA's completion of a National Environmental Policy Act (NEPA) analysis for the CEV project in accordance with NPR 8580.1, Implementing the National Environmental Policy Act and Executive Order 12114.

10.2 VERIFICATION MANAGEMENT

CEV Verification Management consists of defining and managing the policy, requirements, and processes for verifying that the CEV meets Project requirements. This covers the work to certify the CEV System by inspection, demonstration, simulation, analysis and/or test. Verification Management includes development of a plan for the verification and certification of the CEV System (hardware, firmware, and software) and associated subsystems and components, including integration of NASA GFE data. For Orion verification tests involving significant government furnished assets and in some case crewmembers, the testing roles and responsibilities will be as listed in table 10. 1

Test Type	NASA responsibilities	Contractor Responsibilities
NBL Demonstrations	Leads testing event Integrates test objectives Provides test crew, suits, GFE, FCE and required fidelity Orion mockup structure Responsible for cost of test facility time	Provides test engineering data, necessary design data, and engineering support during test preparation and execution. Provides procedures with use of Crew test participants specific to Orion verification test objectives. Responsible for engineering analysis necessary for verification requirement closure.
JSC Orion Mockup Tests/ Demonstrations	Provides flight and ground crew for test, pressure suits, and required fidelity Orion mockup structure	Leads verification testing event, integrates test objectives, and provides crew training for test assets Provides procedures with use of Crew test

Crew Mobility, Ergonomics, Egress/Ingress, etc. (Orion Project testing only)	Responsible for cost of test facility time Provides personnel for test unless specified by the Government	participants specific to Orion verification test objectives. Provides hardware specific to verification test objectives and not already intrinsic to the test article. Responsible for engineering analysis necessary for verification requirement closure.
Post-landing Tests/Demonstrations with Crew-in-the-Loop (Orion Project testing only) - Crew Egress	Provides flight and ground crew for test, pressure suits, umbilicals, and required fidelity Orion mockup structure Responsible for cost of test facility time Provides personnel for test unless specified by the Government	Leads verification testing event, integrates test objectives, and provides crew training specific to the test event. Provides crew procedures specific to Orion verification test objectives. Provides hardware specific to verification test objectives. Responsible for engineering analysis necessary for verification requirement closure.
D&C Testing with Human in The Loop	Leads testing event Integrates test objectives Provides flight and ground crew for test, suits, umbilicals, Responsible for cost of test facility time Provides required fidelity mockup with integrated displays for required tests outside the VTB/ITL Provides crew training and crew procedures specific to the Orion test objectives. Provides test configuration data and required Orion test hardware	Provides engineering support during test preparation and execution.
Orion ECLSS Test Bed Orion human in the loop testing	Leads testing event, integrates test objectives, and provides crew training for test assets Provides test crew, crew suit interfaces and support services Responsible for cost of test facility time Responsible for collection of verification data	Provides test engineering data, necessary design data, and engineering support during test preparation and execution. Provides hardware specific to verification test objectives. Responsible for engineering analysis necessary for verification requirement closure.
Post-O&C Testing (OPI, VAB, Pad)	Leads testing event, integrates test objectives, and provides training for test assets. Responsible for cost of test	Provides test engineering data, necessary design data, and engineering support during procedure development, test preparation and execution.

	facility time. Responsible for collection of test data.	Provides MPCV flight and GSE hardware and software that is necessary to accomplish test objectives. Supports and performs post-test engineering analysis.
AA2 Integrated Avionics & Software Testing	Leads the definition, design, procurement, integration and checkout of the HOTH test rig to support AA2 integrated avionics and software verification and validation testing, and procedures validation. Provides AA2 avionics, software, EGSE and lab infrastructure to outfit the HOTH rig per the CCM. Supports HOTH test rig certification, configuration control, test execution, anomaly investigation and resolution, and post-test analysis.	Provides the EDL-H facility and lab infrastructure for the HOTH test rig. Supports the definition, design, procurement, integration and checkout of the HOTH test rig. Provides AA2 avionics, software, EGSE and lab infrastructure to outfit the HOTH rig per the CCM. Leads HOTH test rig tailored certification, configuration control, test execution, anomaly investigation and resolution, and post-test analysis.
ESM-Related Testing	NASA is responsible for the coordination of NASA/ESA joint tests as define in MPCV 72513 NASA/ESA Bilateral Integration and Verification Plan (BIVP) NASA responsibilities vis-à-vis ESA is the following: • To carry out the joint interface verification tests in accordance to the responsibilities specified • To support ESA tests, where NASA support is needed as agreed in this document • To invite ESA to the respective integration and verification review activities (including	Provides test engineering data, necessary design data, and engineering support during preparation and execution of joint tests. Provides hardware specific to joint verification test objectives. Responsible for engineering analysis necessary for verification requirement closure. Provides MPCV flight and GSE hardware and software that is necessary to accomplish joint test objectives. Supports and performs post-test engineering analysis.

	readiness reviews and formal qualification testing as considered necessary), associated with the verification of SRD related requirements • To make available to ESA all close-out documentation produced by NASA to demonstrate the achieved verification of the MPCV to ESA SM interfaces • To provide ESA with the hardware and data as specified in the test sheets of this plan.	

Table 10.1 CEV Verification Roles and Responsibilities

10.2.1 Verification Requirements and Integration

a) The Contractor shall develop a plan for the verification and certification of the CEV System (hardware and software) and associated subsystems and components by inspection, demonstration, analysis, and test in accordance with **DRD CEV-T-015**, *Master Verification Plan*.
b) The Contractor shall document the verification method for each CEV System level requirement and all lower-level requirements in a verification matrix. The matrix will be included as part of the corresponding specification, requirements, or interface document.
c) The Contractor shall develop and execute a Master Verification Plan for the process of conducting verification, qualification, certification, and acceptance of the CEV Spacecraft system, modules, subsystems, and components. The Contractor shall use **DRD CEV-T-015**, *Master Verification Plan*, to develop the Spacecraft Master Verification Plan. The Contractor may use multiple volumes in the development of the Spacecraft Master Verification Plan to document the module, subsystem, and component level verification plans.
d) Reserved
e) MPCV Human Flight Validation shall be performed by NASA with contractor support

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-015: Master Verification Plan**

10.2.2 Integrated Vehicle Certification and Acceptance

a) The Contractor shall a develop Certification Plan per **DRD CEV-T-016** for CEV equipment, including the process for development of required Certification Data Packages to certify MPCV. The Contractor shall deliver Certification Data Packages per **DRD CEV-T-017** for those deliverables defined in contract attachment J-9.
b) The Contractor shall accomplish qualification of the CEV System and its hardware and software elements in accordance with CXP-70036, Constellation Environmental Qualification and Acceptance

Testing Requirements (CEQATR) Document as defined in **DRD CEV-T-015**, *Master Verification Plan*. Qualification by methods other than test shall be described in the Master Verification Plan Volume II and be approved by the Government.

c) The Contractor shall accomplish acceptance testing of each deliverable as defined by Contract Attachment J-9 in accordance with **DRD CEV-T-039**, *Acceptance Test Plan*.

d) The Contractor shall define pass–fail criteria or acceptance tolerance bands, based on requirements.

Deliverables

The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-016: Certification Plans**
- **DRD CEV-T-017: Certification Data Package**

The following integrated vehicle certification and acceptance information is collected in the DRD specified in Section10.2.1

- **DRD CEV-T-015: Master Verification Plan (MVP)**

10.2.3 Program Integrated Verification Support

a) The Contractor shall participate in the development of integrated verification plans for both internal and external to MPCV ESD program elements.

b) The Contractor shall participate in integrated verification activities involving multiple systems and ESD elements, including necessary in-space communication systems. (Reference informational document ESD 10016, Verification and Validation Plan.)

c) Reserved

d) Reserved

10.3 INTEGRATED TEST AND VERIFICATION

Integrated Test and Verification consists of all tasks associated with ground testing at the integrated mission, integrated vehicle (multiple modules or multiple subsystems) level and verifying that the integrated vehicle meets applicable Project requirements. The test facilities and labs include hardware and software produced for integrated ground testing of high-fidelity hardware provided by the CM and SM development teams (see Section 6). The test facilities and labs also provide for internal and external interface testing for risk reduction.

10.3.1 Integrated Vehicle Hardware Testing

a) The Contractor shall plan and conduct integration and interface checkout testing to assure the assembly has been completed successfully and that hardware and software functional performance meets requirements.

b) The Contractor shall use flight software during verification testing of all subsystems and components.

c) The Contractor shall perform qualification tests using **DRD CEV-T-037**, *Qualification Test Plans and Procedures*, and document the test results in **DRD CEV-T-038**, *Qualification Test Report*, and **DRD CEV-T-017**, *Certification Data Package*. The Contractor shall perform qualification testing at the CEV Spacecraft system, and utilize test data at the intermediate levels of assembly as necessary to accumulate the data necessary for CEV Spacecraft certification. The Contractor shall produce and deliver a Certification Data Package for the Spacecraft, CM, SM, and LAS as defined by **DRD CEV-T-017**, *Certification Data Package*. The Contractor shall provide Certification Data Packages for each subsystem (end-to-end) as required by the MVP, CEV-T-015. Note: Software test documentation is handled in SOW section 6.5.4, CEV Software T&V.

d) The Contractor shall perform acceptance testing at the spacecraft level using **DRD CEV-T-039**, *Acceptance Test Plans and Procedures*, and document the results using **DRD CEV-T-040**, *Acceptance Data Package*. An Acceptance Data Package shall be produced for the spacecraft.

e) The Contractor shall hold Test Readiness Reviews (TRRs) before formal spacecraft level verification activities. The Contractor shall make spacecraft-level test procedures available to NASA two weeks prior to each TRR. The Contractor shall invite NASA to all formal verification activities, including TRRs and test executions.

f) NASA will provide facilities to support testing in accordance with J-12 NASA Provided facilities.

g) The Contractor shall verify software-controlled interfaces using flight-qualified software.

h) The Contractor shall conduct systems tests of the total spacecraft with the flight-qualified hardware and flight software.

i) The Contractor shall conduct tests of ground-based CEV software/hardware systems that interface with flight systems using interface test equipment that has been shown to be a valid emulation of the flight systems before connecting with the flight systems.

j) The Contractor shall conduct tests using flight-qualified hardware and flight software for final acceptance of the ground-based CEV software/hardware systems used to perform launch and flight operations.

k) The Contractor shall include the following types of tests in their program: (1) ground, (2) flight, (3) development, (4) item, (5) functional, (6) Integration, (7) Hardware-In-the-Loop (HWIL), (8) Software-In-the-Loop (SIL), (9) Human-in-the-Loop, (10) nonoperating environment, (11) operating conditions & environment, (12) acceptance, and (13) qualification. The Contractor shall document the test and verification program in the **DRD CEV-T-015**, *Master Verification Plan*.

l) The Contractor may use an iterative test and verification approach, to include laboratory facilities, to conduct component, subsystems, and system level qualification and certification.

m) The Contractor shall provide support in order to conduct verification testing of all interface designs and requirements within the Spacecraft for those verification activities that are NASA led in NASA facilities with NASA Mockups and Contractor supported.

n) NASA will provide facilities with the capabilities to conduct, performance/functional, human in the loop ECLSS testing to support internal and external interface testing for verification.

Deliverables

The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-037: Qualification Test Plans and Procedures**
- **DRD CEV-T-038: Qualification Test Report**
- **DRD CEV-T-039: Acceptance Test Plans and Procedures**
- **DRD CEV-T-040: Acceptance Data Package**

The following Integrated Vehicle Hardware Testing specific information is collected in the DRD specified in Section 10.2.2.

- **DRD CEV-T-015: Master Verification Plan (MVP)**
- **DRD CEV-T-017: Certification Data Package**

10.3.2 Orion Test Labs

Several test labs and rigs will be required to support integration and testing. These include:

- Integrated Test Laboratory (ITL) – One certified avionics, power and software test rig (tailored certification) in Denver for performing integrated mission and integrated vehicle (EM-1 and EM-2) development, integration and verification & validation testing.
- VMC Test Bench (VTB) – Two certified rigs (tailored certification) supporting flight software development, integration and verification & validation testing in Denver and Houston.
- Support Software Development Lab (SSDL) – A certified (tailored certification) test environment supporting simulation, EGSE and data management software development, integration and verification testing from Denver and Houston locations.
- Houston-Orion Test Hardware (HOTH) – One development and test rig, located in Houston, supporting development testing and early integration of avionics and software. This rig is a mix of assets furnished by the prime contractor and NASA.

10.3.2.1 Integrated Test Laboratory (ITL)

The purpose of the Integrated Test Laboratory (ITL) is to perform development, integration, verification, and validation testing of the MPCV EM-1 and EM-2 avionics hardware and software, spacecraft electrical power system and associated internal and external MPCV interfaces using flight equivalent avionics hardware, flight software, and an appropriate suite of certified ground support tools/systems and software. ITL Testing is performed using Flight Equivalent Unit string and an Engineering Development Unit (EDU) string, as defined in the Contract Glossary (J-5).

a) The Contractor shall be responsible for all aspects of the ITL, including requirements, design, implementation, tailored certification, configuration, interfaces, processes, test procedures, test execution, test reports, operations, maintenance, and sparing, in accordance with Contractor Command Media processes and procedures, with NASA oversight, inline participation, and guidance. The Contractor shall validate the ITL capability and capacity to conduct integration, verification, and validation, and tailored certification.
b) The ITL shall include the following capabilities:
   - A hardware suite using Flight Equivalent Units and Engineering Development Units with appropriate released flight software and firmware versions representing the integrated CM/SM avionics, software, power, wiring and GN&C systems.
   - Validated Emulators and Simulators that represent the flight environment and hardware components needed to verify the end-to-end functionality and performance of the integrated spacecraft.
   - Interfaces to ESD elements or emulators for Verification and Validation of External IRD's, including Mission Operations, Ground Operations, Launch Vehicle and communications network interfaces (see 10.3.5.2, 10.3.5.3).
   - Test support capabilities to perform integrated verification to include script generation and execution, data capture and post-test packaging.
   - Support connectivity to the Communications and Tracking Integration Lab (CTIL) to support C&T RF and end-to-end communications testing.
   - The ITL shall accommodate and conduct integrated mission tests with Launch Vehicle, Ground Systems and Space Communication & Network assets, as defined in Bilateral Exchange Agreements, including:
     - ESA SM emulators, ground support equipment and simulations/models
     - SLS Core and Upper Stage emulators, ground support equipment, simulations/models
     - Ground Systems emulators, ground support equipment and simulations/models
     - Connectivity to the JSC Mission Control Center (MCC)
     - Connectivity to the KSC Launch Control Center (LCC)

    - Connectivity to the Deep Space Network and Tracking & Data Relay Satellite System
  - Displays and Controls interfaces to support integration and testing of the crew interfaces.
  - Integration, operation and sustaining engineering of the above items.

c) Reserved

d) In the cases where the contractor has baselined non FEU's for verification and validation, the contractor shall upgrade these items to a minimum set of 1-string of FEU's. The Contractor shall validate the use of non-FEU components and identify the functional and performance differences and limitations.

e) For Power Systems testing, the ITL, at a minimum, include the following:
  - Integrated power quality testing.
  - Flight equivalent power generation, storage, and distribution/control hardware. However, emulators that provide flight equivalent or flight-like performance can be substituted for the power generation and storage hardware as defined by test objectives.
  - Flight equivalent MPCV power interfaces to the EPS (includes interfaces with flight/flight-like electrical loads).
  - Flight-like electrical load emulators (including hardware, software, and interfaces) that provide flight equivalent performance
  - Test capabilities to perform integrated verification and accommodate the electrical testing of the following.
    - MPCV contractor-provided equipment
    - ESA provided equipment
    - Integrated or portable internal/external GFE and payload electrical equipment
    - MPCV electrical interfaces required for ground maintenance, launch support, and launch vehicles.
    - Capabilities for nominal and off-nominal testing (with provisions to isolate and protect the integrity of the test-bed)
    - MPCV-integrated EPS with critical test-point measurements without adversely affecting flight equivalent performance
    - Integration of the above items.

f) The contractor may utilize the following list of GFE products and services to support ITL Power Test Equipment implementation:
  - ISS power emulator development and testing.
  - Spacecraft power systems breadboard
  - NASA JSC building 361 Power Quality Lab and test equipment available for Contractor hardware/software development, integration, and design validation

g) The contractor shall establish a Ground Data System which has the capability to retrieve, organize, store, and distribute to both contractor internal users and NASA users, test data generated by the contractor as well as data provided by NASA in accordance with J-11. This Ground Data System, which may be resident on the contractor's internal network, shall be capable of network interfacing the contractor's development and verification test locations with NASA developed connections to KSC Operations,(external to the Operations & Checkout Building) and NASA JSC Mission Control Center (MCC)

The contractor, with NASA participation, shall conduct network testing to verify connectivity and operational readiness of system.

10.3.2.2 VMC Test Bench (VTB)

The purpose of the VMC Test bench (VTB) is to perform development, integration, verification, and validation testing of the MPCV EM-1 and EM-2 Flight Software and Data (FSW). VTB Testing is performed using Engineering Development Units (EDU's), as defined in the Contract Glossary (J-5). The Contractor shall validate the use of non-FEU components and identify the functional and performance differences and limitations.

The Contractor shall be responsible for all aspects of the VTB, including requirements, design, implementation, tailored certification, configuration, interfaces, processes, test procedures, test execution, test reports, operations, and maintenance, in accordance with Contractor Command Media processes and procedures, with NASA insight, inline participation, and guidance. The Contractor shall validate the VTB capability and capacity to conduct integration, verification, and validation, and tailored certification of MPCV EM-1 and EM-2.

A VTB shall include the following capabilities:

- A hardware suite using EDU VMC's and VPU.
- Validated Simulators that represent the flight environment and hardware components not present in the VTB needed to verify the end-to-end functionality and performance of the FSW.
- The capability to integrate Display and Control (D&C) components with the hardware suite and simulators.
- Test support capabilities to perform integrated verification to include script generation and execution, automated test-execution, data capture, and posttest packaging.
- Integration, operation and sustaining engineering of the above items.
- Common VTB design for EM-1 and EM-2

10.3.2.3 Support Software Development Lab (SSDL)

The purpose of the Support Software Development Lab (SSDL) is to perform development, integration, build, verification, and validation testing of the MPCV EM-1 and EM-2 Ground Software (GSW) consisting of Electrical Ground Support Equipment (EGSE) Software and Model and Simulation (M&S) Software. .SSDL Testing is performed using Software Development Units (SDU's), as defined in the Contract Glossary (J-5). SSDL testing can also be performed with EGSE hardware components on an as available basis.

The Contractor shall be responsible for all aspects of the SSDL, including requirements, design, implementation, certification, configuration, interfaces, processes, test procedures, test execution, test reports, operations, maintenance, and sparing, in accordance with Contractor Command Media processes and procedures, with NASA insight, inline participation, and guidance. The Contractor shall validate the SSDL capability and capacity to conduct integration, verification, validation, and certification of MPCV EM-1 and EM-2.

The SSDL shall include the following capabilities:

- Input/Output Pump (SHIOP) with a Simulation Host.
- Software Development Units (SDU) that represent the EGSE hardware components to develop, integrate, and verify the functionality and performance of the GSW.
- Test support capabilities to perform integrated verification to include script generation and execution, data capture, and posttest packaging.
- Integration and operation of the above items.

- Common SSDL design for EM-1 and EM-2

10.3.2.4 Houston Orion Test Hardware (HOTH)

The purpose of the Houston Orion Test Hardware (HOTH) is to perform early development, integration, dry-run testing of the MPCV EM-1 and EM-2 avionics hardware and software, and associated internal and external CEV interfaces using Engineering Development Unit (EDU) hardware, flight software, and an appropriate suite of ground support tools/systems and software.

NASA will provide the ground support tools/systems using Contractor designs.

The Contractor shall provide the Flight System components, FSW, GSW, and the facility infrastructure to support the HOTH.

b) The HOTH shall include the following capabilities:
   - A single string hardware suite using EDU with appropriate released flight software and firmware versions representing the APWS and GN&C flight system.
   - Emulators and simulators that represent the flight environment and hardware components needed to integrate and test the end-to-end functionality and performance of the APWS and GN&C flight system.
   - Interfaces to external MPCV elements or emulators for Verification and Validation of External IRD’s (see 10.3.5.2, 10.3.5.3).
   - Test support capabilities to perform integrated verification to include script generation and execution, data capture and posttest packaging.
   - Support connectivity to the Mission Control Center (MCC) to support mission command and telemetry testing.
   - Integration, operation, maintenance and sustaining engineering of the HOTH lab shall be the combined responsibility of NASA and the Contractor based on hardware/software provided..

10.3.3 ECLSS Test Bed

The purpose of the Orion ECLSS Test Bed (OETB) is to provide the capability for System-level integration testing with suited test subjects, in order to verify specified requirements for the CEV CM/SM Environmental Control and Life Support System (ECLSS). The OETB includes all hardware and software required for integrated ECLSS Systems testing.

a) NASA will lead and the Contractor shall participate in, the development of detailed requirements for the Orion ECLSS Test Bed (OETB).
b) The Contractor shall provide ECLSS test bed hardware that at a minimum includes the following:
   - A hardware suite representing the CEV Spacecraft, suit loop components (down to the firmware-level).
c) A software suite consistent with the controls necessary for the hardware in (b)(aNASA will provide ECLSS test bed hardware that at a minimum includes the following:
   - A simulator (including hardware, software, and interfaces) that represents the flight environment needed to verify the end-to-end performance of the data processing system.
   - Test capabilities to perform integrated Orion System verification.
   - Integration of the above items.

d) The Contractor shall develop, certify, and deliver the ECLSS hardware, including all applicable operating procedures, instructions, and drawings, to NASA. The contractor shall support installation of ECLSS hardware.
e) The Contractor shall deliver the following in accordance with Attachment J-9:
   - ECLSS suit loop components

10.3.4 Other Integrated Subsystem Testing

a) The Contractor shall conduct verification activities of all interface designs and requirements within the spacecraft (between modules, between subsystems, and between components).

10.3.5 Interface Testing

Interface testing consists of risk reduction testing for both external (external to the MPCV vehicle), and internal (inter-module) interfaces. Interface verification activities are conducted by the modules (see Section 6) and includes development, maintenance, and management of unique test hardware.

10.3.5.1 Internal Interface Testing

Internal Interface testing consists of risk reduction testing for internal (inter-module) interfaces. Interface verification testing is conducted by the modules (see Section 6).

a) The Contractor shall conduct verification activities of all interface designs and requirements within the spacecraft (between modules, between subsystems, and between components).

10.3.5.2 External Interface Testing

External Interface testing consists of verification, validation, and risk reduction testing for external ESD element interfaces. In general, the Contractor is responsible for:

- Verification and validation of the MPCV side of the external interface
- Leading Joint Test activities conducted in the Contractor's facilities
- Supporting Joint Test activities in external facilities

a) The Contractor shall support the Government in defining test objectives.
b) The Contractor shall support NASA in the development of Bi-Lateral Exchange Agreements and Joint Test Plans.
c) The Contractor, in conjunction with NASA, shall allocate the functional, performance and Operational requirements contained in CEV System Requirements Document, CxP 72000, and External Interface Requirements.
d) The Contractor shall support the Government in the development and maintenance of all detailed documentation for test activities to include specifications, design, implementation, interface definitions, test and qualifications documentation on test articles and drawing trees.
e) For the joint ESD element tests, the Contractor shall support periodic Technical Reviews, Plan and Procedure Reviews, and Test Readiness Reviews.
f) The Contractor shall support the Government in the development and maintenance of the test procedure documentation for test activities.
g) The Contractor shall support the Government during test preparation, execution, and post-test tasks. The Contractor shall provide support for the test execution. This includes console support at the launch site for all training events required to certify console operators, combined systems tests in support of test preparation, and test preparation through test configuration break operations. The Contractor shall be available real time with technical and quality resources to provide test execution and resolve deviations or anomalies as they may occur.

h) The Contractor shall support the Government in the development and maintenance of the test reporting documentation including data assessment and archive for test activities.
i) For MPCV Joint Verification Testing:
NASA is responsible for the following:
  - Development of the Integrated Verification Approach
  - Development of Test Plans/Procedures/ICDs
  - Co-leading ICWG on Joint Verification per the J-11

The Contractor is responsible for:
  - Co-leading ICWG on Joint Verification
  - Providing technical support to NASA for Integrated Verification, Test Plans/Procedures
  - Test Requirements for the Contractor side of interface
  - Test Support for Joint Verification Test Programs
  - Joint Verification testing involves Integrated Functional Tests in which the Contractor delivered Emulators and simulators (per Contract Attachment J-9) will used to represent the Contractor side of interface.
  - No additional simulators, instrumentation, Test Equipment, Test Articles are required to specifically support Joint Verification Testing

10.3.5.3 Interface Test Equipment/Emulators

a) The Contractor shall conduct tests of ground-based MPCV software/hardware systems that interface with flight systems using interface test equipment that has been shown to be a valid emulation of the flight systems before connecting with the flight systems.
b) The Contractor shall develop, deliver, install and sustain MPCV System functional and physical interface simulator(s) and emulator(s) in compliance with the relevant Interface Control Document (ICD) requirements for use by other ESD elements to produce and evaluate the element interfaces to the MPCV. The Contractor shall include operating instructions for the interface simulator(s) and emulator(s) in the **DRD CEV-T-040**, *Acceptance Data Package(s)* delivered with the simulators and emulators. The Contractor shall provide the following MPCV emulation platforms:
   1. A KSC-based Ground Operations interface platform.
   2. A MSFC-based Launch Vehicle interface platform.
   3. A JSC-based Mission Operations interface platform.
   4. An ESA ESM Qualification Facility Orion Data Network Special Test Equipment platform.
c) The Contractor shall verify the MPCV spacecraft with physical and functional simulators and emulators prior to integration with the other ESD elements. The Contractor shall define requirements for the other ESD element-provided physical and functional interface simulators and emulators. Physical and functional interface simulator and emulator requirements and interface requirements shall be delivered in accordance with **DRD CEV-T-031**, *CEV <Level> Requirements Specification* and **DRD CEV-T-029**, *Interface Control Documents for ground support equipment*.
d) Reserved
e) Reserved
f) The Contractor shall deliver MPCV emulators to external element teams to support development and integration as defined in J-9 Delivery Items List.
g) NASA will lead and the Contractor shall participate in the Post Landing verification activities.
h) The Contractor shall support the MPCV spacecraft with physical and functional joint test activities with Crew in suits in simulated operational donning and doffing of suits and egress /ingress and suit retrieval events with both contractor and GFE supplied equipment.

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-T-040: Acceptance Data Packages**
- **DRD CEV-T-031, CEV <Level> Requirements Specification for ground support equipment simulators and emulators**
- **DRD CEV-T-029, Interface Control Documents for ground support equipment simulators and emulators.**

10.3.6 Program Integrated Test Support

a) The Contractor shall support inter-project testing for ESD requirements verification and Program-level risk mitigation.

10.3.7 Verification Analysis and Trades

a) Analytical simulations and integrated software models used for test and verification specification compliance at the integrated spacecraft level (Sections 2 and 6 address module and subsystem levels), shall comply with the requirements of paragraph 2.4 (g).

10.4 FACILITIES

This section consists of all activities needed to provide the Integration, Test, & Verification facilities required to complete integrated verification of the spacecraft. This consists of test and verification facility hardware and software needed to support integrated MPCV testing involving multiple subsystems and modules. This does not include test article and test support hardware and software. Outfitting, test article and test support hardware and software is contained in Sections 10.3 and 6.

10.4.1 Reserved

10.4.2 Reserved

10.4.3 Other Facilities

a) The Contractor shall provide the integration, test, & verification facilities required to test and certify the integrated CEV spacecraft. The Contractor shall invite NASA to witness all subsystem facility design reviews and certification activities.
b) The Contractor shall provide the Integration, Test, & Verification (IT&V) facilities required to complete integrated verification of the integrated MPCV spacecraft. The requirements for the IT&V facilities shall be derived from the products developed under Section 10.1, Test and Verification Management and Administration
c) Reserved
d) The Contractor shall perform requirements development, design, integration, manufacturing, assembly, test, verification, validation, qualification, and certification of contractor test facilities.
e) The Contractor shall provide support to NASA for development, design, integration, delivery of manufacturing, assembly and test equipment, verification, validation, qualification, and certification of manufacturing, assembly, at other NASA owned facilities (IDIQ).

10.5 GROUND TEST PATHFINDER HARDWARE

Reserved

10.6 FLIGHT TEST

All abort flight test activities will be managed and conducted by NASA, as a NASA-provided service to the Contractor, with support from the Contractor, for the Design, Development, Test, and Evaluation (DDT&E) phase. As the lead for this activity, NASA has defined flight tests for the Pad Abort (PA) and Ascent Abort (AA) testing of the Launch Abort Vehicle (LAV) in Table 10.2. The PA and AA tests are considered part of the Abort Flight Test Project (AFTP). Table 10.2 provides conceptual guidance for the complexity required for each test article, and the primary supplier of the hardware. The actual complexity required for each test vehicle will be determined by the vehicle design and the required test objectives for each test.

SOW Section 10.6 covers the work associated with pre-production fidelity test hardware furnished by the Contractor and Contractor support requirements for Government-furnished test hardware. For this effort, the Contractor will support NASA in the development of test-unique non-production and production CEV requirements as appropriate. Per Table 10.2, the Contractor will design, manufacture, verify, and deliver the Flight Test Articles (FTAs) appropriate for these tests. For PA-1, NASA shall provide the CM primary structure and will lead the systems engineering and integration (SE&I) effort, and the assembly, integration and test/production (AIT/P) to be performed at Dryden Flight Research Center (DFRC).

a) For AA2, NASA will lead the SE&I effort for LAV and the System. NASA shall perform LAV AI&P to include the GFE ATB adapter integration as defined in Contract Attachment J-9 at the O&C and LAS Processing Facility respectively.
b) For AA-2, the contractor shall perform CSM AI&P to include integration of GFE Separation Ring as defined in contract attachment J-11 and deliver in accordance with contract attachment J-9.
c) The contractor shall provide component and assembly level kits to NASA as defined in contract attachment J-11 for integration into the GFE Separation Ring.
d) Reserved
e) NASA will be responsible for facility development to support this activity.
f) The contractor shall make available the KSC O & C to NASA to prepare for and conduct AA-2 Launch and Flight Operations. (IDIQ) KSC O&C facility EGSE (Payload Control Equipment) will be provided on a non-interference basis with EM vehicle production.
g) The contractor shall support NASA in the preparation and conduct of the AA-2 Flight and Launch Operations on Eastern Test Range) (IDIQ)
h) NASA will be responsible for conducting AA-2 launch, flight and recovery operations and shipment of the CM back to the KSC O & C.
i) The Contractor shall perform post-flight analysis and model correlation for AA-2.
j) The contractor shall perform maintenance and provide temporary storage awaiting NASA disposition of the AA-2 CM vehicle. The Contractor shall deliver the AA-2 Post Flight Test Report per **DRD CEV-D-011**, *Orion AA-2 Flight Test Article (FTA) Post Test Data Results and Report*

Figure 10.2, Abort Flight Test Matrix, shows the components to be used for the PA/AA flight test vehicles, and where appropriate, the primary supplier of the hardware. The PA test will consist of the FTA components without the ATB. NASA will supply the ATB used in AA 2 as identified in Table 10.2.

A test team led by NASA, with Contractor support, will coordinate the development and implementation of the AFTP. SOW Section 10.6 also includes the Contractor support effort associated with PA-1 and AA-2 flight tests.

The Contractor operations support effort for the Orion flight tests is covered in SOW Section 2.7, Flight and Ground Operations Integration. The test unique GSE for the flight tests is covered in SOW Section 10.6.6.9 Flight Test Ground Support Equipment; SOW section 6.1.6.2, 6.2.6.2, 6.4.6.2 Flight Test Article Design and Production. All GSE that is non-Flight Test unique is covered in Sections 2.7.2 e, 6.1.6.1, 6.2.6.1, 6.4.6.1. The Contractor support required for the Orbital Flight Test FTA effort is detailed in SOW Section 10.6.4.1.

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-D-011, Orion AA-2 Flight Test Article (FTA) Post Test Data Results and Report**

Table 10.2 Abort Flight Test Matrix

Test	Test Description	CM/FBC Primary Structure & Integration	SM/SR Primary Support & Integration	LAS Fidelity Support	Heat Shield TPS	Recv[2] Sys	LRS	Avionics OFI	DFI	RCS	EGSE	Int. Vehicle Health Monitors	Docking System
PA-1	0-0 Pad Abort. Early evaluation of launch abort system capability from a pad abort, WSMR test site.	T/NASA	SR[1] T/NASA	T/LM (no BPC or fairings)	Not Req	T/NA SA	Not Req	T/LM	T/NA SA	Not Req	T/LM	Not Req	Not Req
AA-2	Ascent Abort. Demonstration of the launch abort system capability during a mid-altitude abort from Abort Test Booster at max drag and max q. Eastern Range test site.	Refurbished OFT-1/LM	SR T/NASA	F/LM	T/LM	F/NA SA	F/NA SA and LM	Refurbis hed OFT-1/LM	T/LM	F/LM	T/LM[4]	TF/LM	Not Req

Notes: 1) SR used as stand only. CM/SM R&R mechanism will not be functional. Used for qualification testing of the CM/SM R&R and umbilical disconnect mechanisms.

2) Forward Bay Cover will be provided by NASA for PA-1 and All other flights, LM will provide the Forward Cover Assembly.

3) All GSE will be transferred to NASA as documented on the contract attachment J-9

CM – Crew Module; **SM** – Service Module; **SA** – Spacecraft Adapter; **SR** – Separation Ring; **LAS** – Launch Abort System; **TPS** – Thermal Protection System; **LRS** – Landing Recovery System; **OFI** – Operational Flight Instrumentation; **DFI** – Developmental Flight Instrumentation; **RCS** – Reaction Control System; **IVHM** – Integrated Vehicle Health Monitoring; **FTA** – Flight Test Article, **T** – Test HW/SW required to conduct the test but not necessarily representing flight HW or SW in design, **P**- Prototype flight-like hardware in function, early design concept, **F** – Production quality Hardware and Software; **RECV² SYS** – Recovery Systems

10.6.1 Project Management and Tech Planning

Reserved

10.6.2 Flight Test Vehicle (FTV) SE&I

The NASA Flight Test Management Office (FTMO) will lead the SE&I effort relative to the Flight Test Vehicle (ATB + FTA) integrated analysis (systems, mission, and hazard). FTMO will define and control the analysis products that need to pass back and forth between NASA/LM and the ATB contractor.

10.6.3 Abort test Booster (ATB) DDT&E

The NASA FTMO is responsible for the ATB DDT&E and for defining and controlling the test unique interfaces between the LM provided hardware and software and the ATB. The ATB contractor is responsible for the overall FTV integrated analysis with inputs from and outputs to NASA/LM provided by FTMO under section 10.6.2

10.6.4 Flight Test Article (FTA) DDT&E

This consists of the effort to define the number, fidelity, system and interface requirements, and specifications of the FTAs necessary to complete the flight test effort. This also includes the design, development, systems engineering, integration, test, and verification of unique FTAs not provided by Section 6, CEV Spacecraft Development. Unique FT hardware manufacturing, production, and delivery is contained in Section 6.1.6.2, 6.2.6.2, 6.4.6.2.

a) The Contractor shall refine the PA and AA tests defined in Table 10.2.
b) The Contractor shall support the Government in defining Abort Flight Test Program (AFTP) flight test objectives. The OFT-1 and AA-2 requirements shall be documented in CxP 72465, Project Orion Flight Test One and Ascent Abort 2 Flight Test Objectives.
c) Based on the flight tests outlined in Table 10.2, Abort Flight Test Matrix, the Contractor shall document the proposed fidelity of Contractor-furnished FTAs to complete the flight test effort and document the configurations.
d) The contractor shall support NASA in the development of FTO-AFT-FTA-004, Flight Test Article System Requirement Document, for PA1.
e) For PA-1, the Contractor, in conjunction with NASA, shall allocate the functional, performance and operational requirements contained in FTO-AFT-FTA-004, Flight Test Article System Requirement Document to the Flight Test Articles and Ground Support Equipment. The Contractor shall document the requirements developed from this process in the FTA <Level> Specifications, **DRD CEV-D-002**, *Flight Test Article (FTA) <Level> Specifications*.
f) Reserved
g) The Contractor shall develop and maintain system requirements for AA-2 as identified in Table 10.2, Abort Flight Test Matrix. The Contactor shall deliver the requirements in **DRD CEV-D-010**, *AA-2 FTA <Level> Specifications*.
h) Reserved
i) The Contractor shall develop and maintain FTA specifications in **DRD CEV-D-010**, *AA-2 FTA <Level> Specifications for AA-2 LAV*.
j) Reserved
k) The Contractor shall support the development of module, subsystem, and component requirement specifications appropriate for each NASA-furnished FTA configuration based on the flight test objectives.
l) Reserved
m) Reserved

n) The Contractor shall deliver the module-to-module and module to external interface ICDs applicable to AA-2 as ICDs and documented in **DRD CEV-T-029**, *Interface Control Documents*.
o) NASA will provide the following products to the Contractor.
   - CxP-72167, Orion Aerodynamic Database (for all phases of flight)
   - CxP-72168, Orion Aerothermodynamic Database (for all phases of flight)
p) The Contractor shall provide the installation design, associated installation hardware and installation of NASA-provided Development Flight Instruments (DFI) for the PA-1 LAS in accordance with FTO-AFT-FTA-024-PA1, FTA-to-DFI Interface Control Document.
q) NASA will provide the Contractor the ATB-induced environments as documented in a NASA Technical Memorandum.
r) The Contractor shall provide NASA the CEV LAS induced environments Doc # as part of the Environments Design Document.
s) The Contractor shall design the FTAs for the specific natural environments and induced environments that the FTA must operate within and for which the FTA must be qualified, encompassing all phases of FTA production, testing and operation in all modes through disposal Environments Design Document.
t) The Contractor shall define the FTA System Command, Control, Communications, and Information (C3I) interoperability interfaces to be compatible with the range and document these interfaces per **DRD CEV-D-010**, *AA-2 Flight Test Article (FTA) <Level> Specifications*.
u) For the Abort Test Flights identified in Table 10.2, the Contractor shall support FTA Periodic Technical Reviews, and Flight Test Readiness Reviews. For AA2, the Contractor shall include the Flight Test configuration in each major design review.
v) Reserved
w) Reserved
x) The Contractor shall document the as-built FTAs using the flight test program tailored for content and delivery **DRD CEV-T-040**, *Acceptance Data Package*.
y) The Contractor shall perform acceptance testing at the Crew Module and CM component level and document the results using the flight test program tailored for content and delivery **DRD CEV-T-040**, *Acceptance Data Package*.
z) For each Flight Test Article, the Contractor shall deliver in accordance with Attachment J-9.
aa) For PA1 NASA will provide the Contractor the WSMR natural environments as defined in FTO-AFT-FTA-001, Flight Test Article Environmental Requirements Document.
bb) Reserved

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-D-002: Flight Test Article (FTA) <Level> Specifications (PA-1 only)**
- **DRD CEV-D-010, AA-2 Flight Test Article (FTA) <Level> Specifications**
- **DRD-CEV-T-015: Flight Test Article Volume Master Verification Plan**
- **DRD CEV-T-029: Interface Control Documents**
- **DRD CEV-T-040 Acceptance Data Package for Flight Test Program**

10.6.4.1 Orbital Flight Test Flight Test Article (FTA) DDT&E (EFT-1)

This consists of scope to define the number, fidelity, system and interface requirements, and specifications of the FTA necessary to complete the Orbital Flight Test FTA effort. This also includes the design, development, systems engineering, integration, test, and verification of all Orbital Flight Test FTA hardware and software.

a) The contractor shall perform all DDT&E as required to provide an Orbital Flight Test FTA capable of meeting the Orbital Flight Test objectives specified in CxP 72465, Orion Flight Test 1 and Ascent Abort 2 Flight Objectives. CxP 72465 will be added as an applicable document in Attachment J-3.
b) The contractor shall maintain requirements and processes to the NASA approved Orion baseline as documented in **DRD CEV-T-031**, *CEV <Level> Requirements Specification*, to the system, module, and subsystem level.
c) In cases where the Orbital Flight Test FTA requirements and processes will deviate from the baseline as documented in **DRD CEV-T-031**, *CEV <Level> Requirements Specification*, the contractor shall identify, baseline, deliver, and maintain these unique requirements in **DRD CEV-D-007**, *Orbital Flight Test FTA Specification*, to the system, module and subsystem level.
d) The Contractor shall define and baseline the required documentation necessary to manage and implement the Orbital Flight Test FTA. The contractor shall include NASA during the contractor development and baseline of this documentation. The contractor shall make this documentation available for NASA viewing within the Contractor's electronic system in a format readable by a standard Government workstation or otherwise agreed to with the Government.
e) The Contractor shall develop, deliver and maintain **DRD-CEV-D-008**, *Orbital Flight Test FTA Verification Plan*.
f) The Contractor shall document compliance to SR&QA requirements as defined in SOW 3.0 and deliver in its Orbital Flight Test FTA specific SR&QA plan.
g) The Contractor shall ensure that the Orbital Flight Test FTA is built and tested in accordance with the Contractor's product assurance requirements and standards as defined in SOW 3.0.
h) The Contractor shall develop, identify and procure the required GSE necessary to support Orbital Flight Test FTA DDT&E.

Deliverables

- **DRD CEV-D-007: Orbital Flight Test FTA <Level> Specifications**
- **DRD CEV-D-008: Orbital Flight Test FTA Verification Plan**

10.6.4.1.1 Mission Unique Launch Services (Non-Standard)

Mission Unique Launch Services include the turnkey, non-standard launch services that are unique to the OFT-1 spacecraft. The Contractor shall provide the capability to perform the following Mission Unique Services.

Unique Mission Analysis & Hardware/Equipment

1) Contractor Shall Develop The Necessary Modeling And Simulation For The OFT-1 Configuration.
   a) Contractor Shall Plan, Conduct, and Provide Results of Two Wind Tunnel Tests For Aerodynamics And Combined Buffet And Acoustics.
   b) The Contractor Shall Integrate the launch vehicle with the Orion Aero physics Database with Computational Fluid Dynamic Verification.
   c) Contractor Shall Assess Environment Changes As Result Of The OFT-1 Configuration With The Standard Launch Vehicle Baseline Environmental Analysis Updates.
   d) The Contractor Shall Provide An Integrated Aerodynamic Vehicle Certification Report
2) Contractor Shall Assess The Launch Abort System (LAS) Jettison As A Result Of The Dynamic Separation And Plume Impingement Effects
3) Contractor Shall Assess The Orion Service Module Fairing Separation.

4) Trajectory Optimization - Contractor Shall Provide Trajectory Optimization Associated With Orbital Flight Test 1 Mission Objective Requirements
   a) Contractor Shall Design For the Non-standard Vehicle Propellant Offload.
   b) Contractor Shall Design For Trajectory De-orbit Objectives Defined By OFT-1.
   c) Contractor Shall Analyze and Design To The Desired De-orbit Range Safety Requirements
   d) Contractor Shall Include the Necessary Extended Mission Kit Required For Helium and Hydrazine Based On the Mission Duration.
5) Special Flight Instrumentation
6) Non Standard OFT-1 To Launch Vehicle & Ground Interfaces
   a) T-0 Umbilical For Gigabit Data Transfer
   b) Two (2) Orion To Pad T-0 Umbilical Interfaces (Electrical Ground Support Equipment [EGSE], Purge/Vent, Active Thermal Control Subsystems [ATCS] Purges, Power/Data, ATCS);
      – One Umbilical (LAS) To Provide Conditioned Air. Contractor Shall Provide The Supply Duct To The Ground Interface. Contractor Shall Also Provide A Retraction Method And Qualification Of The Design.
      – One Umbilical To Provide Two (2) Purge Lines And Two (2) Coolant Lines (Supply/Return) To Mate With The Flight Disconnects. The Contractor will Provide The Ground Carrier Plate And Retention Mechanism To Contain The Ground Disconnects Including Coolant Lines To The Provided Equipment And Retraction Method Of The Umbilical. Contractor Shall Also Qualify The Overall Umbilical For Mating Capability Retraction And No Re-contact.
      – Access To Orion From The Mobile Service Tower (MST) During Launch Processing;
7) FAA License Processing
8) Systems Analysis
   – Thermal Dynamics- Includes an initial and final thermal model. Different from baseline as LV requires a simpler/reduced model, Thermal efforts model integration for the unique payload adapter, pre-launch assessment for the mission unique T-0 umbilical panel and interfaces.
   – Dynamics – (Loads and Dynamics): Integration work that had been typically performed at the Constellation Level between Ares and Orion now has to be done at the Orion/LV level. Includes interchange and checking of models and coordination do data sent and received to ensure proper application. Loads model interfaces for mission unique payload adapter need to be worked and coordinated.
   – EMI/EMC – analysis & Test; Analysis & test of upper stage with coordination with 45th test wing
   – Mission Analysis: Effort to support two (2) technical reviews per year and to coordinate a trajectory working group. For OFT-1, the spacecraft is integrated with how we fly (attached to the upper stage) with the launch vehicle and requires additional integration on trajectory items such as pointing for com coverage, thermal, etc.
   – Aerosciences: Support for wind tunnel testing, Ascent Aeroheating (usually performed by NASA/CAP but not for OFT-1) and Ascent Airloads. Purge, vent and drains studies integrated to Delta and the launch facility. Other item that is mission specific is the launch hydrogen ignition pressures and temperatures that we have to coordinate as environments.
9) SEIT
   a) EIRD – External Interface Requirements Document, Flight & Ground
   b) NSE – Non-standard Electrical – unique interfaces w/ launch vehicle
10) Structures – Payload adapter structures that were provided by MSFC for Ares 1-Y
11) Software
12) Verification- Addition IRD/ICD Requirement Verification
13) Mission Operations
   – Launch

- Orbital Ops
- Reentry
- Mission Readiness
- Mission Execution Console Support

The Exploration Flight Test 1 (EFT1) mission is a commercial launch; therefore the Contractor shall work with the necessary entities to obtain the required launch and reentry licenses.

10.6.4.1.2 Ground Operations

Ground Operations includes the Pre-launch, Recovery and the Post Mission Operations. Lockheed Martin is responsible for both the Pre-launch and the Post Mission Operations. NASA is responsible for the Recovery Operations with support from Lockheed Martin.

Pre-launch Operations involve the servicing, testing and final assembly of the OFT-1 flight elements (CSM, LAS and LAS Ogives) prior to transport to the pad, and the OFT-1 vehicle specific operations while at the pad and during launch operations through launch (T-0).. Pad operations will be conducted with the Launch Vehicle provider.

Post mission operations include the transport to a West Coast de-servicing location, de-servicing, disassembly and return of the flight hardware back to the manufacturing facility after the mission.

Operations Planning
Operations' Planning is the effort to develop the detailed plans, processes and procedures needed to perform the implementation of the operations. This Operations Planning also includes the definition and implementation of the support equipment required for the execution of the operations. This includes the Mechanical and Electrical support equipment and the Ground Data Systems needed to perform the operations. The Operations Planning effort for OFT1 includes:

a) Concept of Operations - Update
   The Contractor will update the OFT-1 Concept of Operations to reflect vehicle design and programmatic changes.
b) Development of a Ground Operations Plan
   The Contractor will produce an Operations Plan that includes the detailed tasks, identification of the processes and procedures, schedules and the requirements for the resources to accomplish the Ground Operations tasks to include the support equipment, facilities, and manpower requirements.
c) Operations Development
   The Contractor will develop a Detailed Test Plan (DTP) and the procedures to accomplish the Ground Operations. The DTP is to include the Test Information Sheets (TISs) that are to be used in the definition of the procedures to be generated.

   The Contractor will also develop the Manufacturing Work Instructions (MWIs) to accomplish the final assembly of the OFT-1 per the engineering drawing packages.

   The Contractor will develop a detailed operations schedule to accomplish the operations.

d) Ground Support Equipment (GSE)

The Contractor will provide the GSE to accomplish the Pre-Launch and Post Mission operations. This is for the equipment that was to be provided by NASA as defined in Section 2.7.2. (e) Integrated Ground Support Equipment. NASA will continue to provide the GSE for recovery operations that does not directly interface the Crew Module. The contractor will continue the development of the Ground Support Equipment as defined in Section 2.7.2 of this SOW.

e) Ground Data System
The contractor shall establish a Ground Data System which has the capability to retrieve, organize, store, and distribute to both contractor internal users and NASA users, test data generated by the contractor as well as data provided by NASA in accordance with J-11. This Ground Data System, which may be resident on the contractor's internal network, shall be capable of network interfacing the contractor's development and verification test locations with NASA KSC Operations, external to the Operations & Checkout Building, and NASA JSC Mission Control Center (MCC).
   - The contractor, with NASA participation, shall conduct network testing to verify connectivity and operational readiness of system.
   - The contractor shall provide maintenance and operations of the Ground Data System and the associated network up to the external network connections of the Contractor test facilities.
   - The contractor shall integrate test data into the Ground Data System for all ground testing associated with Exploration Flight Test-1(EFT-1) up to launch (T-0), data which is telemetered from vehicle during OFT-1 flight operations, and data which is retrieved during Recovery Operations.

Operations Execution

The Contractor will execute the operations to perform the Pre-Launch, Recovery and Post Mission Operations. This includes:

a) Procurement of the Ground Support Equipment required for Pre-Launch and Post Mission Operations as defined in the planning phase, paragraph 10.6.4.2 (d).
b) Contracting with Payload Processing facilities providers for the Pre-launch and Post Mission Operations activities. This is to provide the facilities and support services needed during the pre-launch and post mission operations.
c) Execution of the Detailed Test Plan, procedures and Manufacturing Work Instructions to accomplish the Pre-Launch and Post Mission operations.

10.6.4.1.3 Flight Operations

Flight Operations includes the operations beginning with launch (T-0), through ascent, on-orbit operations, entry, descent and landing, and subsequent handover to recovery forces post-landing. Lockheed Martin is responsible for the Flight Operations. Real-time leadership of the joint NASA/LM flight control team in the JSC Mission Control Center is delegated to a NASA Flight Director.

Flight Operations Planning

The Operations Planning is the effort to develop the detailed plans, processes and procedures needed to perform the operations. Operations development includes:

a) Concept of Operations - Update
The Contractor will update the OFT-1 Concept of Operations to reflect vehicle design and programmatic changes.
b) Development of a Systems Operations Plan

The Contractor will produce a systems operations plan that includes the detailed tasks, identification of the processes and procedures, schedules and the requirements for the resources to accomplish the tasks (support equipment, facilities, manpower, other), or references to other authoritative documentation.

c) Mission Rules and Launch Commit Criteria
The Contractor, with support from the customer, will develop the operational flight rules and launch commit criteria needed to govern the teams in the operation of the Orion.

d) Procedures Development
The contractor, with support from the customer, will develop the in-flight procedures.

e) NASA Johnson Space Center Mission Control Center (MCC) Facility
NASA will provide the GSE to accomplish Flight Operations, including the MCC facility, workstations, voice loops, and associated NASA Integrated Services Network (NISN) connectivity, as well as a capability to interface with the contractor-established Ground Data System. NASA will also provide Space Network resources for use during live-sky and hardline end-to-end tests with MCC and Orion Test Labs (OTL), including MCC Serial Communication Processor (SCP) Space Link Extension (SLE) Provider equipment and personnel needed to interface with the Space Network Modem located within the test facility.

1) The Contractor will support development and testing of MCC console flight controller user application data files (e.g., displays, real-time plotting tools, event logging).
2) The Contractor will support facility testing with regard to MCC-generated command verification and data acquisition from the vehicle at the O&C building (or other facilities) and Orion Test Labs (e.g. Exploration Development Lab – Houston (EDL-H) or ITL).
3) The Contractor will perform integrated tests of end-to-end command telemetry between the spacecraft, through Telemetry Data Relay Satellite (TDRS), the Space Network and NISN, to the JSC MCC. These tests will be conducted jointly with NASA and the associated NASA assets (TDRS, Space Network, NISN, MCC). The integrated tests will cover development and interim tests culminating in a “Live-Sky” test of the integrated system utilizing the ITL, TDRS and MCC. The Contractor is responsible for scheduling and conducting testing and for system performance up to the ITL Interface with the NASA provided assets. NASA is responsible for making the necessary NASA assets (TDRS, Space Network, NISN, MCC) available during the Contractor scheduled test execution timeframes.

10.6.5 Flight Test Operations DDT&E (IDIQ)

Flight Test Operations DDT&E consists of the generic concepts, plans, procedures, and training for flight test operations and the design, development, systems engineering, integration, test, and verification of the ground hardware and software associated with flight test execution. The element includes all non-recurring costs associated with establishing and maintaining the flight test operations infrastructure. (IDIQ)

10.6.6 Flight Test Hardware Production

10.6.6.1 Reserved

10.6.6.2 Reserved

10.6.6.3 Reserved

10.6.6.4 Reserved

10.6.6.5 Reserved

10.6.6.6 Reserved

10.6.6.7 Reserved

10.6.6.8 Reserved

10.6.6.9 Flight Test GSE Production

Flight Test Article Ground Support Equipment (GSE) covered in this section includes the design, production, and delivery of the FTA-unique Mechanical GSE (MGSE) and Electrical GSE (EGSE), both hardware and associated software, needed for ground and flight operations to support all FTA components furnished by the Contractor. In addition, the GSE covered in this section includes all LAS GSE.

Note: Work associated with GSE common with the production vehicle is covered in Section 2.7.2.(e), Integrated Ground Support Equipment.

a) The Contractor shall manufacture, deliver, and accept (including acceptance testing) the flight test GSE required for the Flight Test Program.
b) The Contractor shall design, develop, certify, produce, and deliver GSE for FTAs for the flight test defined in **DRD CEV-D-002**, *FTA System Requirements*, and the requirements in this SOW.
c) The Contractor shall design the GSE to support FTA C3I Interoperability interfaces to be compatible with the range.
d) The Contractor shall design and produce the FTA GSE required for all phases of FTA production, transportation, integration and checkout, and ground and launch processing
e) The Contractor shall include FTA GSE in FTA Periodic Technical Reviews, FTA System Acceptance Reviews, and Flight Test Readiness Reviews.
f) The Contractor shall document production and S&MA standards.
g) The Contractor shall ensure that the GSE is built and tested in accordance with the Contractor's product assurance requirements and standards.
h) The Contractor shall document the as-built FTA GSE.
i) The Contractor shall design and produce the FTA GSE required for post-test FTA safing and recovery.
j) The Contractor shall include FTA GSE requirements in **DRD CEV-D-002**, *FTA <Level> Specifications*.
k) The Contractor shall complete the FTA GSE and deliver in accordance with Attachment J-9.
l) The Contractor shall operate, maintain and update the FTA GSE for the duration of the flight test activity.
m) The Contractor shall provide procedures for the FTA GSE.
n) The Contractor shall provide training for the use of FTA GSE.

o) The Contractor shall use a ground command, telemetry, and display system that is compatible with the host range. Use of data converters is unacceptable.
p) The Contractor shall develop a common ground telemetry and data network that allows for software updates via the network. Sites include the Contractor's home site, the host range, and DRFC.
q) The Contractor shall provide the design of the ground transportation and handling (GT&H) equipment to NASA.
r) Note: NASA-LaRC will build the GT&H equipment to ship the LaRC provided CMs and LAS pathfinders.
s) The Contractor shall deliver the EGSE in accordance with Attachment J-9.

Deliverables
The Contractor shall deliver and maintain the following document(s):

- **DRD CEV-D-002: Flight Test Article (FTA) <Level> Data Book**

10.6.7 Abort Test Booster Production

Reserved

10.6.7.1 Reserved

10.6.7.2 Reserved

10.6.7.3 Reserved

10.6.7.4 Reserved

10.6.7.5 Reserved

10.6.7.6 Reserved

10.6.8 Flight Test Operations (IDIQ)

Flight Test operations includes the Contractor support for the flight test activities.
Flight Test Operations include the plans, processes, schedules, and products required to perform the flight design, analyses, and flight planning activities; flight products and procedure development; and execution of flight tests as defined in Table 10.2. Flight Test Operations will be the responsibility of NASA; however, it is essential that the Contractor provide the data and support to NASA for the development of the flight test operations products to prepare for and execute the CEV missions.
Note: Flight Test Support for Orion flight tests are covered in Section 2.7.

a) For PA-1 the Contractor shall provide side-by-side support for the LAS, the avionics sub-system, the MGSE and the EGSE. As FTAs increase in functionality and complexity (AA-2), additional support shall be provided as appropriate. Support includes, but is not limited to, EGSE OFI telemetry database updates, EGSE software updates, and EGSE hardware spares and troubleshooting support. Avionics and LAS flight software updates, regression testing, and troubleshooting support.
Note: Consideration should be given to using Ground Operations personnel from KSC to augment the Ground Operations team at WSMR for training purposes.
b) For PA-1 the Contractor shall provide initial training to NASA test team personnel on the LAS module, the CM avionics, the MGSE and the EGSE. As FTAs increase in functionality and complexity (AA-2), additional training shall be provided as appropriate.

c) For PA-1 and AA-2 the Contractor shall provide support for the test execution. This includes console support at the test range for all training events required to certify console operators, combined systems tests in support of launch preparation, and launch through recovery operations. This also includes the Contractor operations and maintenance of the EGSE at the test range.
d) Reserved
e) The Contractor shall provide support for the PA-1 Post Flight Test Report.
f) For PA-1 and AA-2 the Contractor shall provide data to NASA for range safety in accordance with Section 2.7.4, Range Safety, and **DRD CEV-O-007**, *Range Safety Requirements Documents*.
g) For PA-1, the Contractor shall support NASA-provided parachute and pyrotechnic initiator integration into the FTA.
h) For PA-1 and AA-2, the Contractor shall provide support for flight test planning, to include module and subsystem procedures, ground processing, checkout, launch, recovery and refurbishment procedures, flight rules, launch commit criteria, and minimum equipment list required for launch.
i) For AA-2, the Contractor shall provide operations support after FTA DD250 to the government. These operations activities include: CSR non-hazardous and hazardous processing, CSR to LAS stacking and post-stack functional testing, transportation to the pad, FTA to Abort Test Booster stacking and post-FTA stack functional testing and pre-launch integrated testing, pad operations, EGSE support, FTA activation for launch, flight operations, post-recovery CM safing, inspections, data recovery and de-servicing operations.

Deliverables
The Contractor shall deliver and maintain the following document:
- **DRD CEV-D-011, Orion AA-2 Flight Test Article (FTA) Post Test Data Results and Report**

10.7 SPECIAL PROJECTS/STUDIES – T&V (IDIQ)

This section addresses unique projects or studies needed to support, facilitate, improve, or enhance CEV test and verification completeness or effectiveness.
a) The Contractor shall perform special CEV-related studies and analyses as directed by NASA. The Contractor shall define the resources required as part of their response to NASA's request for a task order plan. The trade studies and analyses resulting from special studies shall also include the impact to system safety and life cycle cost.

10.7.1 TPS Flight Test

This is a study to determine the value, feasibility, and necessity of performing a flight test to prove the effectiveness of the TPS materials and application for lunar-return entries.

11 EDUCATION AND PUBLIC OUTREACH (IDIQ)

Education and Public Outreach incorporates the development of the Education and Public Outreach portion of the CEV Project. Provide for the EPO responsibilities in alignment with NASA's Strategic plan for Education. This includes management and coordinated activities, formal education, informal education, public outreach, media support, and web site development.

The following Statement of Work Annex 1 for Recovery Act funded effort (CLIN 3) was effective beginning on August 19, 2009, including all updates prior to the date of this modification, and will end on May 28, 2010.

STATEMENT OF WORK ANNEX 1 FOR RECOVERY FUNDED EFFORTS <HISTORICAL RECORD>

This statement of work (SOW) is a supplement to the SOW contained in the basic contract in Attachment J-1. In as much as the work requirements in this Annex supplement and do not replace the existing SOW, all of the requirements contained in Attachment J-1 and elsewhere in the contract, remain in full force and effect.

Technical Tasks:
The contractor shall deliver work in the three categories which are Ground Test Articles, Engineering Design Units, and Technology Development Testing for Improved Crew Safety. Tasks are more specifically defined in the table below:

ORION PROJECT Priority Stimulus Tasks		**Task Description**
NAME	**IPT**	
GTA		
Ground Test Article (GTA) Heat Shield	Crew Module	Perform initial tooling design and materials procurement associated with Aeronca and PFI tooling for the GTA Ti heatshield for impact testing.
Tooling for Crew Module (CM) GTA	Crew Module	Complete the development of the engineering drawing for GTA tooling for the fabrication and assembly of the Crew Module Ground Test Assembly.
Crew Module GTA Development, Fabrication, Assembly and Integration	Crew Module	Complete the development of the engineering drawings for all of the components for the GTA including the primary and secondary structure and mechanisms. Complete the procurement of all components and manage all of the component procurement efforts. Perform the fabrication of the components, and assembly and integration of the Crew Module GTA.
Service Module (SM) Ground Test Article (GTA) Test Article Build & Tooling	Service Module	Perform the development of the engineering drawings for GTA Service Module (SM) Structures Tooling.
Service Module (SM) Ground Test Article (GTA) Engineering	Service Module	Perform the engineering development activities of the Service Module Ground Test Article Engineering.
Launch Abort System (LAS) Ground Test Article (GTA) Test Article Build & Tooling	Launch Abort	Perform the development of the engineering drawings for GTA Launch Abort System (LAS)

	System	Structures Tooling.
EDU		
ASIC for Time Triggered Gigabit Ethernet (TTGbe) and Vehicle Master Computer	Avionics & Software	Perform FPGA/board prototype risk mitigation testing. Complete the activities required to turn on the ASIC foundry as well as perform the build and test of a prototype SCP, NIC Switch, PDU controller with FPGA. Integrate completed items into a test network in a realistic Orion configuration. Validate requirements for components prior to ASIC IDR.
Avionics & Software Development & qualification tools - Verification Test Boards (VTB)	Avionics & Software	Develop design specifications, produce drawings and parts lists, install and verify the Orion Vehicle master computer Test Benches (VTBs) and the Orion Support Software Development Lab (SSDL). Perform the procurement of hardware and software for the SSDL and the rig hardware for the Orion VTBs.
Communication & Tracking (C&T) early sub activation	Avionics & Software	Complete the engineering specifications, request for proposals and source selection of the subcontracts for specific Communication and Tracking components. Perform long lead procurement for the transponder and baseband processor EDU's.
Recover CEV Avionics Integration Lab (CAIL) Development Costs in FY09 and FY10	Avionics & Software	Complete the detailed design of CEV Avionics Integration Lab software, rig subsystems and lab infrastructure. Perform the procurement of initial CAIL infrastructure and prototyping effort.
Forward Bay Cover (FBC) Retention & Release (R&R) Engineering Development Unit	Crew Module	Perform the CM Forward Bay Cover retention and release EDU hardware design development and engineering drawings for parts procurement and fabrication and test fixture design.
Crew Module (CM)/Service Module (SM) Retention & Release EDU	Crew Module	Perform the CM/SM retention and release EDU hardware design development and engineering drawings for parts procurement and fabrication and test fixture design.
Launch Abort System/Crew Module Retention & Release EDU	Crew Module	Perform the LAS/CM retention and release EDU hardware design development and engineering drawings for parts procurement and fabrication and test fixture design.
Hatches (Docking & Side) Engineering Development Unit (EDU)	Crew Module	Perform the CM hatch (docking and side) EDU hardware design development and engineering drawings for parts procurement and fabrication and test fixture design.

Crew Impact Attenuation System (CIAS) Engineering Development Unit (EDU)	Crew Module	Perform the Crew Impact Attentuation System EDU hardware design development and engineering drawings for parts procurement and fabrication and test fixture design.
Lexan Windows EDU	Crew Module	Perform the CM Lexan window EDU hardware design development and engineering drawings for parts procurement and fabrication and test fixture design.
ECLSS (CM) requirement to meet qualification deliveries - Includes SM	Crew Module	Perform the CM/SM ECLSS EDU hardware design development and engineering drawings for parts long lead procurement and fabrication for the specific subsystems listed below: CO2 and humidity control, Vent and Temp control, Sublimator Assy, Contingency Gas analyzer.
CM/SM ECLSS Long lead Procurement (integrated ECLSS design)	Service Module	Perform the CM/SM Umbilical Quick Disconnect design and analysis of the mechanical devices required to produce engineering development unit hardware and component qualification hardware. Perform service module radiator development testing, preliminary design and analysis, and engineering required for production of hardware required for the Structure Test Article.
Station Power Transfer Unit (SPTU)	Crew Module	Perform the CM Station Power transfer unit EDU hardware design development and engineering drawings for long lead parts procurement.
Aerojet Long lead procurement for Hot Flow/Cold Flow Testing	Crew Module	Complete the fabrication and delivery of the CM reaction control system Cold flow development test article (CFDTA) and Hot Fire Test Article (HFTA).
Crew Module Uprighting System (CMUS) EDUs & Long Lead Procurement	Crew Module	Perform the CMUS EDU hardware design development and engineering drawings for long lead procurement of two inflation tanks (mass emulators) and 1 CMUS EDU.
Service Module Fairing Separation Test Tooling and Panels	Service Module	Complete the design and development of the specific tooling and panels for the service module fairing separation test.
Service Module Propulsion Recovery	Service Module	Perform the engineering and drawings for the service module pressurization system isolation valves and the associated procurement to support the cold gas and hot fire tests of the Orion Main engines.
PMD Design and Analyses support,	Service	Provide the labor for design and analysis for

estimated to be approximately $500K in FY10	Module	the Service Module propellant management device (PMD) units to be used in the hybrid propellant tanks.
PMD Material Procurements, estimated to be approximately $1.0 M in FY 10	Service Module	Procure the long lead items such as double dutch twill screen and titantium metal stock for the initial builds of the PMD development, qual and flight units.
Dollars to go towards Aeroflex contract ($2M-$3M)	Service Module	Complete the hardware builds for the Proof of Concept and EDU units (Inner and Outer Axis, the Solar Array Drive Electronics, and the Unfurling Device (UFD)). Complete the intial hardware builds efforts for the Component Qual and System level Qual units (Inner and Outer Axis, the Solar Array Drive Electronics, and the Unfurling Device (UFD)).
Power Data Unit (PDU) EDU Development		Complete design, release engineering drawings, order and receive material for PDU CTA & DTA and Special Test Equipment.
PDU Conceptual Test Article (CTA) cards		Complete the procurement, build and delivery of the PDU CTA/DTA cards.
D&C Prototypes		Develop, build and deliver the D&C prototypes including Display Unit (DU), Rotational Hand Controller (RHC), Translational Hand Controller (THC), Cursor Control Device (CCD). This includes 2 DUs for SW development; Integration of video on DU prototypes and RHC/THC/CCD prototypes for risk mitigation.
GPS Receiver (GPSR) prototype 2		Develop, build and deliver a GPSR prototype 2 unit. Integrate a new rad-tolerant processor with the existing Mercury design along with the new GSFC fast acquisition algorithms.
Form & Fit Software Development Unit (FFSDU) development		Develop and release the design documentation for the FFSDU.
Vehicle Management Computer (VMC) card Simics model completion		Complete development and test of the VMC Card Simics router card and memory card models and integrate into the contractor desktop environment.
Softsim/CAIL simulation development		Complete the first iteration and deliver the Simulations for Softsim/VTB/CAIL.
System and Network Tool Updates		Finalize the system and network tools for use in SW development.
Crew Module Pressurization Bottle		For the Crew Module Pressurization Bottle, Prepare/update procurement specification and SOW, select Vendor, generate Vendor

		System requirements, review System Requirements, Purchase Long Lead material, and conduct PDR
Crew Module Propellant Tanks		For the Crew Module Propellant Tanks, Prepare/update procurement specification and SOW, select Vendor, generate Vendor System requirements, review System Requirements, Purchase Long Lead material, and conduct PDR
Service Module Tank Isolation Valve		For the Service Module Tank Isolation Valve, Prepare/update procurement specification and SOW, select Vendor, generate Vendor System requirements, review System Requirements, Purchase Long Lead material, and conduct PDR
Long Lead Procurement for OME Isolation Valve		For the Orion Main Engine (OME) Isolation Valve, Prepare/update procurement specification and SOW, select Vendor, generate Vendor System requirements, review System Requirements, Purchase Long Lead material, and conduct PDR
Service Module Mass Gauging Unit		For the Service Module Mass Gauging unit, Prepare/update procurement specification and SOW, select Vendor, generate Vendor System requirements, review System Requirements, Purchase Long Lead material, and conduct PDR
Service Module Latch/Solenoid Valves; Aux Thruster POD Isolation Valves; SM Reaction Control System (RCS) String and Pod Isolation Valves		For the Service Module Latch/Solenoid Valves, Aux Thruster POD Isolation Valves, SM RCS String and Pod Isolation Valves, Prepare/update procurement specification and SOW, select Vendor, generate Vendor System requirements, review System Requirements, Purchase Long Lead material, and conduct PDR
Service Module Heat Exchanger		For the Service Module Heat Exchanger, Prepare/update procurement specification and SOW, select Vendor, generate Vendor System requirements, review System Requirements, Purchase Long Lead material, and conduct PDR
Crew Module Pressure Regulator		For the Crew Module Pressure Regulator, Prepare/update procurement specification and SOW, select Vendor, generate Vendor System requirements, review System Requirements, Purchase Long Lead material, and conduct PDR

Technology Development Testing for Improved Crew Safety		
Material Testing for Thermal Protection System	Crew Module	Perform material testing for the crew module thermal protection system.
Segmented Crew Module (deferred tooling)	Crew Module	Complete the design and development of the specific tooling and handling fixtures for the segmented crew module design.
Materials & Processing (M&P) for Titanium Fasteners and 2050 Aluminum	Crew Module	Complete material testing of titanium 2050 fasteners for the crew module.
ACM for production of the pintle and pintle guides	Launch Abort System	Procure long lead items of CCSIC used in the ACM for production of the pintle and pintle guides. Purchase of the raw material (weaving, cut up, densification) that will be used for ACM motors in support of AA-2 and/or qualification, and final machining of production parts.
Backup Flight System (BFS) for Safe Crew Return After Malfunction		Perform analysis, develop requirements, and advance the design of SCRAM hardware, firmware and software systems contributing to Crew Survival.
Mode 1 Abort Environments Mitigation		Develop design and advance development of a Mode 1 Abort controller that is hardened to survive Mode 1 LAS Abort motor induced vibro-acoustic environments.
ABORT		Perform & assess GN&C analysis and design for maximizing mid-altitude transonic LAS abort probability of crew survival, including assessments of Ares launch vehicle functionality and performance mitigations, modifications of LAS vehicle design including ballast and control authority enhancements, and probabilistic assessments of crew safety metrics for integrated Ares/Orion system performance.

Reporting:

In addition to the above tasks, there are reporting requirements that are in addition to those called for by FAR 52.204-11. The contractor shall provide both financial reporting as well as technical progress reports. The above tasks are more broadly associated with satisfaction of established contract requirements and deliverables, but are delineated above to provide appropriate segregation for the expenditure of ARRA funding, as well as to facilitate reporting as required by the use of the funds. The above tasks are delineated to allow the Contractor to provide information regarding measurable performance against the task schedules and requirements.

The financial reporting shall be in the form of a supplemental report submitted in conjunction with the NF533. LM shall provide the details by Stimulus Category (GTA, EDU, Crew Safety) in the 533 format which include labors hours and total cost, which includes subcontractors and materials. The contractor is required to report the Cost/Hrs in 3 areas (Current actuals, Cum actuals, and Current estimate). Based on Recovery Requirements, dollars shall be tracked, reported, and invoiced separately and shall not be comingled with other funding. For transparency and traceability, the Stimulus Categories shall be identified by WBS Level 2/3 in order split Cost/WYE between by Project CAM.

The contractor shall also provide monthly Recovery Act progress reports. These reports must describe the cumulative progress made, plans forward and shall also describe any difficulties encountered. Progress made shall be estimated and reported using milestone percent complete reporting. The progress reported must not be percent hours exhausted, percent cost incurred, or earned value based. The final report provided shall describe not only work complete but also shall document how this activity has reduced the overall risk to the project and shall also document the way in which lessons learned as the result of these activities have been incorporated into the design and manufacturing efforts.

3. For the period May 29, 2010 to June 25, 2010, the following Statement of Work Annex for Recovery Act funded effort (CLIN 3) is effective.

STATEMENT OF WORK ANNEX 2 FOR RECOVERY FUNDED EFFORTS <HISTORICAL RECORD>

This statement of work (SOW) is a supplement to the SOW contained in the basic contract in Attachment J-1. In as much as the work requirements in this Annex supplement and do not replace the existing SOW, all of the requirements contained in Attachment J-1 and elsewhere in the contract, remain in full force and effect.

Technical Tasks:

The contractor shall deliver work as reflected in the April 2010 Month End IMS tasks for the period of performance for Annex 2 and summarized in the table below:

Category	Statement of Work

Program and IPT Management	• Prepare Cost Performance Report – DRD CEV-B-003
	  – Includes IMS Delivery and Earned Value Performance and Variances
	• Prepare 533M Report – DRD CEV-B-001
	• Prepare Life Cycle Cost analysis for Block 0 program plan
	• Provide EV Surveillance Support
	  – Participate in DCMA Audit Activities
	• Conduct Engineering release process for GTA (approximately 125 releases)
	• Implement Review Board process for ERB (8 meetings), PRB (8 meetings), FRB (4 meetings)
	• Prepare Risk Reviews and incorporate into Risk System
	  – DRD CEV-M-005
	• Prepare Property Finance Reporting - CEV DRD-B-004
	Information Technology
	• Provide support to the collaboration environment to include tool on-boarding, off-boarding The number of support requests in this area is anticipated to be 800 in the month of June, 2010.
	• Provide user support for high end engineering and business systems for problem resolution and deployment of new workstation capabilities. Approximately 250 service tickets will be worked during the period of June, 2010.
	• Provide system administration support of approximately 30 Orion servers including system monitoring, data management and security patching.
	• Deploy the Software Configuration Management integrated tool chain upgrade. This includes upgrades to 4 primary products (IBM Rhapsody, DOORS, Synergy and Change) and deployment of those new versions to approximately 60 users.
	IPT Management
	• Participate in Level II meetings – PRBs (8 meetings per IPT)/ERBs (8 meetings per IPT)/Risk board (2 meetings per IPT)/CPCB (4 meetings per IPT)/PMR (1 meeting per IPT)
	• Prepare weekly and monthly cost and planning reports, 4 weekly and 1 monthly report for Earned value, Variances and EACs

	Quality • Perform Quality Assurance functions associated with receiving and inspection and build of GTA to include oversight of the GTA build process through the month of June • Review/Incorporate revisions/Approve approximately 112 of drawings – EGSE/MGSE/CSM Mechanical SR&QA at Michoud • Enter/Review/Release approximately 13 drawings for GTA • Review all Work Documents for GTA (approximately 27 Documents) Environmental Safety and Health(ESH) • Ensure day to day compliance with Environmental Safety and Health regulations to ensure a safe work environment during daily GTA build process to include lifts and moves, all hazardous operations, and incident reporting as required • Address any ESH issues and problems as they arise during performance in accordance with the primary SOW 3.1. Systems Engineering • Approve 100% of the spacecraft, module and subsystem 607A requirements • Complete 607A study guide • Close 20% of open PRB RIDS and close 20 PDR Action Items • Complete 17 out of 17 subsystems will have agreements on entry and exit criteria for SSDRs and CDR • 607A Design Reference Mission (DRM) details will be 50% complete • The 20 TDSs to be delivered at the end of DAC 4 will be 50% complete • The Functional Failure Analysis will be 25% complete • The pretest analysis products to include 4 GTA test plans and test fixture designs for modal, vibration, acoustic and drop tests will be 10% complete • Complete technical baseline documentation based on 607A ERB decisions • 100% of the M&P defined review plan will be completed • EMI/EMC Update of Lightning Plan based on Optimized Vehicle, 100% of the lighting requirements loaded in cradle and 30% of RIDs will be closed • Crew Radiation evaluation of zonal radiation limits based on H/W changes driven by Optimized Vehicle (OV), 30% of Model will be updated to reflect OV
Software	• Close SW PDR action items • Update SW SRS document to incorporate errata and comments from SW PDR • Set up SW Design environment • Develop SW design documents to prepare for SW CDR deliveries • Transition requirements to Doors • Prepare for integrated Synch Point #2a • Implement SW process streamlining

Safety, Reliability &Quality Assurance	System Safety
	• CSERP
	  – Participate in Phase I Closeout activity
	    • Final closure of action items
	    • Documentation and delivery of DRD resubmittal (S-002,S-003)
	  – Prepare for Phase II kickoff

	Reliability, Maintainability and Support
	• Failure Mode and Effects Analysis/Critical Items List (FMEA/CIL)
	• Develop CDR-level maturity at component level, including review and concurrence through VICB
	• Develop DRD CEV-S-009 (FMEA/CIL)
	• Probabilistic Risk Assessment (PRA)
	    – Update ISS PRA model to 606H+ configuration
	    – Develop DRD CEV-S-010 (PRA Results)
	    – Develop preliminary quantitative LOC/LOM assessments for 607A
	• Reliability & Maintainability (R&M) Predictions
	    – Develop CDR-level R&M predictions at component level
	    – Develop DRD CEV-S-011 (R&M Integrated Report)
	• Develop and provide R&M inputs for EVMS, CDR planning, and trade studies.

Systems Engineering	• Deliver monthly Metrics (M-002) and Margins (T-036) Plans. • Perform requirements baseline and preliminary prototype definition for the Backup Flight Computer System (BFCS) architecture for 607A • Evaluate MMOD based on Optimized Vehicle based off current IMSE • Update the Orion Concept of Operations (O-001) and Orion Integrated Logistics Support Plan (T-011) to incorporate the Block 0 design and reference mission goals and objectives
Crew Module	CDR Preparation Activities: • Subsystem component design • Design reviews • Component testing (e.g. human factors seat testing, pyro shock test) • Flight engineering drawing releases • Interface Control Drawings • Update of Component Specs and preparations for CRADLE integration • Requirements & specifications development • Performance analysis (e.g. sublimator) • Material testing (e.g. MMOD shots, composites, soft good coupons) • Draft test plans & procedures (e.g. EVA/Crew Survival Equip Test Plans) • Mass reduction & projection based on threats & opportunities • Production Integration GTA Activities: • Drawing reviews • Hardware production & integration STA Activities: • Drawing releases EDU Activities: • Drawing releases
Service Module	CDR Preparation Activities: • Subsystem component design • Design reviews • Component testing (e.g. SADA proof of concept, CMSM umbilical) • Propulsion cold flow test • Flight engineering drawing releases

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Component procurement (e.g. award propulsion subcontracts)
Interface Control Drawings
Update of Component Specs and preparations for CRADLE integration
Requirements & specifications development
Performance analysis
Material testing
Draft test plans & procedures
Mass reduction & projection based on threats & opportunities
Production Integration

GTA Activities:

Drawing reviews
Hardware production & integration

STA Activities:

Drawing releases

EDU Activities:

Drawing releases

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<tr><td>Avionics/ Power/ Wiring</td><td>
PDU Activities:

Finalize PWB layouts
Complete Design analysis to start CTA/DTA builds

Harness Activities:

Develop channelization list.
Vet vehicle connectors.

Navigation Sensor Activities:

Update GN&C Component Specs (CEV-T-031) in support of CDR submittal
Conduct GN&C Component design & analyses in support of CDR (Supports GN&C Design Data book: CEV-T-078)
Update GN&C Subsystem & Component Verification Plan (CEV-T-015 Vol XIX) in support of CDR

IT&V Activities:

Update and Peer Review of the AA-2 Avionics, EPS, GN&C, Pyro Control, and Wiring Specification and IRD documents
Support of the Block 0 Optimization Plan and additional Flight Test feasibility assessments as related to Avionics.

C&DH & D&C Activities:

Finalize COTS DFI Configuration

Mounting locations, thermal control plan
Preliminary procurement specification
Vendor Survey / assessment

Participate in D&C CCD and RHC design revisions
Incorporate updated SCRAM design changes into 607A update.
Conduct Network Connector design
Review and update component test plans for CEV2
Participate in Integrated Test Lab level meetings to resolve delivery issues

EPS Activities:

Conduct CM Battery PDR at Yardney Technical Products, Pawcatuck, Ct. with LME&S CPE and analysis labor

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	• Conduct Solar Array Wing (SAW) component design Review with associated LMES CPE and analysis effort • Conduct independent structural analysis of the CM Battery C&T Activities: • Receive the S-band transponders from General Dynamics, ship it to Newtown to be tested and integrated with the first Baseband Processors that will be shipped there from LMSSC in Denver on 6/18/10Transponder Prototype delivery • Work toward completion of the S-band system schematics • Work toward completion of initial Phased Array component PDR design and analysis documentation along with parts and materials documentation review and approval.
Test & Verification	GSE Activities: • EGSE Design & Engineering Release • MGSE Design & Engineering Release • Develop Component level Requirements Documents & Maintenance of Subsystem Requirements Documents to Support Design Reviews • Participate in MGSE Manufacturing Activity FTA Activities: • Requirements Documentation for AA-2 Verification Engineering Activities (All tasks support CDR): • VIS Event Consolidation • Requirements Allocation to VIS Events • Evaluate Verification Requirements, • Component Test Tolerance & Margin Test Engineering Activities: • Develop Detailed Test Planning for Protoqual • Prepare GTA Test Procedure and Manufacturing Support • STA Detailed Test Planning • Test Lab Capability & Requirements Definition Test Labs Activities: • Test Lab Facility Requirements Coordination • Lab Capability & Requirements Design • Software Labs Development (SSDL & VTBs)
Launch Abort System	• CDR design and analysis • Development of Vendor SOWs and deliverables list and specifications • GTA Structures Design • Carbon Carbon SiC Development

Reporting:
Reporting requirements related to Statement of Work Annex 2 for Recovery funded efforts, applicable May 29, 2010 through June 25, 2010:

In addition to the above tasks, there are reporting requirements that are in addition to those called for by FAR 52.204-11. The contractor shall provide both financial reporting as well as technical progress reports. The above tasks are more broadly associated with satisfaction of established contract requirements and deliverables, but are delineated above to provide appropriate segregation for the expenditure of Recovery Act funding, as well as to facilitate reporting as required by the use of the funds. The above tasks are delineated to allow the Contractor to provide information regarding measurable performance against the task schedules and requirements.
The financial reporting shall be in the form of a supplemental report submitted in conjunction with the NF533. The contractor shall provide the details by SOW Category in the 533 format which includes labor hours and total cost, as well as subcontractor and material costs. The contractor is required to report the Cost/Hrs in each area (Current actuals, Cum actuals, and Current estimate). Based on Recovery Act requirements, Recovery Act dollars shall be tracked, reported, and invoiced separately and shall not be comingled with other funding. For transparency and traceability, the SOW Categories shall be identified by WBS Level 2/3 in order split Cost/WYE between by Project CAM.
The contractor shall also provide a monthly Recovery Act progress report for the period from May 29, 2010 to June 25, 2010. This report shall describe the cumulative progress made, plans forward and shall also describe any difficulties encountered. Progress made shall be estimated and reported using milestone percent complete reporting. The progress reported must not be percent hours exhausted, percent cost incurred, or earned value based. The final report provided shall describe not only work complete but also shall document how this activity has reduced the overall risk to the project and shall also document the way in which lessons learned as the result of these activities have been incorporated into the design and manufacturing efforts.
For the categories above (with the exception of Program Management), the progress toward completion of each of these categories will be measured using the Integrated Master Schedule (IMS). Each category will be mapped to the relevant milestone(s) listed in the IMS. This will require that each relevant IMS milestone have a SOW Annex identifier to specify to which category it is mapped. The April 2010 Month End IMS establishes a specific list of tasks that define the CLIN 3 baseline for the Annex 2 performance period. The final report, issued at the conclusion of CLIN 3, shall include the detailed variance explanations for the June 2010 Month End IMS, which documents the actual performance against the baseline. The final report will include a Technical Progress Report by category, which will be an extraction of the details from the IMS along with a detailed narrative describing work accomplished. The Program Management category listed above is not included in the IMS and its performance will be reported on as part of the narrative included in the final report.

The above tasks are delineated to allow the Contractor to provide information regarding measurable performance against the task schedules and requirements. In accordance with the contractor’s proposal of May 26, 2010, the expectation is that all of the above tasks will be performed as described between May 29, 2010 and June 25, 2010 using Recovery Act funding provided on CLIN 3 under the contract. Nonetheless, it is understood that events and circumstances could result in a re-prioritization of effort and a performance outcome different than as described in these task performance descriptions. In such an event, the Contractor shall, as part of its established monthly report, document the results as compared to the performance descriptions, and explain any variations that arose and their cause. Further, to the extent that events and circumstances produce significant re-prioritization of effort as compared to the above, the Contractor shall notify the Government in advance of such re-direction of effort and associated resources.

The June 2010 month end IMS will document completed tasks for the Recovery Act funded efforts. Uncompleted tasks, if any, may be moved back to CLIN 1 for continued performance dependent upon availability of funds.

STATEMENT OF WORK ANNEX 3 FOR RECOVERY FUNDED EFFORTS <HISTORICAL RECORD>

This statement of work (SOW) is a supplement to the SOW contained in the basic contract in Attachment J-1. In as much as the work requirements in this Annex supplement and do not replace the existing SOW, all of the requirements contained in Attachment J-1 and elsewhere in the contract, remain in full force and effect.

Technical Tasks:

The contractor shall deliver work as summarized in the table below:

Category	Statement of Work
Crew Module (CM)	• Deliver PDR Design for the Crew Module (CM) Hydrazine Valves, Service Valves and Filters. Final delivery consists of a Design Package that includes CM propulsion subcomponent information and a Design Review which is consistent with a PDR level of design. This package may include, as necessary, subcomponent procurement specifications and drawings produced and required to build and test development hardware. The completion of this PDR design enables demonstration of how the design will map to and comply with program requirements, including testing to verify compliance, and is significant in allowing for a seamless transition to the rest of the development and production of this hardware. • Deliver PDR Design for the Crew Module (CM) Pressure Regulator. Final delivery consists of a Design Package that includes CM propulsion subcomponent information and a Design Review which is consistent with a PDR level of design. This package may include, as necessary, subcomponent procurement specifications and drawings produced and required to build and test development hardware. The completion of this PDR design enables demonstration of how the design will map to and comply with program requirements, including testing to verify compliance, and is significant in allowing for a seamless transition to the rest of the development and production of this hardware.

Reporting:

Reporting requirements related to Statement of Work Annex 3 for Recovery funded efforts, applicable September 15, 2010 through February 15, 2011:

In addition to the above tasks, there are reporting requirements that are in addition to those called for by FAR 52.204-11. The contractor shall provide both financial reporting as well as technical progress reports. The above tasks are more broadly associated with satisfaction of established contract requirements and deliverables, but are delineated above to provide appropriate segregation for the expenditure of Recovery Act funding, as well as to facilitate reporting as required by the use of the funds. The above tasks are delineated to allow the Contractor to provide information regarding measurable performance against the task schedules and requirements.

The financial reporting shall be in the form of a supplemental report submitted in conjunction with the NF533. The contractor shall provide the details by SOW Category in the 533 format which includes labor hours and total cost, as well as subcontractor and material costs. The contractor is required to report the Cost/Hrs in each area (Current actuals, Cum actuals, and Current estimate). Based on Recovery Act requirements, Recovery Act dollars shall be tracked, reported, and invoiced separately and shall not be comingled with other funding. For transparency and traceability, the SOW Categories shall be identified by WBS Level 2/3 in order split Cost/WYE between by Project CAM.

The contractor shall also provide a monthly Recovery Act progress report for the period from September 15, 2010 through February 15, 2011. This report shall describe the cumulative progress made, plans forward and shall also describe any difficulties encountered. Progress made shall be estimated and reported using milestone percent complete reporting. The progress reported must not be percent hours exhausted, percent cost incurred, or earned value based. The final report provided shall describe not only work complete but also shall document how this activity has reduced the overall risk to the project and shall also document the way in which lessons learned as the result of these activities have been incorporated into the design and manufacturing efforts.

In accordance with the contractor’s proposal of September 10, 2010, the expectation is that all of the above tasks will be performed as described between September 15, 2010 and February 15, 2011 using Recovery Act funding provided on CLIN 3 under the contract.

STATEMENT OF WORK ANNEX 4 – EXPLORATION FLIGHT TEST 1 (EFT-1)

1.0 INTRODUCTION

This statement of work describes the end-to-end EFT-1 Integrated Flight Test and Data Results effort and necessary to obtain critical performance data for the Multi-Purpose Crew Vehicle (MPCV) spacecraft to support the Orion Critical Design Review (CDR) as part of the spacecraft Design, Development, Test and Evaluation (DDT&E) phase. The flight data obtained will support the MPCV Spacecraft Loss of Crew (LOC) and Loss of Mission (LOM) objectives with intent to decompose the data and affect the subsystem(s) design to mitigate future DDT&E cost and schedule risks. Delivery of EFT-1 Flight Test Data constitutes completion of efforts covered under this SOW Annex.

1.1 OBJECTIVES

The Contractor shall plan, integrate, execute and manage the end-to-end activities of EFT-1 Integrated Flight Test Launch Support Services as required to provide the resulting data to support the EFT-1 requirements and mission objectives as defined in CXP-72465, "Project Orion Flight Test Objectives."

As the turn-key provider for EFT-1 Integrated Flight Test and Data Results, the Contractor shall be the integrating body for all Launch System interfaces between the hardware providers, operational, processing and recovery elements, and regulatory Agencies necessary to execute the flight test.

The Contractor shall execute EFT-1 using a commercial launch model by working with the required entities to ensure the necessary data and certification products associate with execution of the EFT-1 effort. NASA will not be accepting formal delivery (i.e., DD250) of any hardware under this EFT-1 effort.

1.2 EFT-1 CONFIGURATION

The following more clearly defines the configuration for the EFT-1 Standard Launch Services:

a) MPCV/LV Adapter to provide the transition between launch vehicle interface and MPCV Spacecraft (NASA Government Furnished Property).
b) Launch Vehicle (LV) capable of meeting flight test requirements outlined in this SOW;
c) Integrated Stack – A term used to describe the combination of the MPCV Spacecraft, the selected Launch Vehicle and the MPCV/LV Adapter (i.e., the components described in a, b and c above).

1.3 EFT-1 INTEGRATED FLIGHT TEST AND DATA RESULTS DATA SUBMITTAL REQUIREMENTS

Data to be submitted by the Contractor in support of this Annex to the SOW is specified in Contract Attachment J-2 with the applicability of each Data Requirement Document (DRD) defined herein.

2.0 EFT-1 INTEGRATED FLIGHT TEST AND DATA RESULTS MANAGEMENT AND ADMINISTRATION

The Contractor shall provide management, technical direction, coordination, and administrative effort to ensure that the SOW requirements are properly implemented and performed in a timely and effective manner.

3.0 EFT-1 INTEGRATED FLIGHT TEST AND DATA RESULTS REQUIREMENTS

The contractor shall provide standard launch services inclusive of the launch vehicle and its support infrastructure, integrate the MPCV spacecraft to the launch vehicle, launch and perform orbital operations as defined in the Orion EFT-1 CxP 72465, and deliver the MPCV performance data (flight and post flight) after the flight test is complete.

3.1 EFT-1 INTEGRATED FLIGHT TEST AND DATA RESULTS INTEGRATED STACK INTERFACE CONTROL DOCUMENT (ICD)

The Contractor shall prepare and manage an Interface Control Document for the Integrated Stack. The ICD shall contain the component descriptions, Integrated Stack wiring diagrams and interface to facilities, complete interface and compatibility drawings, orbital insertion criteria, special requirements affecting the this ICD shall be made available to NASA to support the delivery of the Government Furnished Equipment (GFE) referenced in Section 3.6.

3.2 EFT-1 INTEGRATED FLIGHT TEST AND DATA RESULTS MISSION ANALYSIS (MA)

The Contractor shall perform Launch System Mission Analysis to meet the EFT-1 mission requirements.

3.3 EFT-1 INTEGRATED FLIGHT TEST AND DATA RESULTS PRODUCT ASSURANCE AND SAFETY

The Contractor shall provide the necessary product assurance and safety capabilities necessary to implement the EFT-1 mission requirements. The contractor shall implement a standard set of hardware and site safety processes commensurate with the contractor's internal command media.

The Contractor shall perform an integrated orbital debris assessment on the EFT-1 Integrated Stack in accordance with NPR 8715.6A and NASA-STD-8719.14, including aspects of the Launch Vehicle elements that contribute to the debris assessment on this test flight. The integrated orbital debris assessment shall be delivered as DRD CEV-S-007, "Orbital Debris Assessment" in the current DRD format as augmented with the launch vehicle aspects noted.

Deliverables:
The Contractor shall deliver and maintain the following document(s):
- **DRD CEV-S-007: Orbital Debris Assessment (augmented)**

3.4 EFT-1 INTEGRATED FLIGHT TEST AND DATA RESULTS FLIGHT TEST DATA RESULTS AND REPORT

a) The Contractor shall provide NASA access to the near real-time spacecraft telemetry data being acquired during execution the flight test.
b) The Contractor shall provide the EFT-1 mission performance data as defined in DRD CEV-D-009.

Deliverables:
The Contractor shall deliver and maintain the following document(s):
- **DRD CEV-D-009: Exploration Flight Test 1 Post Test Data Results and Report**

3.5 EFT-1 INTEGRATED FLIGHT TEST AND DATA RESULTS REVIEWS

The Contractor shall provide status on the activities in this SOW. The following is a list of potential topics:
a) All tasks started, in work, or completed during the previous period against the planned milestones appearing in the schedule;
b) Launch vehicle production and/or launch service status;
c) Planned or possible changes to the remaining effort;
d) Significant technical accomplishments, problems, or issues requiring resolution;

3.6 EFT-1 INTEGRATED FLIGHT TEST AND DATA RESULTS GROUND AND FLIGHT HARDWARE

a) The Contractor shall provide launch services, mission integration, and launch operations as required to meet the mission requirements of EFT-1. The Contractor shall be responsible for the manufacturing and checkout of the Launch Vehicle, integration of the Spacecraft and associated equipment with the Launch Vehicle, verification of Launch vehicle/Spacecraft/GSE interfaces, countdown, and launch.
b) The Contractor shall provide a launch site capable of integrating the launch vehicle and spacecraft, then launching the Integrated Stack to meet the required EFT-1 mission requirements.
c) The Contractor shall integrate the NASA provided MPCV/LV Adapter (GFE) into the EFT-1 Integrated Stack design and flight configuration as required to meet the mission requirements of CxP 72465 and the requirements of the ICD in section 3.1 of this Annex.

3.7 INTEGRATED FLIGHT TEST OPERATIONS

a) The Contractor shall perform all activities necessary to safely and effectively transport the MPCV Spacecraft from the Orion Integration Facility to the launch complex, and all activities to integrate the elements into the Integrated Stack to meet the mission requirements of EFT-1.
b) The Contractor shall provide launch support and operational support, to include flight test booster, integration, production, and operational considerations and requirements to meet EFT-1 mission requirements.

c) The Contractor shall utilize a Launch Vehicle that shall transport the MPCV spacecraft as required to meet the objectives of CXP-72465 Project Orion Flight Test Objectives. The profile follows a sequence similar to the GTO trajectories, using the Integrated Stack performance for ascent, on-orbit flight, and a re-entry from a high apogee beyond earth orbit that maximizes velocity, commensurate with a lunar return, to stress the entry, descent and landing functions, including the heat shield, propulsion, guidance/navigation/control, and parachute recovery systems.
d) The Contractor shall provide flight test data and engineering evaluation shall be provided in the DRD specified in section 3.4 of this Annex.

ATTACHMENT J-2

DATA PROCUREMENT DOCUMENT

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) regulation or clause, the regulation will take precedence over the DPD, per FAR 52.215-8.

1.2 DPD Description: This DPD consists of 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.

1.2.2.1 The DRL and the Data Requirements Matrix (DRM) are the same under this contract.

1.2.2.2 The following definitions apply for submission activities:

Initial – First release of a document.
Update – Update to a document.
Final – Baseline version of the document. The baseline version of the document shall be maintained and updated as required throughout the life of the contract.

1.2.2.3 Unless otherwise specified, days called out in the submission matrix are calendar days.

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
B	Business
D	Demo
M	Management
O	Operations
S	Safety
T	Technical

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

1.2.3.4 To facilitate the usage and maintenance of the DPD, the DRD's have been divided into sections 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 pages that precedes the DRD's.

1.2.4 Reserved

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

TYPE	DESCRIPTION
1	All issues and interim changes to those issues require written approval from the requiring organization before formal release for use or implementation.
2	NASA reserves a time-limited right to disapprove in writing any issues and interim changes to those issues. Data shall be submitted to the procuring activity for review not less than 45 calendar days prior to its release for use or implementation. The Contractor shall clearly identify the release target date in the “submitted for review” transmittal. If the Contractor has not been notified of any disapproval prior to the release target date, the data shall be considered approved. To be an acceptable delivery, disapproved data shall be revised to remove causes for the disapproval before its release.
3	These data shall be delivered by the Contractor as required by the contract and do not require NASA approval. However, to be a satisfactory delivery, the data must satisfy all applicable contractual requirements.
4	These data are produced, or used during the performance of the contract, and are made available to NASA via the contractor’s collaborative environment (such as, LM Project Link) and are retained by the Contractor. They shall be delivered when NASA requests it according to instructions in the request.
5	These data are incidental to contract performance and are retained by the Contractor in those cases where contracting parties have agreed that formal delivery is not required. However, the Contracting Officer or the Contracting Officer’s Representative shall have access to and can inspect this data at its location in the Contractor’s or subcontractor’s facilities, or in an electronic database accessible to the Government.

2.0 STATEMENT OF GENERAL REQUIREMENTS

2.1 Applicable/Reference Documents: Documents included in Section 13.2 Applicable Documents of each DRD include “Applicable” and “Meets/Exceeds” documents as defined by Attachment J3 of this contract. The document versions are the issue specified in the Statement of Work and Attachment J3, and form a part of the DPD to the extent specified herein. Documents listed in Item 13.2 of a DRD apply only to the preparation of the deliverable documentation described by that DRD.

References to documents other than Section 13.2 Applicable Documents in the data requirements of this DPD may sometimes be utilized, and shall be indicated in Section 11, Remarks of the DRD. These do not constitute a contractual obligation on the Contractor. These documents are typically, “informational” as defined in Attachment J3 of this contract. 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 and Transmittal

2.3.1 Distribution: Distribution of required documentation shall be in quantities determined by the Contracting Officer. Recipient names and email 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: Electronic submission of data deliverables is required. Electronic deliverables shall be printable where possible. The Contractor will not be required to deliver the data in a printable format for data deliverables such as binary executables, CAD models, mathematical models, etc. which are not printable. The versions of all submittals shall be confirmed prior to delivery such that the delivered version corresponds to the intended delivered version.

Data submittals in MS Word, MS Project, Excel or PowerPoint shall consist of a single, searchable Adobe Acrobat PDF file in addition to the native Word, Excel, Project, or PowerPoint electronic file(s).

Where a single native format file is not possible, multiple files may be integrated into a single ZIP file for submission with the concurrence of NASA. The organization of the contents of the integrated ZIP file must be made readily apparent to the reader, and each file within the integrated product shall be clearly identifiable and traceable within the organization of the integrated product.

All native format files delivered by the Contractor shall be readable by COTS software. Where the native file formats are not readable by COTS software, and with the concurrence of the NASA COTR, the Contractor shall deliver the application (source code and executable) required in order to read the native file format. The preferred format for CAD data will be Pro Engineer. The Contractor may request an alternative format.

2.3.2.2 Hardcopy Format: In addition to the electronic submittal, one hardcopy package of specific data deliverables shall be delivered to the NASA Contracting Officer for the Government contract file. DRD's which require hardcopy submittals will indicate this in Item 13.4, Format of the DRD's description. The hardcopy package shall consist of the Contractor's Transmittal Memo and one copy of the data deliverable.

2.3.3 Transmittal

2.3.3.1 Type 1, 2, and 3 data shall be transmitted to NASA via the Integrated Collaborative Environment (ICE) in accordance with Attachment J-14, hardcopy, or other mechanism agreed to by the

Contracting Officer, COTR, and Project representatives who are responsible to receive, index, and store the data deliverables.

2.3.3.2 Data Transmittal Package: Each data transmittal package shall include:

a. Transmittal memorandum that specifies the meta-data below for each data transmittal:
   1. Contract number.
   2. Data Requirements Description (DRD) number.
   3. DRD data type (specified in Item 3 on the DRD).
   4. Submission date or milestone being satisfied.
   5. Document number and revision.
   6. Document title.
   7. File names of all files being delivered; multiple files per document must be clearly related to the document.
   8. Requested response date.
b. Printable electronic files or hardcopy data.

2.3.4 Use of the ICE Repository: See J-14, ICE Operating Environment for details on using the ICE repository.

2.4 Reserved

2.5 Contractor's Internal Documents: 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. The format being used by the Contractor's internal documents shall be readable by COTS tools.

2.6 Document Identification: Type 1, 2, and 3 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. This 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.

2.7 Reference to Other Documents and Data Deliverables in Data Submittals: 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.

2.8 Maintenance of Type 1 Document Submittals

2.8.1 Revisions of Type 1 documentation shall be 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).

3.0 Reserved

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-B-001
3. **DATA TYPE**: 3
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Financial Management Report (533)

7. **DESCRIPTION/USE**:
The NASA Form 533 (NF533) reports provide data necessary for the following:

a) Projecting costs and hours to ensure that dollar and labor resources realistically support project schedules.

b) Evaluating Contractor's actual cost and fee data in relation to negotiated contract value, estimated costs, and budget forecast data.
c) Planning, monitoring, and controlling project resources.
d) Accruing cost in NASA's accounting system, providing project and functional management information, and resulting in liabilities reflected on the financial statements

8. **DISTRIBUTION**: As Determined by the Contracting Officer
Per Data Requirements Matrix

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
The due dates for the NF533M and NF533Q reports are outlined in Chapter 3 of NPR 9501.2D. The following is a summary of the NF533 due date requirements:

a) NF533M: Due not later than 10 working days after calendar month end. One hardcopy 533M shall be delivered two working days later to the specified NASA contracts representative

b) NF533Q: Due not later than 10 working days after the month proceeding the quarter being reported.

The due dates reflect the date the NF533 reports are received by personnel on the distribution list, not the date the reports are generated or mailed by the contractor. It is critical that the NF533 reports are submitted in a timely manner to ensure adequate time for NASA to analyze and record the cost into the NASA accounting system.

533 M and Q reporting should reflect costs at WBS Level 2 with the exception of Crew Module (1.6.1), Service Module (1.6.2), Launch Abort System (1.6.4) and CEV Software (1.6.5) which shall be reported at Level 3.

533 reports by WBS should include summary pages for WBS levels 1 and 2 that equal the sum of all lower level WBS costs contained in the report.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 1.2.(a)

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:

NF533 Monthly and Quarterly Cost Reporting. The M/Q report shall provide a report for projecting costs and equivalent personnel (EP's) for evaluating Contractor's actual cost and fee, for the planning, monitoring, and controlling of project and program resources, and for accruing cost.

13.2 **APPLICABLE DOCUMENTS**:

Applicable Documents per J3:
NPD 9501.1G: NASA Contractor Financial Management Reporting System
NPR 9501.2D: NASA Contractor Financial Management Reporting

Meets/Exceeds Documents per J3:
533 DRD-eCCR: 533 Electronic Submission Example

13.3 **CONTENTS**:

An initial NF533 report is required in the NF533Q format to be used as a baseline for the life of the contract. The initial (baseline) NF533Q report shall be submitted by the contractor within 30 days after authorization to proceed has been granted. The initial report shall reflect the original contract value detailed by negotiated reporting categories and shall be the original contract baseline plan. In addition to the initial (baseline) report, monthly NF533 reporting shall begin no later than 30 days after the incurrence of cost.

Column 7b (planned cost incurred/hours worked for the month) and 7d (cumulative planned cost incurred/hours worked) of the NF533M represent the negotiated baseline plan for the contract. There may not be a relationship between the estimates provided in columns 8 of the NF533M to columns 7b and 7d. Columns 7b and 7d represent the legally binding contract negotiated baseline plan plus all authorized changes.

Short and long-term cost estimates, which include all data entered in columns 8 and 9a on the NF533M and NF533Q reports, shall be based on the most current and reliable information available.

Prior period cost adjustments should be reported in column 7a and 7c of NF533M and column 7a of the NF533Q with a footnote discussing the reasons for and amounts of the adjustments.

Monthly NF533 reporting is no longer required once the contract is physically complete, provided the final cost report includes actual cost only (no estimates or forecasts). The contractor must continue to submit monthly NF533 reports as long as estimates for the following period are included. If the final cost of a contract changes after the submission of the 'final' contractor cost report, the contractor must submit a revised NF533 report in the month the cost change is recognized.

Electronic NF533 Requirement

In addition to submitting the NF533M or NF533Q in a hardcopy format, the contractor, upon request, shall submit the NF533 electronically by the same due date as the hardcopy. The data shall be submitted via email using the Government prescribed flat file format (see attached Agency

Defined File Format for an example of the layout details) and shall include the following header information from the hardcopy.
<insert table 1 here>

The flat file will also contain detail information for each Reporting Category (RC). A Reporting Category correlates to a task order, delivery order, or Work Breakdown Structure (WBS) and is the level at which cost is reported. Each RC can have Sub-Reporting Category line items (detailed cost elements) that add up to a RC. The Contractor is required to coordinate with the NASA Resource Analyst assigned to the contract in order to establish and maintain the Reporting Categories the contractor shall use to comply with this data requirement. The chart below describes the data elements to be included in this section of the flat file (see attached Agency Defined File Format for specific layout details).
<insert table 2 here>

The flat file shall be saved as a text file with no extension (do not include .txt after the file name) and named in strict accordance with the specific format described in the attached Agency Defined File Format document.
Distribution:
LF6 Cost Accounting (1 hardcopy)
_____ Contracting Officer (1 hardcopy)
_____ Budget/Program Analyst (1 hardcopy)
_____ Technical (1 hardcopy)
_____ Upon Request, E-mail Account (1 electronic copy)

File names must be provided in a specific format. Each file name will begin with the SAP 2 Character center abbreviation listed below. The contract number and date will be included in the file name as well. Below is a sample file name.

MACFPS001_NAS00-0001_yyyy_mm_dd
<insert table 3 here>
SAP 2 Charter Center Abbreviations

Reference sample format ' 533DRD-eCCR.'

13.4 **FORMAT**: Cost Elements Definitions
Labor Reported to NASA as hours are incurred.

Equipment & Materials (commercial off-the-shelf)
Generally reported to NASA when received and accepted by the Contractor.

Manufactured Equipment
Defined as any equipment that is produced to specific requirements that make it useless to anyone else without rework. Cost should be reported to NASA as the equipment is being manufactured. The straight-line method for estimating accrued costs or the use of supplemental information obtained from the vendor are acceptable methods used to calculate the cost accrual amount.

Leases Reported to NASA using a proration over the life of the lease.

Travel Reported to NASA as costs are incurred.

Subcontracts Actual and estimated costs reported by prime Contractor’s shall include subcontractors' incurred costs for the same accounting period. Where subcontract costs are material, they should be separately identified on NF533 reports. The prime Contractor shall include in the total cost of each subdivision of work the accrued cost (including fee, if any) of related subcontractor effort. Subcontractors should, therefore, be required to report cost to the prime Contractor, using the accrual method of accounting. If the G&A and fee reported by a subcontractor are at the total subcontractor level, these costs must be allocated to specific sub- divisions of work. Data submitted by the subcontractor should be structured similarly to the prime Contractor's NF533 to enable the prime Contractor to properly report to NASA. For firm fixed price subcontracts with a contract value greater than $500,000, the prime Contractor is required to document the methodology used to generate the sub- contractor costs reported and provide this information to the Contracting Officer and Center Deputy Chief Financial Officer (Finance).

Unfilled Orders
Reported as the difference between the cumulative cost incurred to date and amounts obligated to suppliers and subcontractors.

Fee
Should be accrued as earned using a consistent and auditable method to determine the amount. For example: an acceptable method would be to use historical data to determine the amount to accrue each month. Fee should be reported on the NF533 following the 'Total Cost' line. Award fee must be reported by the following categories: Base Fee, Fee Earned, Interim Fee, Provisional Fee, Potential Additional Fee, and Total Fee. If any of the above fee categories do not pertain, they should not be included in the NF533.

Prompt Payment Discounts
Cumulative cost reported to NASA should be the full incurred cost. The prompt payment discount amount taken should be reported as a separate line item on the NF533 below the cumulative cost amounts for the contract.

13.5 **MAINTENANCE**: The Contractor shall provide a revised NF533M immediately to correct errors when deemed necessary by the NASA Financial Management Division. The revised NF533M shall be delivered prior to closure of the current JSC account system for the month. The reports shall be maintained electronically by the Contractor.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-B-002
3. **DATA TYPE**: 3
4. **DATE REVISED**: 11/1/2005
5. **PAGE**: 1
6. **TITLE:** Workforce Reporting

8. **DESCRIPTION/USE**:
The report is used by NASA to provide workforce information to center management. The supplemental report is used by NASA Headquarters to support congressional inquiries.

8. **DISTRIBUTION**: As determined by the Contracting Officer

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 1.2.(b).

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The reports provide workforce data by geographic location.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The Annual workforce report should provide Equivalent Personnel (EPs) by location, specifically on or near site (NASA center), and by state for workforce outside of the responsible NASA center area. The report shall include contract labor, subcontract labor, and purchased labor. The data should be reconcilable to other financial deliverables. The content and frequency of the supplemental workforce report may vary based on specific direction provided by NASA Headquarters to support congressional inquiries. It’s most common form is an annual request to provide workforce data by state, congressional district, or Zip Code.

13.4 **FORMAT**: Annual submissions: Electronic format per Section J-2 2.3.2.1. Supplemental Submissions: Specific formatting will be mutually agreed upon by the Contractor and NASA

13.5 **MAINTENANCE**: Supplemental Management Information Reports shall be submitted but should reconcile with the NF533.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-B-003
3. **DATA TYPE**: 3
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE:** Cost Performance Report

9. **DESCRIPTION/USE**:

This Data Requirements Description (DRD) contains the format and content preparation instructions for the data product generated by the specific and discrete task requirement as delineated in the contract. This report consists of two major sections.

a. The three required cost reporting formats contain data for measuring contractors' cost and schedule performance on the NASA Crew Exploration Vehicle (CEV) acquisition contract. Format 1 provides data to measure cost and schedule performance by product-oriented Work Breakdown Structure (WBS) elements, the hardware, software, and services the Government is buying. Format 3 provides the budget baseline plan against which performance is measured. Format 5 is a narrative report used to explain significant cost and schedule variances and other identified contract problems and topics. CPR data shall be used by NASA project management to: (1) integrate cost and schedule performance data with technical performance measures, (2) identify the magnitude and impact of actual and potential problem areas causing significant cost and schedule variances, and (3) provide valid, timely project status information to higher management. The CPR is a management report. It provides timely, reliable summary-level data with which to assess current and projected contract performance. The CPR's primary value to NASA is its ability to reflect current contract performance measurement status and reasonably project future contract performance. It is important that the CPR be as accurate as possible so it may be used for its intended purpose, which is to facilitate informed, timely decisions. It will be used by the NASA component staff, including project and program managers, engineers, cost estimators, and financial management personnel, to confirm, quantify, and track known or emerging contract problems and serve as a basis for communicating with the contractor. The CPR data shall accurately reflect how work is being planned, performed, and measured and shall be consistent with the actual contract status.

b. The CPR shall be used to obtain cost and schedule performance information. Refer to the Federal Acquisition Regulation (FAR) or Federal Acquisition Regulation Supplement clause on contract. The CPR data elements shall reflect the output of the contractor's integrated management system which shall be complaint with the American National Standards Institute/Electronic Industries Alliance Standard 748 (ANSI/EIA-748), Earned Value Management Systems (EVMS) (current version in effect at time of contract award)

c.3 Significant variances require problem analysis. The thresholds for significant variances are:

	Cum-to-Date	Current Month	At Completion
Schedule Variance	+/-1% and +/-$1.0M	+/-10% and +/-$300K	
Cost Variance	+/-1% and +/-$1.0M	+/-10% and +/-$300K	+/ -$8M

8. **DISTRIBUTION**: As determined by the Contracting Officer

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix.

11. **REMARKS**:

The Cost Performance Report shall be available for online viewing at any time during the effort by NASA using appropriately protected Internet/Intranet technologies.

The CPR shall be submitted monthly by the 15th working day of the month following the month being reported.

The time increments to be used in Format 3 will correspond (within the limits of the Contractor’s disclosed fiscal calendar) with the government fiscal year.

CPR reporting shall reflect costs at WBS Level 3 with the exception of Spacecraft, which shall be reported at Level 5.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 1.2.(d), Referenced in SOW Paragraph: 2.4

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Cost Performance Report (CPR) includes data to measure cost and schedule performance.

13.2 **APPLICABLE DOCUMENTS**:
ANSI/EIA-748-98: Earned Value Management Systems

13.3 **CONTENTS**:

13.3.9. Content. The CPR shall contain the following:

13.3.9.1. Heading Information - Formats 1, 3 and 5. Preparation instructions for Heading Information (Blocks 1 through 4) apply to Formats 1, 3 and 5.

13.3.9.1.1. Contractor. Enter in Block 1.a the Contractor's name and division (if applicable). Enter in Block 1.b the facility location and mailing address of the reporting contractor.

13.3.9.1.2. Contract. Enter the contract name in Block 2.a, the contract number (and the applicable Contract Line Item Number(s) (CLINs)) in Block 2.b, the contract type in Block 2.c, and the contract share ratio (if applicable) in Block 2.d.

13.3.9.1.3. Project. Enter in Block 3.a the project name, number, acronym, type, model, and series, or other designation of the prime item(s) purchased under the contract. Indicate the project phase (development, production, etc.) in Block 3.b. Indicate whether the Contractor’s EVMS has been accepted by NASA and the date of the acceptance.

13.3.9.1.4. Report Period. Enter the beginning date in Block 4.a and the ending date in Block 4.b of the period covered by the report.

13.3.9.1.5. Security Classification. Enter the appropriate security classification at the top and bottom of each page.

13.3.9.1.6. Dollars in _ (to be filled in by Offeror)____. If reported dollar amounts are in thousands, millions, or billions, enter the factor at the top of each page.

13.3.9.2.Format 1 - Work Breakdown Structure. Submission of Format 1 using a product-oriented WBS is mandatory and shall be in accordance with the Center WBS standard. If there are deviations, a mapping shall be provided.

13.3.9.2.1. Contract Data.

13.3.9.2.1.1. Quantity. Enter in Block 5.a the number of principal items to be procured on this contract.

13.3.9.2.1.2.Negotiated Cost. Enter in Block 5.b the dollar value (excluding fee or profit) on which contractual agreement has been reached as of the cutoff date of the report. For an incentive contract, enter the definitized contract target cost. Amounts for changes shall not be included in this item until they have been priced and incorporated in the contract through contract change order or supplemental agreement. For a cost plus fixed fee, award fee, or incentive fee contract, enter the estimated cost negotiated. Changes to the estimated cost shall consist only of estimated amounts for changes in the contract scope of work, not for cost growth ('overrun') above the original estimated cost.

13.3.9.2.1.3.Estimated Cost of Authorized, Unpriced Work. Enter in Block 5.c the amount (excluding fee or profit) estimated for that work for which written authorization has been received, but for which definitized contract prices have not been incorporated in the contract through contract change order or supplemental agreement.

13.3.9.2.1.4. Target Profit/Fee. Enter in Block 5.d the fee or percentage of profit that shall apply if the negotiated cost of the contract is met. (See 13.3.9.2.1.2 above.)

13.3.9.2.1.5. Target Price. Enter in Block 5.e the target price (negotiated contract cost plus profit/fee) applicable to the definitized contract effort.

13.3.9.2.1.6. Estimated Price. Based on the most likely estimate of cost at completion for all authorized contract work and the appropriate profit/fee, incentive, and cost sharing provisions, enter in Block 5.f the estimated final contract price (total estimated cost to the Government). This number shall be based on the most likely management EAC in Block 6.c.1 and normally will change whenever the management estimate or the contract is revised.

13.3.9.2.1.7. Contract Ceiling. Enter in Block 5.g the contract ceiling price applicable to the definitized effort.

13.3.9.2.1.8. Estimated Contract Ceiling. Enter in Block 5.h the estimated ceiling price applicable to all authorized contract effort including both definitized and undefinitized effort.

13.3.9.2.1.9. Over Target Baseline/Over Target Schedule. Enter in Block 5.i the date the last over target baseline or over target schedule was implemented (if applicable).

13.3.9.2.2. Estimated Cost at Completion. These blocks shall present the Contractor's range of estimated costs at completion. The range of estimates is intended to allow contractor management flexibility to express possible cost outcomes. Contractors shall provide the most accurate Estimates at Completion (EACs) possible through project-level assessments of factors that may affect the cost, schedule, or technical outcome of the contract. Such project-level assessments shall include consideration of known or anticipated risk areas, and planned risk reductions or cost containment measures. EACs shall be reported without regard to contract ceiling.

13.3.9.2.2.1. Management Estimate at Completion - Best Case. Enter in Block 6.a.1 the Contractor's best case EAC. The best case estimate is the one that results in the lowest cost to NASA. This estimate shall be based on the outcome of the most favorable set of circumstances. If this estimate is different from the most likely EAC (Block 6.c.1), the assumptions, conditions, and methodology underlying this estimate shall be explained briefly in Format 5. This estimate is for informational purposes only; it is not an official company estimate. There is no requirement for the Contractor to prepare and maintain backup data beyond the explanation provided in Format 5.

13.3.9.2.2.2. Management Estimate at Completion - Worst Case. Enter in Block 6.b.1 the Contractor's worst case EAC. The worst case estimate is the one that results in the highest cost to NASA. This estimate shall be based on the outcome of the least favorable set of circumstances. If this estimate is different from the most likely EAC (Block 6.c.1), the assumptions, conditions, and methodology underlying this estimate shall be explained briefly in Format 5. This estimate is for informational purposes only; it is not an official company estimate. There is no requirement for the Contractor to prepare and maintain backup data beyond the explanation provided in Format 5.

13.3.9.2.2.3. Management Estimate at Completion - Most Likely. Enter in Block 6.c.1 the Contractor's most likely EAC. This estimate is the contractor's official contract EAC and, as such, takes precedence over the estimates presented in Column (15) of Formats 1 and 2 and Blocks 6.a.1 and 6.b.1. This EAC is the value that the Contractor's management believes is the most likely outcome based on a knowledgeable estimate of all authorized work, known risks, and probable future conditions. This value need not agree with the total of Column (15) (Block 8.e). However, any difference shall be explained in Format 5 in such terms as risk, use of Management Reserve (MR), or higher management knowledge of current or future contract conditions. The assumptions, conditions, and methodology underlying this estimate shall be explained briefly in Format 5. This EAC need not agree with EACs contained in the Contractor's internal data, but must be reconcilable to them. The most likely EAC shall also be reconcilable to the Contractor's latest statement of funds required as reported in the CFSR, or its equivalent.

13.3.9.2.2.4. Contract Budget Base. Enter in Block 6.c.2 the total of negotiated cost (Block 5.b) and estimated cost of authorized, unpriced work (Block 5.c).

13.3.9.2.2.5. Variance. Enter in Block 6.c.3 the contract Budget Base (Block 6.c.2) minus the most likely estimate at complete (Block 6.c.1). This value shall be explained in Format 5 according to applicable contractual requirements.

13.3.9.2.3. Authorized Contractor Representative. Enter in Block 7.a the name of the authorized person (project manager or higher level designee) signing the report. Enter that person's title in Block 7.b. The authorized person shall sign in Block 7.c. Enter the date signed in Block 7.d. Electronic signatures are encouraged.

13.3.9.2.4. Performance Data.

13.3.9.2.4.1. Column (1) -Work Breakdown Structure Element. Enter in Column (1) of Block 8.a the noun description of the CWBS items for which cost information is being reported. CWBS elements and levels reported shall be those specified in the contract. (See d.1 above.)

13.3.9.2.4.2. Cost of Money. Enter in Columns (2) through (16) of Block 8.b the Facilities Capital Cost of Money applicable to the contract.

13.3.9.2.4.3. General and Administrative. Enter in Columns (2) through (16) of Block 8.c the appropriate General and Administrative (G&A) costs. If G&A has been included in the total costs reported in Block 8.a above, G&A shall be shown as a non-add entry on this line with an appropriate notation. However, if these contracts require CCDRs, the Contractor must report costs without G&A for CWBS elements reported in Block 8.a if the Government requests such information on an exception basis. If a G&A classification is not used, no entry shall be made other than an appropriate notation to that effect.

13.3.9.2.4.4. Undistributed Budget (UB). Enter the amount of budget applicable to contract effort that has not yet been identified to CWBS elements at or below the reporting level. For example, if contract changes were authorized late in the reporting period, they should have received a total budget; however, assignment of work and allocation of budgets to individual CWBS elements may not have been accomplished as of the Contractor’s accounting period cutoff date. Budgets that can be identified to CWBS elements at or below the specified reporting level shall be included in the total budgets shown for the CWBS elements in Block 8.a and shall not be shown as UB. Enter in Column (15) of Block 8.d the EAC for the scope of work represented by the UB in Column (14) of Block 8.d. Enter in Column (16) of Block 8.d the variance, if any, and fully explain it in Format 5. The reason(s) for UB shall be fully explained in Format 5.

13.3.9.2.4.4.1.Use of Undistributed Budget. UB is used to accommodate temporary situations where time constraints prevent adequate budget planning or where contract effort can only be defined in very general terms. UB shall not be used as a substitute for adequate contract planning. Formal budgets shall be allocated to contract effort and responsible organizations at the earliest possible time, preferably within the next reporting period.

13.3.9.2.4.5. Subtotal (Performance Measurement Baseline). In Columns (2) through (16) of Blocks 8.a through 8.e, enter the sum of the costs and budgets for direct, indirect, cost of money, and G&A. This subtotal represents the dollars in the allocated budget (less MR), which is the Performance Measurement Baseline (PMB) against which performance is measured.

13.3.9.2.4.6. Management Reserve (MR). MR is an amount of the overall contract budget withheld for management control purposes and is held for project unknowns (realized risks on authorized work scope). Reserve is held for future needs and shall not be used to offset cumulative cost variances. It shall not be eliminated from contract prices by the Government during subsequent negotiations nor used to absorb the cost of contract changes. In Column (14) of Block 8.f enter the total amount of budget identified as MR as of the end of the current reporting period. The amounts shown as MR in Formats 1, 2, and 3 should agree. Amounts of MR applied to CWBS elements during the reporting period shall be listed in Block 6.b of Format 3 and explained in Format 5.

13.3.9.2.4.6.1. Negative Management Reserve. Negative entries shall not be made in Management Reserve (Column (14) of Block 8.f). There is no such thing as ' negative MR.' If the contract is budgeted in excess of the Contract Budget Base (the negotiated contract cost plus the estimated cost for authorized, unpriced work), the provisions applicable to formal reprogramming and the instructions in paragraphs 13.3.9.2.5.1, 13.3.9.2.6.6., 13.3.9.2.6.7., and 13.3.9.4.1.7 apply.

13.3.9.2.4.7. Total. Enter the sum of all direct, indirect, cost of money, and G&A costs, and UB and MR (if applicable) in Columns (2) through (14) of Block 8.g. The Total lines of Format 1 (Block 8.g) and Format 2 (Block 5.g) should agree. The total of Column (14), Block 8.g, should equal the Total Allocated Budget shown in Block 5.f on Format 3.

13.3.9.2.5. Reconciliation to Contract Budget Base.

13.3.9.2.5.1. Formal Reprogramming. In exceptional cases, the Contractor, with the approval of the Government, may establish performance measurement budgets that exceed the Contract Budget Base. This process is called formal reprogramming. The Contractor and the Government shall agree on how the results of a formal reprogramming will be reported in the CPR before the formal reprogramming is initiated. This agreement and any other pertinent details on the reporting of the formal reprogramming shall be included in Format 5. Blocks 9.a and 9.b are used to reconcile the higher performance measurement budgets, also called an 'Over Target Baseline,' to the Contract Budget Base. (See13.3.9.2.6.6.,, 13.3.9.2.6.7., 13.3.9.4.1.7. and 13.3.9.6.5 below for more information on reporting Over Target Baselines (Formal Reprogramming).)

13.3.9.2.5.2. Variance Adjustment. In a formal reprogramming (Over Target Baseline), the Contractor may: (1) apply the additional budget to completed work, thereby eliminating some or all of the existing cost or schedule variances, (2) apply the additional budget to remaining work, (3) apply some of the additional budget to completed work and some to remaining work, and/or (4) apply some of the additional budget to MR. If the Contractor uses a portion of the additional budget to eliminate variances applicable to completed work, the total adjustments made to the cost and schedule variances shall be shown in Columns (10) and (11) of Block 9.a. The total cost variance adjustment entered in Column (11) of Block 9.a should be the sum of the individual cost variance adjustments shown in Column (12) of Block 8.g.

13.3.9.2.5.3. Total Contract Variance. In Columns (10) and (11) of Block 9.b, enter the sum of the cost and schedule variances shown on the Total line (Block 8.g) and on the Variance Adjustment line (Block 9.a). In Column (14) enter the Contract Budget Base from Block 6.c.2. In Column (15) enter the management EAC from Block 6.c.1. In Column (16) of Block 9.b enter the difference between Columns (14) and (15) of Block 9.b.

13.3.9.2.6. Columns (2) Through (16). Since compliance with the ANSI/EIA-748 (current version in effect at time of contract award) is contractually required, the data in Columns (2) through (16) shall reflect the output of the contractor's ANSI/EIA-748 compliant integrated management system.

13.3.9.2.6.1. Column (2) and Column (7) - Budgeted Cost - Work Scheduled. For the time period indicated, enter the Budgeted Cost for Work Scheduled (BCWS) in these columns.

13.3.9.2.6.2. Column (3) and Column (8) - Budgeted Cost - Work Performed. For the time period indicated, enter the Budgeted Cost for Work Performed (BCWP) in these columns.

13.3.9.2.6.3. Column (4) and Column (9) - Actual Cost - Work Performed. For the time period indicated, enter the Actual Cost of Work Performed (ACWP) without regard to ceiling. In all cases, costs and budgets shall be reported on a comparable basis.

13.3.9.2.6.4. Column (5) and Column (10) - Variance – Schedule (i.e., accomplishment). For the time period indicated, these columns reflect the differences between BCWS and BCWP. For the current period column, Column (5) (schedule variance) is derived by subtracting Column (2) (BCWS) from Column (3) (BCWP). For the cumulative to date column, Column (10) (schedule variance) is derived by subtracting Column (7) (BCWS) from Column (8) (BCWP). A positive number in Column (5) and Column (10) indicates a favorable variance. A negative number (indicated by parentheses) indicates an unfavorable variance. Significant variances as specified in the contract shall be fully explained in Format 5. If the contract does not specify variance analysis thresholds, the Contractor shall provide appropriate variance analyses.

13.3.9.2.6.5. Column (6) and Column (11) - Variance - Cost. For the time period indicated, these columns reflect the difference between BCWP and ACWP. For the current period column, Column (6) (cost variance) is derived by subtracting Column (4) (ACWP) from Column (3) (BCWP). For the cumulative to date column, Column (11) (cost variance) is derived by subtracting Column (9) (ACWP) from Column (8) (BCWP). A positive value indicates a favorable variance. A negative value (indicated by parentheses) indicates an unfavorable variance. Significant variances as specified in the contract shall be fully explained in Format 5. Since the contract does not specify variance analysis thresholds, the contractor shall provide appropriate variance analyses.

13.3.9.2.6.6. Column (12a) and Column (12b) Reprogramming Adjustments - Cost Variance and Schedule Variance. Formal reprogramming (Over Target Baseline) results in budget allocations in excess of the Contract Budget Base and, in some instances, adjustments to previously reported variances. If previously reported variances are being adjusted, the adjustment applicable to each reporting line item affected shall be entered in Column (12a) if for a cost variance and Column (12b) if for a schedule variance. The total of Column (12a) and Column (12b) should equal the amount shown on the Variance Adjustment line (Block 9.a) in Column (10) and Column (11).

13.3.9.2.6.7. Column (13) Reprogramming Adjustments - Budget. Enter the total amounts added to the budget for each reporting line item as the result of formal reprogramming (Over Target Baseline). The amounts shown shall consist of the sum of the budgets used to adjust cost variances

(Column (12)) plus the additional budget added to the CWBS element for remaining work. Enter the amount of budget added to MR in the space provided on the Management Reserve line (Block 8.f of Column (13)). The total of Column (13) should equal the budget amount by which the Total Allocated Budget exceeds the Contract Budget Base as shown in Block 5.g of Format 3. An explanation of the reprogramming shall be provided in Format 5.

13.3.9.2.6.7.1. Formal Reprogramming Reporting. Columns (12) and (13) are intended for use only in situations involving formal reprogramming (Over Target Baseline). Internal replanning actions within the Contract Budget Base do not require entries in these columns. Where contractors are submitting CPR data directly from automated systems, the addition of Columns (12) and (13) as shown may not be practical due to computer reprogramming problems or space limitations. In such cases, the information shall be provided in Format 5. Contractors shall not be required to abandon or modify existing automated reporting systems to include Columns (12) and (13) if significant costs will be associated with such change. Nor shall contractors be required to prepare the report manually solely to include this information.

13.3.9.2.6.7.2. Formal Reprogramming Timeliness. Formal reprogramming (Over Target Baseline) can be a significant undertaking that may require more than a month to implement. To preclude a disruption of management visibility caused by a reporting hiatus, formal reprogramming shall be implemented expeditiously. If a reporting hiatus is needed, the Contractor and the Government shall agree on the date and duration of the hiatus before the formal reprogramming is initiated.

13.3.9.2.6.8.Column (14) - At Completion - Budgeted. Enter the budgeted cost at completion for the items listed in Column (1). This entry shall consist of the sum of the original budgets plus or minus budget changes resulting from contract changes, internal replanning, and application of MR. The total (Block 8.g) should equal the Total Allocated Budget shown in Block 5.f on Format 3.

13.3.9.2.6.9. Column (15) - At Completion - Estimated. Enter the latest revised estimate of cost at completion including estimated overrun/underrun for all authorized work. If the subtotal (Block 8.e) does not agree with the most likely management EAC (Block 6.c.1), the difference shall be explained in Format 5.

13.3.9.2.6.10. Column (16) - At Completion - Variance. Enter the difference between the Budgeted - At Completion (Column (14)) and the Estimated - At Completion (Column (15)) by subtracting Column (15) from Column (14). A negative value (indicated by parentheses) reflects an unfavorable variance. Significant variances as specified in the contract shall be fully explained in Format 5. If the contract does not specify variance analysis thresholds, the contractor shall provide appropriate variance analyses.

13.3.9.4. Format 3 - Baseline.

13.3.9.4.1. Contract Data.

13.3.9.4.1.1. Original Negotiated Cost. Enter in Block 5.a the dollar value (excluding fee or profit) negotiated in the original contract. For a cost plus fixed fee, incentive, or award fee contract, enter the estimated cost negotiated. For an incentive contract, enter the definitized contract target cost.

13.3.9.4.1.2. Negotiated Contract Changes. Enter in Block 5.b the cumulative cost (excluding fee or profit) applicable to definitized contract changes that have occurred since the beginning of the contract.

13.3.9.4.1.3. Current Negotiated Cost. Enter in Block 5.c the sum of Blocks 5.a and 5.b. The amount shown should equal the current dollar value (excluding fee or profit) on which contractual agreement has been reached and should be the same as the amount in Negotiated Cost (Block 5.b) on Format 1.

13.3.9.4.1.4. Estimated Cost of Authorized, Unpriced Work. Enter in Block 5.d the estimated cost (excluding fee or profit) for contract changes for which authorization has been received from the contracting officer, but for which contract prices have not been incorporated in the contract, as shown in Block 5.c of Format 1.

13.3.9.4.1.5. Contract Budget Base. Enter in Block 5.e the sum of Blocks 5.c and 5.d.

13.3.9.4.1.6. Total Allocated Budget. Enter in Block 5.f the sum of all budgets allocated to the performance of the contractual effort. The amount shown shall include all MR and UB. This amount should be the same as that shown on the Total line in Column (14) on Format 1 (Block 8.g) and Format 2 (Block 5.g).

13.3.9.4.1.7. Difference. Enter in Block 5.g the difference between Blocks 5.e and 5.f. In most cases, the amounts shown in Blocks 5.e and 5.f will be identical. If the amount shown in Block 5.f exceeds that shown in Block 5.e, it usually is an indication of a formal reprogramming (Over Target Baseline). The difference shall be explained in Format 5 at the time the negative value appears and subsequently for any changes in the difference between Contract Budget Base and the Total Allocated Budget.

13.3.9.4.1.8. Contract Start Date. Enter in Block 5.h the date the Contractor was authorized to start work on the contract, regardless of the date of contract definitization. (Note: Long-lead procurement efforts authorized under prior contracts are not to be considered.)

13.3.9.4.1.9. Contract Definitization Date. Enter in Block 5.i the date the contract was definitized.

13.3.9.4.1.10. Planned Completion Date. Enter in Block 5.j the completion date to which the budgets allocated in the PMB have been planned. This date represents the planned completion of all significant effort on the contract. The cost associated with the schedule from which this date is taken is the Total Allocated Budget (Block 5.f of Format 3).

13.3.9.4.1.10.1. Performance Measurement Schedule Inconsistent With Contractual Schedule. In exceptional cases, the Contractor may determine that the existing contract schedule cannot be achieved and no longer represents a reasonable basis for management control. With Government approval, the contractor may rephase its performance measurement schedule to new dates that exceed the contractual milestones, a condition known as 'Over Target Schedule.' These new dates are for performance measurement purposes only and do not represent an agreement to modify the contract terms and conditions.

13.3.9.4.1.10.2. Over Target Schedule Agreement. The Government and the Contractor shall agree on the new performance measurement schedule prior to reporting it in the CPR. The Contractor shall provide pertinent information in Format 5 on any schedule milestones that are inconsistent with contractual milestones, beginning the month the schedule is implemented and each month thereafter.

13.3.9.4.1.10.3. Indicators of a Performance Measurement Schedule Inconsistent With the Contractual Schedule. Formal reprogramming or internal replanning may result in performance measurement milestones that are inconsistent with the contractual milestones (Over Target Schedule). A difference between the planned completion date (Block 5.j) and the contract completion date (Block 5.k) usually indicates that some or all of the performance measurement milestones are inconsistent with the contractual milestones.

13.3.9.4.1.11. Contract Completion Date. Enter in Block 5.k the contract scheduled completion date in accordance with the latest contract modification. The cost associated with the schedule from which this date is taken is the Contract Budget Base (Block 5.e of Format 3).

13.3.9.4.1.12. Estimated Completion Date. Enter in Block 5.l the Contractor's latest revised estimated completion date. This date represents the estimated completion of all significant effort on the contract. The cost associated with the schedule from which this date is taken is the 'most likely' management EAC (Block 6.c.1 of Format 1).

13.3.9.4.2. Performance Data.

13.3.9.4.2.1. Column (1) -Performance Measurement Baseline (Beginning of Period). Enter in Block 6.a the time-phased PMB (including G&A) that existed at the beginning of the current reporting period. Most of the entries on this line (e.g., for Columns (4) through (9)) are taken directly from the PMB (End of Period) line on the previous report. For example, the number in Column (4) on the PMB (End of Period) line from the last report becomes the number in Column (3) on the PMB (Beginning of Period) line on this report. The number in Column (5) (End of Period) last report becomes Column (4) (Beginning of Period) on this report, etc. (if each of the two columns covers the same length of time).

13.3.9.4.2.2. Baseline Changes. In Block 6.b, list all significant baseline changes that have occurred during the reporting period. This listing shall include the contract changes and supplemental agreements authorized during the reporting period, allocations from MR and UB, and any significant rephasing of budgets. All significant authorized baseline changes shall be listed whether priced or unpriced.

13.3.9.4.2.3. Performance Measurement Baseline (End of Period). Enter in Block 6.c the time-phased PMB as it exists at the end of the reporting period. The difference between this line and the PMB (Beginning of Period) represents the effects of all significant changes, including the authorized changes, allocations of MR made during the period, and changes to time phasing due to internal replanning or formal reprogramming. The reasons for these changes shall be explained in Format 5.

13.3.9.4.2.4. Management Reserve. Enter in Block 7 the total amount of MR remaining as of the end of the reporting period. This value should agree with the amounts shown as MR in Format 1.

13.3.9.4.2.5. Total. Enter in Column (16) of Block 8 the sum of Column (16) of Block 6.c (PMB (End of Period)) and Column (16) of Block 7 (Management Reserve). This amount should be the same as that shown on the Total line (Block 8.g) in Column (14) on Format 1.

13.3.9.4.3. Column (2) - BCWS - Cumulative To Date. On the PMB (Beginning of Period) line (Block 6.a), enter the cumulative BCWS as of the first day of the reporting period. This should be the same number reported as BCWS -Cumulative To Date on the Total line (Column (7) of Block 8.g) of Format 1 of the previous CPR. On the PMB (End of Period) line (Block 6.c), enter the cumulative BCWS as of the last day of the reporting period. This should be the same number reported as BCWS - Cumulative to Date on the Total line (Column (7) of Block 8.g) of Format 1 for this CPR.

13.3.9.4.4. Column (3) - BCWS For Report Period. On the PMB (Beginning of Period) line (Block 6.a), enter the BCWS planned for the reporting period. This should be the number in Column (4) on the PMB (End of Period) line (Block 6.c) on the previous CPR.

13.3.9.4.5. Columns (4) Through (14). Enter the names of each month for the contract period of performance in the headings of each of the Columns (4) through (9), and the names of the appropriate periods in the headings of each of the Columns (10) through (14) of Block 6. Columns beyond (14) may be added when necessary or desirable. In the PMB (Beginning of Period) line (Block 6.a), enter the BCWS projection reported in Format 3 of the previous CPR as PMB (End of Period) (Block 6.c). In the PMB (End of Period) line (Block 6.c) of this report, enter the projected BCWS by month for the next six months and for periodic increments (monthly, quarterly, or annually) thereafter for the remainder of the contract. The time phasing of each item listed in Column (1) of Block 6.b need not be shown in Columns (4) through (14). It is useful to show the time phasing of any baseline changes. (Note: For the purposes of illustration, Sample Format 3 has Columns (4) through (14) for reporting BCWS. The actual number of columns will vary from contract to contract.)

13.3.9.4.6. Column (15) - Undistributed Budget. On the PMB (Beginning of Period) line (Block 6.a), enter the number from Column (15) on the PMB (End of Period) line (Block 6.c) from the previous CPR. On the PMB (End of Period) line, enter the UB shown in Column (14) of Block 8.d on Format 1 of this report.

13.3.9.4.7. Column (16) - Total Budget. On the PMB (Beginning of Period) line (Block 6.a) enter the number from Column (16) on the PMB (End of Period) line (Block 6.c) from the previous CPR. In the section where baseline changes that occurred during the period are listed (Column (1) of Block 6.b), enter the amount of each of the changes listed. On the PMB (End of Period) line (Block 6.c), enter the sum of the amounts in the preceding columns on this line. On the Management Reserve line (Block 7), enter the amount of MR available at the end of the period. On the Total line (Block 8) enter the sum of the amounts in this column on the PMB (End of Period) line and the Management Reserve line. (Note: This should equal the amount in Block 5.f on this format and also the amount of the Total line in Column (14), Block 8.g, of Format 1.)

13.3.9.6. Format 5 - Explanations and Problem Analyses.

13.3.9.6.1. General. Format 5, Explanations and Problem Analyses, is a narrative report prepared to amplify and explain data in the other CPR formats. Format 5 shall normally address the following: (1) contractually required cost, schedule, and EAC variance analyses, (2) MR changes and usage, (3) UB contents, (4) differences between the best case, worst case, and most likely management EAC, if any, (5) the difference between the most likely management EAC and the estimate in Block 8.e of Column (15), if any, (6) significant differences between beginning of period PMB time phasing and end of period PMB time phasing in Format 3, (7) performance measurement milestones that are inconsistent with contractual milestones (Over Target Schedule), and (8) formal reprogramming (Over Target Baseline) implementation details. Any other topic relevant to contract cost, schedule, or technical performance may be addressed in this format. The date(s) of the Integrated Baseline Review(s) may also be addressed in this format. Contractors may elect to attach subcontractor Format 5 reporting and cross reference this analysis in the Format 5 reporting submitted to the Government to gain time efficiencies and meet submission dates.

13.3.9.6.2. Total Contract. Provide a summary analysis that identifies significant problems affecting performance. Indicate corrective actions required, including Government action where applicable. Significant changes since the previous report shall be highlighted. Discuss any other issues affecting successful attainment of contract cost, schedule, or technical objectives that the Contractor deems significant or noteworthy. This section is brief, normally one page.

13.3.9.6.3. Cost and Schedule Variances. Explain all variances that exceed specified variance thresholds. Explanations of variances shall clearly identify the nature of the problem, significant reasons for cost or schedule variance, effect on the immediate task, impact on the total contract, and the corrective action taken or planned. Explanations of cost variances shall identify amounts attributable to rate changes separately from amounts applicable to hours worked; amounts attributable to material price changes separately from amounts applicable to material usage; and amounts attributable to overhead rate changes separately from amounts applicable to overhead base changes or changes in the overhead allocation basis. To reduce the volume of variance analysis explanations, the Contractor may refer to a prior CPR's variance analysis explanations if the explanation for the current CPR's variance has not changed significantly. The contractor shall classify and document all variances as either ‘risk-driven cost & schedule growth’ or ‘externally-driven cost & schedule growth’ (see below for definitions) in Format 5 as source information for the CADRe. The source of this information shall be at the Control Account level, however, the consolidation and customer reporting can be done at higher levels within the performing organization ‘Risk-Driven Cost & Schedule Growth’ (RDCG & RDSG) is that cost and schedule growth caused by overruns and funded or unfunded changes, linked to technical risks. ‘Externally-Driven Cost & Schedule Growth’ (EDCG & EDSG) is that cost and schedule growth caused by overruns and funded or unfunded changes, linked to external factors (e.g., requirements changes, technical enhancements not driven by risk, perturbations to budgets by external agents causing schedule changes, etc.) over which the contractor has little, if any, control. (NOTE: The EDCG & EDSG drivers shall be specifically identified in variance analysis reporting). Explanations of schedule variances and the impact on the contract shall be performed in parallel with the schedule analysis called out by the IMS DID.

13.3.9.6.3.1. Setting Variance Analysis Thresholds. In Format 5, the Government will require only that amount of variance analysis that satisfies its management information needs. Excessive variance analysis is burdensome and costly, and detracts from the CPR's usefulness, while too little information is equally undesirable.

13.3.9.6.4. Other Analyses. In addition to variance explanations, the following analyses are mandatory:

13.3.9.6.4.1. Management Estimate at Completion. If the best or worst case management EACs differ from the most likely estimate (Column (1) of Block 6 of Format 1), a brief explanation of the difference shall be provided. Also, if the most likely management EAC differs from the total entered in Column (15) of Format 1, the difference shall be explained. The explanations shall focus on such areas as a knowledgeable, realistic risk assessment; projected use of MR; estimate for UB; and higher management's knowledge of current or future contract conditions. The assumptions, conditions, and methodology underlying all management EACs shall be explained. (See 13.3.9.2.2 to 13.3.9.2.2.3., 13.3.9.2.2.5, 13.3.9.2.6.9, and 13.3.9.2.6.10 above.) The reasons for significant shifts in time phasing of the EAC shall also be explained.

13.3.9.6.4.2. Undistributed Budget. Identify the effort to which the UB applies. Also, explain any variance between the UB and the estimate for UB in Formats 1. (See 13.3.9.2.4.4)

13.3.9.6.4.3. Management Reserve Changes. Identify the sources and uses of MR changes during the reporting period. Identify the CWBS and organizational elements to which MR is applied, and the reasons for its application. (See 13.3.9.2.4.6. above.)

13.3.9.6.4.4. Baseline Changes. Explain reasons for significant shifts in time phasing of the PMB shown on Format 3. (See 13.3.9.4.2.3. above.)

13.3.9.6.4.5. Staffing Level Changes. Explain significant changes in the total staffing.

13.3.9.6.5. Formal Reprogramming (Over Target Baseline). If the difference shown in Block 5.g on Format 3 becomes a negative value or changes in value, provide information on the following:

13.3.9.6.5.1. Authorization. Procuring activity authorization for the baseline change that resulted in negative value or change.

13.3.9.6.5.2. Reason. A discussion of the reason(s) for the change.

13.3.9.6.5.3. CPR Reporting. A discussion of how the change affected CPR reporting (i.e., amount allocated to MR, adjustments to cost or schedule variances, etc.). (See 13.3.9.4.1.7., 13.3.9.2.5.1., and 13.3.9.2.6.7. above.)

13.3.9.6.5.4. Schedule. Indicate whether the contract schedule was retained for performance measurement or was replaced with a schedule that exceeds the contractual schedule (Over Target Schedule).

13.3.9.6.5.5. Over Target Schedule. If a performance measurement schedule exceeding the contractual schedule (Over Target Schedule) has been implemented, provide a discussion of the pertinent information, such as authorization, reasons, and significant dates. (See 13.3.9.4.1.10.1 above.)

13.4 **FORMAT**: CPR formats shall be completed according to the instructions outlined in this DRD:

Those CPR Forms are reproduced at the end of this document and can also be found in the Bidder's Reference Library. Contractor formats shall be substituted for CPR formats whenever they contain all the required data elements at the specified reporting levels in a form suitable for NASA management use.

13.5 **MAINTENANCE**: Changes shall be incorporated by complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-B-004
3. **DATA TYPE**: 3
4. **DATE REVISED**: May 2009
5. **PAGE**: 1
6. **TITLE**: Property Financial Reporting

7. **DESCRIPTION/USE**:
This DRD describes the monthly and annual property financial reports.

8. **DISTRIBUTION**: As determined by the Contracting Officer

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 1.2.(a).

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
This report provides an itemized financial reporting of Government property.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
Monthly Property Financial Reports
a. Monthly property financial reports are required with item level supporting data. This data shall be submitted for all items with an acquisition cost of $100,000 or more, in the contractor's and its subcontractors' possession, in the following classifications: real property, equipment, special test equipment, special tooling, and agency peculiar property. Monthly reporting is not required for property in the above classifications with an acquisition cost under $100,000. Monthly data shall also be submitted for items of any acquisition cost in the classifications of materials and contract work-in-process (WIP). Itemized monthly data is required for materials and WIP line items of $100,000 and over. Summary monthly data is required for materials and WIP line items under $100,000. The monthly reports shall be electronically submitted using the Contractor-Held Asset Tracking System (CHATS) (http://nasachats.gsfc.nasa.gov/) using the format described in the CHATS user's manual.
b. Acquisition costs shall be developed using actual costs to the greatest extent possible, especially costs directly related to fabrication such as labor and materials. Supporting documentation shall be maintained and available for all amounts reported, including any amounts developed using estimating techniques.
c. All Adjustments shall be thoroughly explained and directly related to a specific fiscal year. If the fiscal year cannot be determined, the default shall be the previous fiscal year.
d. Work Breakdown Structures (WBS) shall NOT be provided for all Contractor acquired property (CAP), WIP, and any new materials acquired.

Annual Property Financial Reports (NF 1018 Reports)
a. Contractors shall report all NASA-owned property in US dollars,

regardless of location.
b. Negative reports are required.
c. This reporting shall be completed in accordance with the NASA FAR Supplement (NFS) Subpart 1845.7101 and any supplemental guidance provided by the Contracting Officer. This reporting via NASA Form (NF) 1018 shall be submitted electronically using the Electronic Submission System (NESS) (http://ness.gsfc.nasa.gov/).

13.4 **FORMAT**: The monthly reports shall be electronically submitted using the Contractor-Held Asset Tracking System (CHATS) (http://nasachats.gsfc.nasa.gov/) using the format described in the CHATS user's manual.

The annual reporting via NASA Form (NF) 1018 shall be submitted electronically using the Electronic Submission System (NESS) (http://ness.gsfc.nasa.gov/).

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

Keep CEV-D-001 as RESERVED

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-D-002
3. **DATA TYPE**: 2/3/5
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE:** Pad Abort-1 Flight Test Article (FTA) <Level> Specifications

7. **DESCRIPTION/USE**:

The FTA <Level> Specification DRD is utilized to address the flight test unique requirements for the developmental flight test articles and for flight test unique ground support equipment. The FTA <Level> Specification DRD documents the allocation of the:
- Flight Test Mission and Flight Objectives (CxP 72166) to the FTA System Requirements Specification.
- FTA System Level requirements to the FTA Module level & Contractor provided Ground Support Equipment (GSE) Module level requirements specification
- FTA & GSE module requirements to the FTA &GSE subsystem level
- FTA & GSE subsystem requirements to the hardware component and software CSCI level, and GSE End Item level

To specify the interface requirements between each module, between Contractor-provided GSE & FTA, between each subsystem, and between Computer Software Configuration Items (CSCIs). Also to specify requirements imposed upon or by manual operations, or other system components to achieve one or more interfaces among the modules, subsystems, and CSCIs. To be used in conjunction with the Software Requirements Specification as a basis for design and proto-qualification testing of software systems and CSCIs.

To provide documentation in the form of drawings and/or written records to identify for each side of an interface those necessary design definitions between one or more systems, modules, subsystems, computer software configuration items (CSCI's), manual operations, contractors and/or Government agencies to provide control of and ensure an agreeable and compatible interface. The Interface Control Document (ICD) provides the design solutions to the requirements found in the system specifications and/or the Interface Requirements Document (IRD); these companion documents serve to communicate and control interface design decisions.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

For PA-1 Contractor-provided FTA & GSE, all module, subsystem, hardware component-level and software CSCI-level, and end-item-level requirement documents have FTO-AFT-FTA-004, FTA SRD, as their parent document. A common format shall be used across the module, subsystem, hardware componentend item-level, and software CSCI-level requirements documents.

In naming each document, <Level> should be replaced with the appropriate name (e.g., FTA Crew Module Requirements Specification, etc.).

For PA-1, all module level and subsystem level are type 2 documents. All external interface and subsystem level interface documents are type 2 documents.

For PA-1, all hardware component-level, end item-level requirements and SRS documents are type 3 documents. All internal interface documents are type 3 documents.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 10.6.4.
Referenced from SOW Paragraph(s): 6.1.6.2, 6.2.6.2, 6.4.6.2, 6.5.2, 10.6.6.9.
Related DRD(s): CEV-T-031

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**: The FTA <Level> Specification DRD establishes the format and contents of the following requirements specifications:
- Contractor-provided FTA & GSE Module Requirements Specifications
- The subsequent Cotractor-provided subsystem, hardware component-level and software CSCI-level, and end item-level requirements specifications, including GSE components and CSCIs.

The Internal Interface Requirements Document (IRD) shall contain the interface requirements between each of the CEV modules, subsystems, and CSCI interfaces within the FTA & GSE. This specification also details provisions for qualification and requirements traceability. An IRD shall be produced for each CSCI that interfaces to another CSCI and for each CSCI that interfaces directly to a hardware component. The corresponding interface verification requirements for the IRDs will be contained in the applicable Interface Control Document (ICD).

The Interface Control Documents (ICD's) identify design definitions for each side of an interface that shall ensure design control and compatibility. An ICD may describe any number of software interfaces.

13.2 **APPLICABLE DOCUMENTS**:

Applicable Documents Per J3:
FTO-AFT-FTA-004, FTA SRD

FTO-AFT-OPS-001, Concept of Operations
FTO-AFT-FTA-001, FTA Environmental Requirements document
FTO-AFT-FTA-003, FTA Geometry and Mass Properties document

Meets/Exceeds Documents Per J3:
NPR 7150.2: NASA Software Engineering Requirements
Army Test and Evaluation Command (ATEC) Regulation 385-1, ATEC Safety Program
Department of the Army Pamphlet 385-64, Ammunition and Explosives Safety Standards
IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207; 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data.
RCC Standard 321-02, Common Risk Criteria for National Test Ranges
White Sands Missile Range Regulation 385-17, Missile Flight Safety

13.3 **CONTENTS**:

The FTA Systems Requirements Specification shall be the allocation of the "Mission and Flight Objectives" document, CxP 72166, to the Flight Test.

The FTA module requirements specifications shall decompose the FTA system functional, performance, and operational requirements to the module level. A FTA module is defined as a self-contained unit of a spacecraft that performs a specific task or class of tasks in support of the major function of the craft. For example, a FTA may be broken up into a crew module, a service module, etc.

The GSE module requirments specification shall decompose FTA System GSE functional, performance, and operational requirements to the GSE Subsystem level.

The FTA & GSE subsystem requirements specifications shall decompose the FTA & GSE module functional, performance, constraints and design requirements to define the design and architecture of the total subsystem, including software.

The FTA component & GSE end item requirements specifications shall contain the decomposition of the requirements from the FTA & GSE subsystem level through the lowest level of the decomposition. This specification will document the allocated functional, performance, constraints and design requirements for the FTA & GSE subsystem to the component/end item-level. For the purposes of this DRD, 'component' will be used to describe each level of the decomposition below the subsystem level as defined by the Contractor. The decomposition of the subsystem is continued until a procurement or build-to specification has been developed. A component is defined as an aggregate of hardware and/or software that can be characterized by one specification, is designed by a single activity to be functionally tested, and is verified as a unit.

The Software Requiremetns Specification (SRS) details the software functional, performance, interface, operational, and quality assurance requirements. SRSs are produced for each CSCI. At the contractor's discretion, SRSs can be produced as a single document with a section for each CSCI.

Each document shall contain a section titled 'Verification'. For each requirement in the documents, there shall be a corresponding verification requirement. The document shall contain, in addition to the verification requirements, a verification traceability matrix that establishes the relationship between each requirement and its verification requirements, and contains the methods that will be used to accomplish the indicated verification actions.

The Internal Interface Requirements Document (IRD) shall define all physical, functional and procedural interface requirements to ensure system, hardware, GSE, and software compatibility. The IRDs shall include the following:

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

b. Functional - Interfaces involving the interaction or influence of conditions imposed by one subsystem or component upon another or by external sources such as fluids, thermal, electrical, environmental, data, and loads.

c. Procedural - Interfaces involving critical sequence of events occurring in assembly, disassembly, alignment, service operations, and computer programs.

For software, using IEEE/EIA 12207.1-1997 as Meets/Exceeds, IRD shall include:

d. Requirements imposed on one or more modules, subsystems, configuration items, manual operations or other system components to achieve one or more software interfaces among these entities.

1. Interface identification and diagrams.
2. Project-unique identifier of interface.
3. Precedence and criticality of requirements.

e. Proto-qualification provisions.

f. Requirements traceability.

The Interface Control Document (ICD) shall document the physical, functional, and procedural interface design. The ICD shall provide the descriptive text and diagrams to fully describe the interface implementation. The ICD shall address all of the engineering disciplines associated with the interface design. The ICD shall identify all applicable workmanship and applicable standards being utilized as part of the interface design. The ICD shall provide traceability from the Interface Requirements Document (IRD) to document design compliance with the requirements.

The ICD shall address the following class of interfaces:
(a) Physical - Interfaces involving physical mating and spatial relationships between interconnecting parts of interfacing end items, including clearance envelopes established to avoid interferences and to permit access.
(b) Functional - Interfaces involving the interaction or influence of conditions imposed by one subsystem or component upon another or by external sources such as fluids, thermal, electrical, environmental, data, and loads.
(c) Procedural - Interfaces involving critical sequence of events occurring in assembly, disassembly, alignment, service operations, and computer programs.

For software, in accordance with NPR 7150.2 NASA Software Engineering Requirements (class C & D definitions & requirements, only), and using IEEE/EIA 12207.1-1997 as Meets/Exceeds, the ICD shall include:
(d) Priority assigned to the interface by the interfacing entity(ies).
(e) Type of interface (e.g., real-time data transfer, storage-and-retrieval of data) to be implemented.
(f) 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, receive.
(g) 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.
(h) Specification of communication methods that the interfacing entity(ies) will use for the interface.
(i) Specification of protocols the interfacing entity(ies) will use for the interface.
(j) Other specifications, such as physical compatibility of the interfacing entity(ies).
(k) 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.
(l) Interface compatibility, e.g., little endian vs. big endian.

13.4 **FORMAT**: Documents shall be electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

D-003 Consolidated with D-002 and T-031.

Keep D-003 as RESERVED

RESERVED

Keep D-004 as RESERVED

KEEP CEV-D-005 AS RESERVED

KEEP CEV-D-006 AS RESERVED

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DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-D-007
3. **DATA TYPE**: 2
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Orbital Flight Test FTA <Level> Specification

1. **DESCRIPTION/USE**:

The Orbital Flight Test spcecification documents a brief desciption of the Orbital Flight Test operational concept, a subset of the Block 0 requirements, the Orbital Flight Test unique requirements, and a subset of tailored Block 0 requirements to verify the Orbital Flight Test system as derived from the flight test objectives, mission critical events, Test Like You Fly exceptions, and program risk to support Mission Success.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

No component specifications or software requirements specifications will be delivered for Orbital Flight Test.

Orbital Flight Test components common to Block 0 will be designed to the Block 0 requirements.

The Orbital Flight Test Specification does not fall under the CEV-T-031 or the CEV-D-002 DRD description.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 10.6.4.6.1
Related DRDs: CEV-D-008 (Orbital Flight Test FTA Verification Plan)

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:

The Orbital Flight Test specification establishes the content for the system, module, subsystem, GSE, and interface requirements for Orbital Flight Test.

13.2 **APPLICABLE DOCUMENTS**:

Applicable Documents per J3:
CxP 72465, Project Orion Flight Test One and Ascent Abort 2 Flight Test Objectives

13.3 **CONTENTS**:

The Orbital Flight Test Specification includes:

1. A description of the Orbital Flight Test operational concept
2. Applicable Block 0 requirements as described below
3. Orbital Flight Test Unique Interface and functional/performance requirements as described below

4. Tailored Block 0 requirements as described below

The Orbital Flight Test specification shall include a brief description of the Orbital Flight Test operational concept. The description of the operational concept provides a foundation for the remaining content requirements.

The Orbital Flight Test specification shall define the requirements down to the subsystem level (system, module, subsystem, GSE, and interface requirements)and shall document a subset of the Block 0 requirements needed to verify the Orbital Flight Test system in support of flight test objectives, mission critical events, Test Like You Fly exceptions, and program risk to ensure Mission Success.

The Orbital Flight Test specification shall include requirements on the unique interfaces to Orbital Flight Test as well as unique functional/performance requirements. This includes, but is not limited to, launch vehicle, mission control, ground operations, assembly/integration/testing at the launch site, and development flight instrumentation.

The Orbital Flight Test requirements shall include any tailored Block 0 requirements to align the Orbital Flight Test requirements with the Orbital Flight Test mission. In addition, the Block 0 applicable documents will drive certain Orbital Flight Test requirements to be created. In the event that the Block 0 applicable documents are tailored to support Orbital Flight Test, the Orbital Flight Test specification will provide actual tailored language or pointers to the artifacts that contain the actual tailored language.

The Orbital Flight Test specification shall include the traceability between the Orbital Flight Test requirements and the Flight Test Objectives as defined in CxP 72465.

The Orbital Flight Test specification shall include the functional, performance, and operational requirements to support the Orbital Flight Test mission.

This document shall contain a section titled 'Verification'. For each requirement in the documents, there shall be one or more verification methods identified. The document shall contain a definition of each verification method that identifies the general verification approach, and is consistent with identification of the verification methods used in the Orbital Flight Test Verification Plan, D-008. The document shall also contain a verification traceability matrix that establishes the relationship between each requirement and the verification methods that will be used to accomplish the indicated verification actions.

13.4 **FORMAT**: Documents shall be electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-D-008
3. **DATA TYPE**: 2
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Orbital Flight Test FTA Verification Plan

7. **DESCRIPTION/USE**:
The Verification Plan documents the verification planning and implementation activities that will provide evidence that the Orbital Flight Test System meets the identified Orbital Flight Test requirements.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
The Orion Master Verification Plan, Vol 1, DRD CEV-T-015 should be utilized as the overall parent document for guidance and relevant content with specificity to verifying the Orbital Flight Test Vehicle requirements.
Information Documents per J3:
CXP-72097: Crew Exploration Vehicle Master Verification Plan

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.1.7.
Referenced from SOW Paragraph(s): 6.1.4, 6.2, 6.2.1, 6.2.6, 6.2.7
Related DRD(s):CEV-D-007 (Orbital Flight Test Spec)

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Orbital Flight Test VP shall discuss all disciplines and activities required for the verification of Orbital Flight Test flight test article hardware, software, and associated GSE. The Orbital Flight Test VP provides a thorough description of the approach and structure for implementing the verification program, as well as detailed descriptions of the planned verification activities for each Orbital Flight Test Specification requirement.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
This plan shall define the verification planning and implementation activities that provide evidence that the Orbital Flight Test system was verified to meet Orbital Flight Test performance requirements. Orbital Flight Test testing shall be planned as part of an integrated program; i.e., test plans for an individual element shall be tailored to that element’s operational requirements. This plan shall be subject to NASA approval and be configuration controlled in accordance with DRD CEV-M-003, Configuration Management Plan and Reports.

The Orbital Flight Test VP shall define the verification and certification process for the design, functional, interface and specialty engineering requirements relative to the Orbital Flight Test system.

The Orbital Flight Test VP shall include verification success criteria that are specific to Orbital Flight Test performance and operational parameters. These verification success criteria will be satisfied using the methods of test, analysis, inspection or demonstration for compliance.

In addition to demonstration, analysis and inspection, the Orbital Flight Test VP shall address all necessary types of testing required to verify the complete Orbital Flight Test Vehicle and supporting system architecture.

The Orbital Flight Test VP shall include:

1. Overview of the Orbital Flight Test verification program.
2. Description of the Project's organizational structure for implementing the verification program, including the organizations involved in component vs. system tests, review and signoff authority for compliance data.
3. Verification matrix that clearly documents the verification method or methods employed for each Orbital Flight Test requirement. For each major test (i.e. formal verification, acceptance article, etc.), a test plan shall be available for review. Test objectives shall be planned to verify compliance with specified Orbital Flight Test requirements, including interfaces.
4. For each verification activity identified in the verification matrix:
   (a) A detailed description of the activity
   (b) The verification configuration and its relationship to the flight configuration
   (c) The associated prerequisites, constraints, objectives, procedures, relevant environmental conditions, pass/fail criteria, and analysis models, if applicable.
   (d) Verification success criteria individually defined considering function, complexity, redundancy, design, maturity and maintenance requirements.
5. Acceptance tests ground-rules that assure Acceptance Test Procedures (ATPs) will demonstrate conformance to specification requirements and provide quality control assurance against workmanship or material deficiencies.
6. Ground-rules assuring proto or qualification test (or demonstration) hardware and software test articles shall be of the same configuration and manufacturer, and be manufactured under the same production processes as the flight hardware and software, unless variances are approved formally by the contractors and NASA and adequately documented according to the test article supplier's established configuration management procedures.
7. Definition of the retest groundrules during the acceptance phase when any of the following occurs:
   (a) A previously mated and verified interface has been de-mated
   (b) Modification, repair, replacement, or rework occurs after inspection or testing
   (c) The article or material is subject to drift or degradation during storage or handling
   (d) Software changes occur that affect requirements or flight software capabilities.

   Based on the results of the analyses, re-verification type and scope shall be subject to government review.
8. Functional compliance matrix that identifies all safety-critical functions and provides detailed descriptions of the associated verification methods(s) for each safety-critical function including the verification configuration and its relationship

to the flight configuration, as well as the associated prerequisites, constraints, objectives, procedures, relevant environmental conditions, pass/fail criteria, and analysis models, if applicable.

9. Detailed time-correlated sequence of verification activities that enables critical path management.
10. Description, planned usage, and certification plans of the support equipment, software, facilities, and tools necessary to execute the system verification activities.
11. Identification of the resources required to perform the required verification activities as well as resource owners and/or providers. These resources (e.g., facilities, software, simulators) include those that do not currently exist or existing resources that need to be upgraded.
12. Certification plans for ground systems (reference SOW section 9).
13. A detailed description of the verification closure process.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Appendices, if utilized, require re-delivery only when changed.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-D-009
3. **DATA TYPE**: 3
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Orion Exploration Flight Test 1 (EFT-1) Flight Test Article (FTA) Post Test Data Results and Report

7. **DESCRIPTION/USE**:
Provides quick-look/summary data and detailed reporting with respect to post-flight analysis of the EFT-1 flight test.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Quick-Look report and Flight Data due within 14 days following the EFT-1 launch. Final report due within 90 days after EFT-1 launch.

10. **SUBMISSION FREQUENCY**: N/A

11. **REMARKS**: Supporting Analyses – Analyses and similar products which are prepared by the contractor as required to understand or properly make use of the flight data, the final report, or remedial actions resulting from the flight, shall be "made available" to NASA via the electronic Windchill "Tech Baseline" folders.

12. **INTERRELATIONSHIP**: Parent SOW paragraph(s): Annex 4 of Attachment J-1, Statement of Work. Related SOW paragraph(s): 10.6.8

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:

13.2 **APPLICABLE DOCUMENTS**: ‘
Applicable Documents per J3:
CxP 72465, Project Orion Flight Test One and Ascent Abort 2 Flight Test Objectives

13.3 **CONTENTS**:

1. Quick-look report – Presentation accompanied by verbal briefing, to address initial observations and near-term action required with respect to the major spacecraft functional areas (e.g., environments, loads, aerosciences, structure, mechanisms, GNC, avionics/power/software, propulsion, thermal control) and flight test objectives.
2. Final report - Presentation accompanied by verbal briefing, to address detailed performance as well as subsequent action required with respect to the major spacecraft functional areas (e.g., environments, loads, aerosciences, structure, mechanisms, GNC, avionics/power/software, propulsion, thermal control) and flight test objectives. Additionally, report shall address other significant areas as appropriate (e.g., design processes, manufacturing, procurement, AI&T, operations) and include conclusions from the flight test and recommendations based on the results.
3. Flight Data – All OFI system data (both as recorded on the ground and on-board) as well as all DFI system data shall be archived and

available to NASA via an appropriate electronic means. Ancillary data and unique tools needed to process raw flight data (e.g., calibration curves) shall also be available to NASA.

13.4 **FORMAT**: Contractor may divide into volumes/books and separate presentations if necessary. Electronic format requirements per Section J-2 2.3.2.1 shall be followed as well.

13.5 **MAINTENANCE**: None.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-D-010
3. **DATA TYPE**: 2
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Ascent Abort-2 (AA-2) FTA <Level> Specification

2. **DESCRIPTION/USE**:

The AA-2 Flight Test specification documents a brief desciption of the AA-2 Flight Test operational concept, a subset of the MPCV Systems Requirements Document (SRD), the AA-2 Flight Test unique requirements, and a subset of tailored MPCV SRD requirements to verify the AA-2 Flight Test system as derived from the flight test objectives, mission critical events, Test Like You Fly exceptions, and program risk to support Mission Success.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

No component specifications or software requirements specifications will be delivered for Orbital Flight Test.

AA-2 Flight Test components with common hardware design to EM1/EM2 will be designed to the MPCV SRD requirements.

The AA-2 Flight Test Specification does not fall under the CEV-T-031,the CEV-D-002, nor the CEV-D-007 DRD descriptions.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 10.6.4.6.1
Related DRDs: CEV-D-0011 (AA-2 Verification Plan)

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:

The AA-2 Flight Test specification establishes the content for the system, module, subsystem, GSE, and interface requirements for AA-2 Flight Test.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
CxP 72465, Project Orion Flight Test One and Ascent Abort 2 Flight Test Objectives

13.3 **CONTENTS**:

The AA-2 Flight Test Specification includes:
1. A description of the AA-2 Flight Test operational concept
2. Applicable MPCV SRD requirements as described below
3. AA-2 Flight Test Unique Interface and functional/performance requirements as described below

4. Tailored MPCV requirements as described below

The AA-2 Flight Test specification shall include a brief description of the AA-2 Flight Test operational concept. The description of the operational concept provides a foundation for the remaining content requirements.

The AA-2 Flight Test specification shall define the requirements down to the subsystem level (system, module, subsystem, GSE, and interface requirements)and shall document a subset of the MPCV SRD requirements needed to verify the AA-2 Flight Test system in support of flight test objectives, mission critical events, Test Like You Fly exceptions, and program risk to ensure Mission Success.

The AA-2 Flight Test specification shall include requirements on the unique interfaces to AA-2 Flight Test as well as unique functional/performance requirements. This includes, but is not limited to, launch vehicle, mission control, ground operations, assembly/integration/testing at the launch site, and development flight instrumentation.

The AA-2 Flight Test requirements shall include any tailored SRD requirements to align the AA-2 Flight Test requirements with the AA-2 Flight Test mission. In addition, the EM1/EM2 applicable documents will drive certain AA-2 Flight Test requirements to be created. In the event that the EM1/EM2 applicable documents are tailored to support AA-2 Flight Test, the AA-2 Flight Test specification will provide actual tailored language or pointers to the artifacts that contain the actual tailored language.

The AA-2 Flight Test specification shall include the traceability between the AA-2 Flight Test requirements and the Flight Test Objectives as defined in CxP 72465.

The AA-2 Flight Test specification shall include the functional, performance, and operational requirements to support the AA-2 Flight Test mission.

This document shall contain a section titled 'Verification'. For each requirement in the documents, there shall be one or more verification methods identified. The document shall contain a definition of each verification method that identifies the general verification approach. The document shall also contain a verification traceability matrix that establishes the relationship between each requirement and the verification methods that will be used to accomplish the indicated verification actions.

13.4 **FORMAT**: Documents shall be electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-D-011
3. **DATA TYPE**: 2
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Orion Ascent Abort-2 (AA-2) Flight Test Article (FTA) Post Test Data Results and Report

7. **DESCRIPTION/USE**:
Provides quick-look/summary data and detailed reporting with respect to post-flight analysis of the AA-2 flight test.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Quick-Look report and Flight Data due within 14 days following the AA-2 launch. Final report due within 90 days after AA-2 launch.

10. **SUBMISSION FREQUENCY**: N/A

11. **REMARKS**: Supporting Analyses – Analyses and similar products which are prepared by the contractor as required to understand or properly make use of the flight data, the final report, or remedial actions resulting from the flight, shall be "made available" to NASA via the electronic Windchill "Tech Baseline" folders.

12. **INTERRELATIONSHIP**: Parent SOW paragraph(s): Annex 4 of Attachment J-1, Statement of Work. Related SOW paragraph(s): 10.6.8

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
CxP 72465, Project Orion Flight Test One and Ascent Abort 2 Flight Test Objectives

13.3 **CONTENTS**:

1. Quick-look report – Presentation accompanied by verbal briefing, to address initial observations and near-term action required with respect to the major spacecraft functional areas (e.g., environments, loads, aerosciences, structure, mechanisms, GNC, avionics/power/software, propulsion, thermal control) and flight test objectives.

2. Final report - Presentation accompanied by verbal briefing, to address detailed performance as well as subsequent action required with respect to the major spacecraft functional areas (e.g., environments, loads, aerosciences, structure, mechanisms, GNC, avionics/power/software, propulsion, and thermal control) and flight test objectives. Additionally, report shall address other significant areas as appropriate (e.g., design processes, manufacturing, procurement, AI&T, operations) and include conclusions from the flight test and recommendations based on the results.

3. Flight Data – All OFI system data (both as recorded on the ground and on-board) as well as all DFI system data shall be archived and available to NASA via an appropriate electronic means. Ancillary data and unique tools needed to process raw flight data (e.g., calibration curves) shall also be available to NASA.

13.4 **FORMAT**: Contractor may divide into volumes/books and separate presentations if necessary. Electronic format requirements per Section J-2 2.3.2.1 shall be followed as well.

13.5 **MAINTENANCE**: None.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-M-001
3. **DATA TYPE**: 3
4. **DATE REVISED**: 12/11/2006
5. **PAGE**: 1
6. **TITLE**: CEV Prime Project Management Plan

7. **DESCRIPTION/USE**:

The CEV Prime Project Management Plan will describe the scope of the project and the implementation approach, including the systems and processes, to provide overall coordination of management activities under this contract. It describes the structure and environment within which the project operates.

The CEV Prime Project Management Plan will also be used to integrate these activities into the broader NASA operational plans which utilize other government agencies and contractors. It will be used to identify Contractor management office and systems engineering structure for use by NASA personnel to identify reporting structures, to assist in evaluating performance measurement baseline status, and to ensure appropriate S&MA participation.

8. **DISTRIBUTION**: As determined by the Contracting Officer

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

Informational Documents per J3:
MPCV-72008: Orion MPCV Program Plan

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 1.1.a., 2.6, 2.8
Referenced from SOW Paragraph(s): 1.1.c, 2.3.(a)

13. **DATA PREPARATION INFORMATION**:

13.1 **<u>SCOPE</u>**:

The Contractor shall provide information giving NASA insight into staffing, organizational structure, management approaches, and processes used across the entire CEV Project.

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

Applicable Documents per J3:
MPCV-72000: Multi-Purpose Crew Vehicle (MPCV) Systems Requirements Document

13.3 **<u>CONTENTS</u>**:

The plan shall be in consonance with the SOW. The plan shall cover all aspects of project management for the Contractor CEV Project including, but not be limited to, the following:
(a) Narrative and graphical descriptions of the management, technical, and business approaches used to accomplish and monitor contractual tasks, as well as the methods the contractor will employ to provide government

insight, data accessibility, and/or deliverables.
(b) Interfaces between the Contractor, NASA centers, and other contractors or entities that are necessary and pertinent to the accomplishment of contractural tasks.
(c) Including such things as data, analyses, equipment, and software deliverables, schedules, interfaces, and other technical/managerial interactions.
(d) Risk methodology and assessment of risks inherent in the management, technical, and business approaches including the process for incorporating lessons learned from previous applicable projects/programs.
(e) Narrative description of the contractor's management approach to defining processes, plans and procedures for project control and systems engineering including such items as logistics and integration of government furnished equipment/data and services.
(f) Narrative description of the contractor's acquisition strategy, including make/buy decisions and rationale.
(g) Planned reporting to NASA of performance to plan in preparation for major milestone reviews and regularly scheduled reviews.
(h) Narrative description of contractor controls applicable to any tasks and activities exceeding established cost or schedule plans, including requirements for providing recovery plans.
(i) Narrative description of the contractor's proposed scope and approach implementing cooperative relationships with associate contractors.
(j) Discuss your approach to data rights and intellectual property (IP) while minimizing the cost to the Government. Address what patents, copyrights, trademarks, and trade secrets will be delivered to the Government and the cost of such data/IP. Identify any limited data rights or restricted computer software issues, especially in the context of what the various corporate team members will provide. Explain how licensing agreements will be negotiated with vendors and how that data/IP will be treated, specifically identifying any requested special license agreements.
(k) Also as part of the Project Management Plan, the Contractor shall develop and implement a plan that periodically streamlines the CEV Project with the objectives of continually improving the efficiency and effectiveness of the project operation and of accelerating the schedule. The intent of this plan is to periodically examine the project processes, procedures and organization and identify improvements that provide greater responsiveness, and reduced schedule and cost. Some examples of items to be addressed include:

- Maximum use of Contractor-based documentation and processes
- Maximum use of IT resources to increase the productivity of each team member
- Ensuring a very close Contractor/NASA working relationship for all team members, especially including the NASA contracting officer (CO) and contracting officer technical representative (COTR)
- Reviewing the project documentation/deliverables to reflect the latest changes in the project and modify the data requirements list accordingly
- A documented minimum content for each project data requirement descripton (DRD)
- A documented minimum amount of reporting and statusing to NASA project, Agency and external forums.
- A minimum set of requirements in the MPCV-72000, Multi-Purpose Crew Vehicle (MPCV) Systems Requirements Document.
- A minimum set of project-wide metrics necessary to capture the progress and early identification of issues and problems. Update the metrics reported based on the life cycle phase and/or project management direction.
- An aggressive effort to minimize requirements changes/additions over the life of the project.
- Improving the change order review, approval and implementation

process for those changes deemed mandatory.

- A rapid but well-documented hardware and software modification process
- Measures to streamline overall project management, drawing on 'lessons learned' from small, efficient project teams.
- Innovative teaming arrangements that results in a lower cost to the government.
- New procedures that result in faster and better design, coordination and communication with no adverse affects on performance.
- Expertise of the team
- Collocation of the team

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor proposed changes to document format shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-M-002
3. **DATA TYPE**: 1/4*
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Performance Assessment Plan and Reports

7. **DESCRIPTION/USE**:
The Performance Assessment Plan provides the overall contract performance measurement approach. The initial submittal will be used in developing the Surveillance Plan.

The Performance Assessment Reports are a key component of performance assessments.

8. **DISTRIBUTION**: As determined by the Contracting Officer

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
NASA Data Management will send notification to the following:
Financial Office
Assessment Office
Contracting Officer
Contracting Officer's Technical Representative (COTR)
* Plan is Type 1, Reports are Type 4,
Note: All software performance measures will be reported in the Software Metrics Report, CEV-T-049.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 1.1.b
Referenced from SOW Paragraph: 1.2.(d)

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Performance Assessment Plan shall describe the Contractor's overall approach to contract performance assessment and the implementation process for accomplishing metric evaluation and reporting.

The Performance Assessment Reports shall provide a self-assessment.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
MPCV-72000: Multi-Purpose Crew Vehicle (MPCV) Systems Requirements Document
NPR 9501.2D: NASA Contractor Financial Management Reporting

13.3 **CONTENTS**:
The Performance Assessment Plan shall consist of the following:
(a) Description of the Contractor's approach and rationale for assessing performance, including reporting on the status of 'should' requirements in MPCV-72000, Multi-Purpose Crew Vehicle (MPCV) Systems Requirements Documentand the SOW.

(b) Description of the methods the Contractor plans to use to assess performance, systems used, reporting mechanisms, and how the data will be used to improve future performance and adjust to changing requirements.
(c) Description of management systems and processes used to implement the plan including the developing, timely gathering, compiling, maintaining, auditing, analyzing, reporting, and providing management review of performance metrics.
(d) Description of the performance metrics including references to SOW paragraphs.
(e) Description of the Technical Performance Parameters (TPPs) selected by the Contractor, and approved by NASA, for monitoring during the design and development. Examples of TPPs are margins for mass properties, power allocation, volume, CPU utilization, bandwidth/throughput.

The metric description shall consist of at least the following for each metric:
(a) Definition and description of the metric
(b) Graphical representation
(c) Algorithm (if calculated)
(d) Assessment criteria for expected (standard) performance and excellent performance

The Performance Assessment Reports for metrics shall consist of the following:
(a) Contractor's summary assessment ('metric score card') for all metrics
(b) Status of all Technical Performance Parameters and their margin growth/loss and forecast
(c) Metrics as described in the plan updated to reflect actual performance and quality during the period
(d) Narrative performance assessment by month for each metric
(e) Historical performance data
(f) Index of any changes to metrics since the last period
(g) Recommended action (i.e.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes shall be submitted to NASA for approval. Complete re-issue of the documents are required. The Performance Assessment Plan, including metrics, shall be reviewed annually and updated as required. Metrics shall be evaluated, updated and reported on a monthly basis on the web.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-M-003
3. **DATA TYPE**: 2/3
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Configuration and Data Management Plan and Reports

7. **DESCRIPTION/USE**:
To describe the Contractor's method for accomplishing the configuration management requirements of the contract. This will assure that a process will be used to appropriately and accurately define the configuration baselines of the contractor-provided products. To describe the Contractor's plan for implementation of the data management requirements for the CEV Project. This will assure the Contractor's understanding of the process necessary to capture non-CM data relating to the project.

8. **DISTRIBUTION**: As Determined by the Contracting Officer

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
Configuration and Data Management Plan is Type 2
Configuration Management Reports are Type 3

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 1.3.(a) and 1.3(b).
Related DRD(s): CEV-T-006

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Configuration and Data Management Plan (CDMP) provides the Contractor's approach for implementation of configuration management in accordance with the SOW. The Contractor may combine this DR with the DRD CEV-T-006 Software Configuration Management Plan. If the Contractor chooses to combine the documents, the Contractor shall meet the requirements of both DRs.

13.2 **APPLICABLE DOCUMENTS**:
Meets/Exceeds Documents per J3:
NASA-STD-0005 NASA Configuration Management Standards

13.3 **CONTENTS**:
The Configuration and Data Management Plan shall define the scope and depth of the Contractor's efforts including management, organization, planning, and the relationship of the configuration management program to the Contractor's other administrative and technical organizations. The plan shall specify the Contractor's management policies and identify, by specific reference, standard practices and detailed work instructions to be used in implementing the configuration management program. The CDMP shall provide the information defined in MIL-HDBK-61A. The plan shall include a preliminary data submittal schedule for fulfilling submission of data in the specific quantities, media, and due dates required. It will also discuss how the Contractor shall verify and validate their CM system through an internal audit process. The plan shall describe how the Contractor implements configuration management using their interface to the Exploration Systems Mission Directorate (ESMD) Integrated

Collaborative Environment (ICE).

The Contractor shall use the ESMD Integrated Collaborative Environment (ICE) as defined in Attachment J-14 to implement the change flow process and to maintain the official project baseline files. The Contractor shall provide access to the native CM systems and data.

The plan shall also include the following elements related to Data Management:
(1) Data identification
(2) Data control
(3) Data status accounting
(4) Data management verification and audits
(5) Data management organization
(6) Data storage and retrieval procedures
(7) Subcontractor procedures
(8) Special restrictions
(9) Data management of Make Available Data, including the contrators plan to organize this data in the contractor's collaborative environment at the DRD Level.

The Reports shall define the baseline of the delivered products capturing the 'as required,' 'as designed,' 'as tested,' 'as built' and 'as delivered' with a record of approved and implemented changes to the baseline. The reports shall contain references to change authorization and implementation documents.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

KEEP CEV-M-004 AS RESERVED

KEEP CEV-M-005 AS RESERVED

KEEP DRD CEV-M-006 AS RESERVED

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-O-001
3. **DATA TYPE**: 3
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Contractor's CEV Concept of Operations

7. **DESCRIPTION/USE**:
This document describes the contractor-recommended life cycle operations concepts for the entire CEV System. It provides an integration mechanism with the CEV design process to assure operational needs and attributes are appropriately implemented in the design. While the CONOPS does not represent explicit design-to requirements, it is expected that the CONOPS will be reflected in the allocated requirements baseline derived using the CONOPS as a source.

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

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.7.1.
Referenced from SOW Paragraph(s): 2.7.2.(e)

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Contractor's CEV Concept of Operations describes operations for the entire CEV System from delivery of the spacecraft to the launch site, through pre-launch processing, pre-mission flight design and planning, launch, flight , re-entry, landing, and disposal and/or refurbishment for a future flight. It addresses operations from the flight crew, ground operations, and flight operations perspectives.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
MPCV-72000: Multi-Purpose Crew Vehicle (MPCV) Systems Requirements Document

Meets/Exceeds Documents per J3:
ANSI/AIAA G043-1992: Guidance for Preparation of Operational Concept Documents

13.3 **CONTENTS**:
This plan consists of the CEV Contractor plan and recommendations for CEV operations including Contractor Support to Operations

Contractor CEV Concept of Operations
The Contractor CEV CONOPS shall provide guidance to the CEV System developers on how the CEV System is to be used, operated, and maintained in a given environment so that their designs, development, integration, and tests will accommodate CEV goals, missions, and operational philosophy. The document shall describe the contractor's concept of the 'what, where, when, who, why, and how' of CEV System operations from

delivery to KSC through disposal of assets.

The Contractor CEV CONOPS shall address the following:
(a) Description of operations concept. This includes scenarios from CEV spacecraft delivery to the launch site, through pre-launch processing, pre-mission flight design and planning, launch, flight, re-entry, landing, and disposal and/or refurbishment for a future flight.
(b) Fundamental spacecraft capabilities.
(c) Description of the operational environment.
(d) Operations constraints due to spacecraft design. Including, but not limited to, attitude constraints, consumables (prop and non-prop), thermal constraints, power constraints, processing constraints, and facility constraints.
(e) Roles and Responsibilities of the Flight Crew, Ground Operations, and Flight Operations. Include description of automation.
(f) Nominal, off-nominal, and emergency operational scenarios in narrative and graphical form.
(g) Provide evidence that the Contractor's specifications and design support the concepts and provide the supporting rationale for any deviations.
(h) Identify and provide supporting rationale for the CEV spacecraft limiting factors (e.g. systems' performance, consumables, etc.) for each DRM and across all DRMs.
(i) Description of CEV System integration with Exploration flight and ground systems.

13.4 **FORMAT**: The CONOPS shall be narrative and delivered in electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be incorporated by complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-O-002
3. **DATA TYPE**: 2
4. **DATE REVISED**: 12/20/2005
5. **PAGE**: 1
6. **TITLE**: Flight Hardware/Software Operations and Maintenance Requirements Development Plan and Requirements Document

7. **DESCRIPTION/USE**:
To define the process for developing the operations and maintenance requirements, and the delivery of those requirements.

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

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.7.2.
Referenced from SOW Paragraph(s): 2.7.2.(b)
Related DRD(s): CEV-T-011

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Flight Hardware/Software Operations and Maintenance Requirement Development Plan describes the Contractor’s approach to develop requirements necessary for the development of safe and effective operational procedures.

The Flight Hardware/Software Operations and Maintenance Requirements Document defines the requirements for the CEV ground operations.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The Flight Hardware/Software Operations and Maintenance Requirements Development Plan shall contain the Contractor’s approach and processes for developing the operations and maintenance requirements.

The Flight Hardware/Software Operations and Maintenance Requirements Document shall contain the requirements necessary to develop NASA ground processing, launch, and post-landing operations procedures for the CEV. Requirements shall include limited-life, time and cycle limits, expected operational limits (e.g., temperature, pressure, humidity, voltage, current, preventive maintenance), and storage requirements. Each requirement shall include technical rationale, derivation of operational limits and tolerances, and, if reusable, the fair wear and tear criteria.

The Flight Hardware/Software Operations and Maintenance Requirements Development Plan and the Flight Hardware/Software Operations and Maintenance Requirements Document shall include detail at a level commensurate with the state of the system design at the time of document delivery.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be incorporated by complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-O-003
3. **DATA TYPE**: 3
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Launch Site Support Requirements Documentation

7. **DESCRIPTION/USE**:
This document shall be used to coordinate the identified resources to enable the hardware developer and ground operations to complete the necessary work on the flight hardware during pre-launch and post-launch operations. Support requirements include shared services and facilities provided by KSC, Cape Canaveral Air Force Station (CCAFS), and the landing and recovery site.

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

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.7.2.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
Provides the launch site support requirements needed by the hardware developer and ground operations personnel for work to be done at either KSC or CCAFS.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The Launch Site Support Requirements Documentation shall identify the operations resources (e.g., commodities, office space, special flight hardware access requirements, telephones, fax machines) required by the CEV Contractor to process the CEV System at KSC/CCAFS.

The Launch Site Support Requirements Documentation shall identify the operations resources required by the flight vehicle during ground operations and landing and recovery operations.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be incorporated by complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-O-004
3. **DATA TYPE**: 2
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: CEV Operations Data Book

7. **DESCRIPTION/USE**:
The CEV Operations Data Book (ODB) is the single authoritative source of properly validated data which most accurately and completely describes the CEV operational performance capabilities and limitations. This document will be used by the project, engineering, ground operations, flight operations, training, and rescue teams as a vehicle operating guide for ground operations planning, crew activities planning, flight attitude planning, trajectory design, center of gravity management, consumables management, systems analysis, procedures development, flight rules development, flight techniques, training curriculum development, crew recovery & rescue, and stowage planning.

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

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.7.3.(a).

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The CEV ODB provides design and performance information pertaining to spacecraft flight capability envelopes for all subsystems as well as integrated spacecraft performance. This document provides flight vehicle operating limitations and constraints, launch escape capabilities, system and vehicle performance data, vehicle capability envelopes, off-nominal analytical information, hardware/software integrated functionality, crew recovery and rescue information, and cargo limitations.

This data will be kept current and will be based on the highest level of data qualification available at the time of publication (i.e., specification, estimation, studies, analyses, simulations, ground tests, flight tests, and flight operations). Due to the need for the standardization of CEV source data, the ODB shall be used as the standard operational database for all mission design and planning, simulations, studies, and analyses.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The CEV ODB will be delivered in these Volumes:

I. CEV Spacecraft Systems Performance and Constraints Data
II. CEV Spacecraft Systems Electrical Equipment List
III. CEV Mission Mass Properties Data
IV. CEV Spacecraft Systems Contingency Analysis Data
V. CEV Aerodynamic and Astrodynamic Performance and Constraints Data

VI. CEV Crew Module Landing and Emergency Rescue Data
VII. CEV Flight Capability Envelopes
VIII. CEV Ascent, Orbit, and Entry Structural Envelopes

The content to be included in each volume shall be coordinated with the NASA subsystem managers to ensure the CEV ODB contains the appropriate level of detailed information to meet the users' needs.

The specific content of each volume is:

1. Volume I: CEV Spacecraft Systems Performance and Constraints Data

(a) Vehicle system configurations and coordinate systems.
This data shall include pictorial representations of the CEV showing coordinate systems, locations, axes, dimensions, separation planes, etc.

(b) Constraints and operational limitations.
This data shall include CEV spacecraft operational hardware and software constraints and limitations and the corresponding result if a limit is exceeded or a constraint is violated.
(Constraints are defined as those methods of operation or procedures for operation imposed upon hardware components/systems, which if violated, may affect crew safety, result in performance degradation, or affect mission timelines. Limitations are defined as those measurable or detectable operational limits, which if exceeded, will affect crew safety or result in performance degradation.)

(c) Operational performance and operational data.
This information shall include a supporting discussion for the CEV spacecraft constraints and operational limitations. It also contains descriptions of the fundamental performance of CEV spacecraft systems's and subsystems's components. Typically, fundamental data is used for Systems Analysis and for computer modeling and simulation. Consequently, data is defined at a basic level and the user is responsible for properly utilizing the data for evaluation purposes.
(This section typically includes CEV spacecraft system descriptions; functional block diagrams; subsystem block diagrams; subsystem characteristics; simplified logic control schematics; operational mode descriptions; safe mode operation; command processing; command memory dumps; fault detection, isolation, and recovery (FDIR) triggers; integrated vehicle health management (IVHM) information; system alerts; operational ranges of critical parameters; and mass, volume, and capacity properties for consumables and other storage).

2. Volume II: CEV Spacecraft Systems Electrical Equipment List

The Electrical Equipment List (EEL) shall describe the CEV spacecraft electrical equipment, its power usage, quality of the data, electrical bus identification, cooling code, circuit protection, panel switch or circuit breaker, procurement specification, and schematic drawing number and applicable notes. The content of this volume is divided into subsystems.

3. Volume III: CEV Mission Mass Properties Data

(a) CEV Body Referenced Coordinate System Definition:
This section shall define the requirement for the coordinate system that describes the locations of the centers of mass of CEV system components, and the orientations of body referenced vectors. Examples of body referenced vectors include axes of symmetry, rotational axes, thrust

vectors, lift vectors, sensor, instrument, and antenna pointing vectors, window normal vectors, etc. The coordinate system has three orthogonal axes and an origin that are fixed with respect to the CEV structure. The definition shall include engineering drawings and mathematical descriptions of the coordinate system. The engineering drawings provide views along the positive and negative orthogonal axes, and several oblique views to give a clear intuitive understanding of the relationship between the vehicle structure and the coordinate system. The mathematical description shall include transformation matrices between the body referenced system and other coordinate systems that will be used with the CEV. Examples of coordinate systems requiring transformation matrices include body-fixed coordinate systems defined by the axes of instrument pointing hardware, the navigational base coordinate system, if different from the body-centered system, and geocentric, heliocentric, or selenocentric inertial and rotating coordinate systems that are used in flight dynamics computations.

(b) CEV Mass Properties Data:
This requirement shall provide the total mass, center of mass, and moments and products of inertia of the CEV in several standard configurations. It shall also contain the individual masses and centers of mass of CEV system components for which masses may vary. Mass and center of mass data shall be given for a vehicle with dry consumables tanks, full consumables tanks, and for vehicle configurations in which externally mounted appendages, such as antennas, booms, or solar arrays, are in both the stowed and deployed positions. The data shall also include the centers of mass of storage volume compartments, and of crew positions occupied during powered flight and atmospheric entry. The mass properties data shall include the algorithm used to calculate total vehicle mass and center of mass, given the values for individual vehicle components, consumables masses, crew and crew equipment masses, and stowed cargo mass. Moments of inertia about the three orthogonal body axes, and products of inertia, shall be provided for each vehicle configuration. Moments and products of inertia are required for attitude dynamics computations, such as executing attitude maneuvers, or establishing a stable rotational rate about a body axis.

4. Volume IV: CEV Spacecraft Systems Contingency Analysis Data

This volume of the CEV ODB shall contain data that supplements Volume I data. This volume shall expand upon the data documented in Volume I to include failure signatures and off-nominal CEV spacecraft systems and subsystem operations. It also includes constraints associated with systems and subsystems operation under the described conditions. The data presented is for use in contingency situations or when systems and subsystems are operating in an off-nominal manner. This data is not required to have been verified by test; it will be derived primarily from analyses. The input data for these analyses, may be based on assumptions made from estimates, extrapolations, or best engineering judgment.

5. Volume V: CEV Aerodynamic and Astrodynamic Performance and Constraints Data

This volume of the CEV ODB shall contain the authoritative source for aerodynamic and flight performance characteristics data for the CEV and shall provide the astrodynamic values and associated uncertainties of the constants and models used in trajectory prediction. The required information is detailed below:

(a) Aerodynamic data.

The document shall provide a database of aerodynamic constants, parameters, and vehicle characteristics that are used for CEV atmospheric and orbital flight performance simulations, trajectory computations, vehicle development, and analyses. These data shall include a full technical description of CEV aerodynamic characteristics, including coefficients of lift and drag, cross sectional areas, and ballistic numbers for standard vehicle flight phases, configurations, and control modes. Configurations include nominal and contingency aerodynamic characteristics for atmospheric entry, on-orbit drag characteristics with and without booms, arrays, or antennas deployed, and aerodynamic characteristics following ascent aborts.

(b) Astrodynamic Constraints and Parameters
The document shall provide a database of astrodynamic constants and parameters that are used for CEV orbital and atmospheric flight performance simulations, trajectory computations, vehicle development, and analyses. These data shall include astrodynamic constants, and a full technical description of the reference ellipsoids, geopotential models, and gravitational perturbation models used for the Earth and the Moon. The data shall also include lunar and solar orbital perturbation models for vehicles in Earth orbit, and the seasonal atmospheres, solar flux models, and vehicle data used for modeling drag perturbations. The data shall include heliocentric-ecliptic orbital elements for the Earth, and geocentric-ecliptic and geocentric-equatorial orbital elements for the Moon at the J2000.0 standard epoch. The data shall include full technical descriptions, including transformation matrices, of the inertial and body-fixed rotating coordinate systems used in CEV astrodynamic computations.

6. Volume VI: CEV Crew Module Landing and Emergency Rescue Data

This volume shall be a source document of properly validated CEV Crew Module data to be used by qualified landing, splashdown, and rescue personnel for the development of training information. This document shall contain illustrations for training associated with the CEV Crew Module, including layouts of structures and systems of interest to landing, splashdown, and rescue personnel. This volume shall document hazards and safety precautions, flight crew apparel, seat restraints and emergency breathing systems; emergency egress and entry procedures, emergency powerdown procedures; and payload hazards.
A condensed, quick reference version of the above information shall be provided in a separate section for use in the field.

This document shall not replace specific crash/rescue/firefighting training directives and instructions issued by NASA, military and civil agencies.

7. Volume VII: CEV Flight Capability Envelopes

(a) Center of Mass Envelopes:
The document shall provide center of mass envelope data for the CEV. The center of mass envelope is a three dimensional volume within which the vehicle’s center of mass must be located to ensure dynamic stability and controllability. The center of mass envelope may have different boundaries in different flight phases. The boundaries of the center of mass envelope must be defined for powered flight guidance and control, coasting flight attitude control, atmospheric entry and landing guidance and control, and unguided ballistic entry. The boundaries of center of mass envelopes for nominal and contingency operations do not represent absolute stability and control limits, but include a margin of safety.

(b) Thermal Envelopes:
The document shall provide thermal envelope data for the CEV. Thermal envelopes define maximum peak temperatures, maximum heating rates, and lower temperature limits within which the vehicle may safely operate. Different thermal envelopes may apply to different parts of the vehicle and different flight phases. Thermal envelopes shall be defined for nominal ascent, entry following ascent abort, on-orbit operations, nominal entry, and contingency entry operations. Entry thermal envelopes shall be defined for entry from low Earth orbit, and direct entry from an inbound trans-lunar trajectory. All entry thermal envelopes shall include vehicle attitude limits (pitch, yaw, roll, bank) with respect to the velocity vector. On-orbit thermal limits shall include operational thermal envelopes for parts of the vehicle that may require attitude management for thermal control or conditioning. Thermal envelopes for nominal and contingency operations do not represent absolute thermal limits, but include a margin of safety.

(c) Translational Delta-V Capabilities:
The document shall provide translational delta-V capabilities data for the CEV. The translational delta-V capabilities define how much change in orbital velocity is attainable using the fully loaded CEV propulsion system. Delta-V capability is a function of vehicle mass, propellant load, specific impulse (Isp) of the propulsion system, and the gravitational acceleration of the central body. Capabilities shall be defined for operations in Low Earth Orbit (LEO), trans-lunar space, and lunar orbit. Delta-V capability must equal the greatest total mission delta-V required of the vehicle plus a margin of safety. The nominal performance envelopes (thrusts - maximum and minimum if throttle-able, maximum burn times, etc.) for orbital maneuvering engines shall be documented in Volume I, CEV Spacecraft Systems Performance and Constraints Data.

(d) Attitude Control System Delta-V Capabilities:
The document shall provide attitude control system delta-V capabilities data for the CEV if propulsive attitude control systems are used. The attitude control delta-V capabilities define how much change in velocity is available for establishing and nulling out attitude rates about the vehicle body axes. Data shall include minimum and maximum attitude rates attainable. Minimum attitude rates are a function of the thrust of attitude control system thrusters and vehicle moments of inertia. Maximum attitude rates may be limits imposed by flight software or attitude control thruster burn time limits. Attitude control system delta-V capabilities should also include the possible thruster combinations used for attitude maneuvers about body axes, and those that could be used to augment the translational delta-V capability. Delta-V capability for attitude control must equal the maximum mission requirement plus a margin of safety. Attitude control thruster performance envelopes (thrusts, maximum burn times, etc.) shall be documented in Volume I, CEV Spacecraft Systems Performance and Constraints Data.

(e) Launch Abort System (LAS) Operational Envelope and Capabilities:
The document shall provide Launch Abort System Operational envelope data for the CEV. The operational envelope of the LAS shall define when in the ascent trajectory it may be used, from the launch pad through jettison, and the velocity at which it must be jettisoned during a nominal ascent. The documented LAS capabilities shall include the expected accelerations and the family of trajectories that the LAS/CEV would follow, assuming LAS activation at different points during ascent. The data shall also describe the relative motion versus time between the LAS and the CEV after the LAS separates from the CEV following an ascent abort.

(f) Entry Corridor Definition Criteria:
The document shall provide entry corridor definition criteria for the CEV. The entry corridor definition criteria provide guidance for computing the minimum and maximum entry flight path angle limits, with and without dispersions, which permit safe entry into the Earth's atmosphere and precision landing. The entry corridor depends on the atmospheric density profile, and vehicle speed, mass, and aerodynamic characteristics. Therefore, entry corridors are computed on a flight-specific basis. Entry from LEO and entry from an inbound trans-lunar trajectory require different entry corridors. The shallow boundary of an entry corridor is the minimum entry flight path angle required to prevent an unwanted reversal in the sign of altitude rate from negative to positive. This could result in a large downrange error for landing, or even atmospheric skip-out. The steep boundary of the entry corridor is the maximum entry flight path angle that can be flown without violating thermal or structural load limits, or acceleration limits for the crew. Entry corridor definitions shall be documented for typical entries from LEO, and trans-lunar entries using standard seasonal atmospheres. Entry corridors shall be documented with and without atmospheric dispersions, uncertainties in navigation accuracy, vehicle center of mass, and aerodynamic characteristics.

(g) Entry Guidance Limits:
The document shall provide entry guidance limits for the CEV. Entry guidance limits define the maximum entry trajectory dispersions that the guidance and control systems can successfully correct, while ensuring that the vehicle remains within structural, thermal, and acceleration limits during entry, and achieves its trajectory targets at the end of the entry guidance phase. Entry guidance limits also include the acceptable tolerances for each target parameter at the end of the entry guidance phase. Entry guidance targets could include latitude, longitude, altitude, altitude rate, heading, drag acceleration, dynamic pressure, and other parameters plus their associated tolerances at the end of the entry guidance phase. The specific entry guidance limits and entry guidance targets depend on the entry guidance algorithms chosen for the vehicle, and vehicle design.

(h) Entry Cross Range Limits:
The document shall provide entry cross range limits for the CEV. Cross range limits are the maximum distances to the right or the left of the ground track, at which the CEV is capable of touching down. Cross range is measured perpendicular to a tangent to the ground track. Cross range capability is a function of vehicle aerodynamic characteristics, vehicle control capabilities, and the geometry of approach to the landing site. Cross range limits are used in planning deorbit and landing opportunities.

(i) Landing Footprint Accuracy:
The document shall provide landing footprint accuracy data for the CEV. Landing footprint accuracy defines the downrange and cross range dimensions of landing ellipses about the targeted touchdown coordinates for various levels of uncertainty in onboard navigation accuracy, onboard guidance and control capability, and environmental dispersions. Landing footprint accuracy will help to define the required landing site characteristics for touchdown on land.

(j) Sensed Acceleration Limits:
The document shall provide sensed acceleration limits for the CEV. Onboard rate gyros and accelerometers sense translational and rotational vehicle accelerations and incorporate this information into onboard navigation. The minimum detectable translational accelerations and

rotational rates, and their associated uncertainties, must be specified.

8. Volume VIII: CEV Ascent, Orbit, and Entry Structural Envelopes

(a) CEV Longitudinal and Lateral Load/Acceleration Limits:
The document shall provide load/acceleration limits for the CEV. The longitudinal and lateral structural load limits define the maximum positive and negative accelerations that the CEV structure can withstand along longitudinal and lateral body axes, and maintain structural integrity. For ascent, these limits should take into account the loads expected during nominal ascent, vehicle staging, loads resulting from Launch Escape Tower activation on the launch pad, and at all points in the ascent trajectory up to LET jettison, and loads expected during entry and touchdown following ascent aborts.

For the orbit phase, limits include the maximum acceptable structural load limit for the docking mechanism, and the minimum force required (if any) for the docking mechanism to work. This will help to define the acceptable range of relative rates for docking with other vehicles. On-orbit load limits should also specify the maximum longitudinal and lateral accelerations allowable for deployed appendages, such as antennas, booms, and solar arrays. These structural limits are relevant to the design of deploy mechanisms and on- orbit maneuver planning to prevent damaging deployed structures because of accelerations caused by maneuvers.

For entry and landing, these limits should take into account accelerations expected during entry along the steep boundary of the nominal entry corridor, and also for an unguided ballistic entry if that is an acceptable entry downmode option. Mach number, dynamic pressure, and acceleration limits for the deployment of parachutes or other drag inducing systems, and touchdown on land and water are also required. Touchdown acceleration limits will factor into the design of parachutes or other drag inducing systems.

(b) Lateral Motion Limits for CEV Touchdown on Land and on Water:
The document shall provide lateral motion limits for CEV touchdown. Lateral motion limits define how fast the CEV may be moving horizontally at touchdown on land or water, without violating structural integrity, tumbling, or harming the crew. If the vehicle lands within lateral motion limits, it should remain upright and intact, and not violate crew acceleration limits. Surface winds, the capabilities of landing systems, vehicle center of mass and coefficient of friction, and the characteristics of landing surfaces all factor into these limits. These limits influence landing system design and landing site requirements.

(c) CEV Dynamic Pressure Limits:
The document shall provide dynamic pressure limits for the CEV. Dynamic pressure limits specify the maximum force per unit area that the CEV structure can withstand without violating structural integrity, or overstressing points of connection between separate vehicle elements, during ascent and entry. Dynamic pressure is a function of the atmosphere and the vehicle’s trajectory.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes will be incorporated by electronic revision with change tracking.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-O-005
3. **DATA TYPE**: 3
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Flight Operations Procedures Data

7. **DESCRIPTION/USE**:
This document contains the CEV Contractor inputs to spacecraft procedures. This document will be used by the NASA-led flight operations team to develop the initial CEV spacecraft procedures.

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

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.7.3.(a).

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The procedures inputs shall include nominal operations, including in-space assembly, the activation and checkout of systems, deactivation of systems, steady-state operations,and in-flight maintenance; and nominal and off-nominal time-critical actions. The content includes input for all crew and mission control center based executable procedures affecting onboard systems and functions.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The CEV Flight Operations Procedures Data document shall include the following:
1. CEV Procedure Data Inputs - Detailed, step-by-step procedure inputs for all CEV spacecraft flight operations.
(a) The procedure data inputs shall cover nominal operations, including in-space assembly, the activation and checkout of systems, deactivation of systems, steady-state operations, and in-flight maintenance; and nominal and off-nominal time-critical actions.
(b) The procedure data inputs shall include the data for both the flight crew and the mission control center-based executable procedures affecting on board CEV systems and functions.
(c) The procedure data inputs shall reflect integration across the flight software, vehicle hardware, and available telemetry.
(d) Where required, the procedure data inputs shall include initial condition verification steps used prior to action steps.
(e) Where required, the procedure data inputs shall include status verification step(s) necessary to verify that an action or series of actions were successfully accomplished.

2. Associated supporting documentation for the procedures, including:
(a) Task description, frequency, and estimated completion time.
(b) Rationale for each step in each procedure and source of that information.

(c) Information on the source of all parameter numeric values used in procedures.
(d) Execution notes, such as equipment needed, information required to perform a task, etc.
(e) Initial conditions and final conditions.
(f) Operational constraints (i.e. limitations on how, in what sequence with other actions, or when the task may be performed.)

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be incorporated by complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-O-006
3. **DATA TYPE**: 3
4. **DATE REVISED**: May 2009
5. **PAGE**: 1
6. **TITLE**: CEV Stowage Capabilities and Services Handbook

7. **DESCRIPTION/USE**:
The CEV Stowage Capabilities and Services Handbook provides the procedures, development process/product flows, dependencies, capabilities and constraints, and required planning and operations information used in developing generic and flight specific stowage products for each CEV mission.

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

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.7.3.(a).

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The CEV Stowage Capabilities and Services Handbook will be used by equipment providers, spacecraft loading and unloading personnel, manifest planners, and flight controllers to ensure that equipment is properly stowed and that all operational requirements are being met during planning and operations.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The CEV Stowage Capabilities and Services Handbook shall provide the procedures, development process/product flows, dependencies, and required planning and operations information used in developing stowage products and services.

The CEV Stowage Capabilities and Services Handbook shall include, but is not limited to, the functional areas of:
1. Stowage Operations Documentation. This document shall include information covering the following areas as a minimum:
(a) Overview of CEV Stowage Capabilities.
(b) Layout and schematics of Stowage Locations and Volumes.
(c) Physical Dimensions.
(d) Mechanical Dimensions and interfaces.
(e) Available Services (e.g., power, cooling, and thermal controls and constraints, etc.).
(f) Environmental Conditions (e.g., humidity/environmental, pre-launch atmospheric controls and constraints, electromagnetic interference (EMI), etc.).
(g) Operational Restrictions and Rationale (e.g., center of gravity and real-time operations and handling constraints, temporary stowage restrictions/constraints, etc.).
(h) Procedures and Rationale (e.g., procedures to access or open stowage

compartments, unfasten restraints, connect to vehicle services, power up and power down, stowage compartment and content labeling system, etc.).
(i) Requirements for Stowed Equipment (including pre-launch, on-orbit, temporary stowage, landing and post landing timeframes).
(j) Operations safety processes and documentation to provide stowage safety compliance evaluation.
(k) Schedule and process (e.g., schedule/process for late load into vehicle pre-launch, for delivery of hardware for packing, labeling and to support pre-launch loading).

13.4 **FORMAT**: Delivered in electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be incorporated by complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-O-007
3. **DATA TYPE**: 3
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE:** Range Safety Requirements Documents

7. **DESCRIPTION/USE**:
Provide MPCV analyses and data products as required by Range Safety Requirements Documents which include the AFSPCMAN 91-710, Range Safety User Requirements Manual and the NPR 8715.5A, Range Safety Program. These Range Safety Requirements Documents are to be tailored for MPCV by the ESD/Human Exploration Rage Safety Panel (HERSP). These tailored Range Safety Requirements Documents address all MPCV range safety responsibilities.

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

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
The HERSP will lead the development of the tailored Range Safety Requirements and obtain Range approval of these tailored Range Safety Requirements. The HERSP will also lead the integration of all range safety products.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.7.4
Referenced from SOW Paragraph(s): 2.7.2(a), 3.3
Referenced from SOW Paragraph(s): 10.6.8

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:

(a) For flights conducted at the Eastern Range, analyses and data products addressing the tailored AFSPCMAN 91-710 and the NPR 8715.5A shall be provided for two different flight configurations:
   1. Un-crewed flight test missions
   2. Crewed missions

(b) The tailored Range Safety Requirements address processing, launch, ascent, entry, and landing phases.

13.2 **APPLICABLE DOCUMENTS**:
Meets/Exceeds Documents per J3:
- *AFSPCMAN 91-710 Range Safety User Requirements Manual (as tailored)*
- *NPR 8715.5A: Range Safety Program (as tailored)*

13.3 **CONTENTS**:
1. MPCV analyses or other data products required to satisfy tailored AFSPCMAN 91-710 requirements. Applies to flights conducted at the Eastern Range.

2. MPCV analyses and data products required to satisfy tailored NPR 8715.5A.

13.4 **FORMAT**: Format shall follow documented processes and procedures in AFSPCMAN 91-710 or other pertinent and applicable Range Safety Requirements Documents. Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be incorporated by complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-O-008
3. **DATA TYPE**: 2/3*
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Ground Systems Requirements, Plans, Reports and Design Data

7. **DESCRIPTION/USE**:
Volume I: Define CEV requirements for NASA-provided facilities, facility systems, NASA-provided support equipment to support ground operations in preparation for flight.
Volume II: Deliver plans and design data for CEV Contractor-provided support equipment end items to support ground operations in preparation for flight.
Volume III: Deliver an operations and maintenance plan and requirements for Contractor-provided support equipment necessary for CEV ground operations
Volume IV: Deliver a sustaining engineering plan for Contractor-provided support equipment necessary for CEV ground operations.

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

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
* Plan submitted at SDR will be Data Type 2. Reports will be Data Type 3.

As part of the Quarterly PMR, the ground system project report addresses design, acquisition, build/modification and certification activities of CEV Contractor-provided support equipment including schedules, procedures, progress to date, expenditures, and cost forecast.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.7.2.(a), 2.7.2.(b). Related DRD(s): CEV-T-005, CEV-T-029, CEV-T-031, CEV-T-035, CEV-T-048, CEV-T-087

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
Provide design and development details of CEV Contractor-provided ground systems, the CEV design requirements for Government-provided ground systems, and operations and maintenance requirements for Contractor-provided GSE.

13.2 **APPLICABLE DOCUMENTS**:
Appliacable Docuemnts per J3:
CxP 72506 CEV Orion Standard for the Design and Fabricaiton of Ground Support Equipment

13.3 **CONTENTS**:
CEV Ground Systems Requirements, Plans, Reports and Design Data shall consist of four volumes, each providing the Contractor's requirements, plan or approach to a different aspect of ground systems.
I. Ground Systems End Item Requirements Document and Report
II. Ground Systems End Item Implementation Plan and Report
III. Ground Systems Operations and Maintenance Plan and Requirements

Documentation
IV. Ground Systems Sustaining Engineering Plan

The volumes are to include detail at the level commensurate with the state of the design at the time of document delivery.

1. Volume I: Ground Systems End Item Requirements Document and Report
The document shall define the requirements for NASA provided facilities, facility systems, and NASA provided Ground support equipment and associated software. This volume shall flowdown the requirements from the Ground Support Equipment SRD (DRD CEV-T-031) and the Software Requirements Specification (DRD CEV-T-048) for GSE.

Requirements for NASA provided facilities and facility systems shall include:
(a) Narrative description of the purpose and/or function of the facility, room, system, and/or equipment item.
(b) Physical dimensions of the item(s) or area including any required lifting weight, center of gravity, and ceiling hook height.
(c) Number and skill of personnel assigned to a facility or area by discipline (e.g., managers, engineers, accountants, secretaries, and administrative personnel requiring office space; technicians, mechanics, inspectors, requiring break rooms and lab space).
(d) Hazard identification (e.g., classification of hazards, type of propellants, types of vents, types of purges, maximum fuel/oxidizer propellant quantities, types of ordinance, power voltages and frequencies, noise levels, RF radiation levels).
(e) Environmental requirements (e.g., temperature, humidity, particle counts, radio frequency shielding, noise attenuation, etc.).
(f) Power, grounding and lighting, including the use of uninterruptible power systems and supplies for ground operations activities.
(g) Plumbing/venting and commodities for ground operations activities.
(h) Fire and hazard protection.
(i) Communications, data networking systems.
(j) Special structural needs (e.g., vibration controls, floor loading, etc.).
(k) Security (e.g., facilities, facility systems, personnel, hardware, software, badging, and access control).
(l) Material handling requirements (e.g., crane or hoist requirements).
(m) Environmental pollution controls.
(n) Backup power and other backup or contingency requirements (chilled water, hot water, etc.).
(o) Internal IRD (DRD CEV-T-035) for all interfaces with flight hardware, NASA and Contractor-provided ground support equipment, facility systems, and facilities.
(p) References to any special studies and analyses that influenced the requirements.
(q) Consideration of human engineering requirements.
(r) Special operational requirements.

Requirements for NASA Provided ground support equipment and associated software shall include:
(a) Narrative description of the purpose and/or function of the support equipment item.
(b) Physical dimensions of the item(s) including any required lifting weight, center of gravity, and ceiling hook height.
(c) Number and skill of personnel assigned to operate the Contractor-provided support equipment.
(d) Hazard identification (e.g., classification of hazards, type of propellants, types of vents, types of purges, maximum fuel/oxidizer propellant quantities, types of ordinance, power voltages and frequencies, noise levels, RF radiation levels).

(e) Environmental requirements (e.g., temperature, humidity, particle counts, radio frequency shielding, noise attenuation, etc.).
(f) Power, grounding and lighting, including the use of uninterruptible power systems and supplies for ground operations activities.
(g) Communications, data networking systems.
(h) Special structural needs (e.g., vibration controls, etc.).
(i) Material handling requirements.
(j) Environmental pollution controls.
(k) Backup power and other backup or contingency requirements.
(l) Storage requirements.
(m) Internal IRD (DRD CEV-T-035) for all interfaces with flight hardware and support equipment.
(n) Internal IRD (DRD CEV-T-035) for all interfaces with facilities and support equipment.
(o) References to any special studies and analyses that influenced the requirements.
(p) Consideration of human engineering requirements.
(q) Special operational requirements.

The volume shall identify and include the Contractor's researched innovative technologies and methodologies for infusion into ground systems to improve safety, efficiency and life cycle costs.

The quarterly ground system project report addresses requirements development activities of CEV Contractor-NASA provided ground systems including schedules, procedures, progress to date, expenditures, and cost forecast.

2. Volume II: Ground Systems End Item Implementation Plan and Report
For Contractor-provided support equipment and associated software, the implementation plan provides the detailed hardware and software implementation approach and preliminary designs. This volume shall be in accordance with the ground systems requirements defined in the Volume I of this document.

The following elements are included as appropriate:
(a) Provide descriptions, approaches, and preliminary designs with the intent to satisfy each of the requirements End Item Specification per DRD CEV-O-008, Volume I.
(b) Environmental assessments, hazards abatements, analyses, and impact statements, as required.
(c) Proposed site locations for activation and operational use.
(d) Support equipment projected cost analyses
(e) Project design, acquisition and build/modification approaches, concepts, and schedules
(f) ICD (DRD CEV-T-029) for all interfaces with flight hardware and support equipment.
(g) Proposed initial spares to be purchased for each support equipment item.
(h) Plans to maintain and reconfigure these ground systems to be consistent with each configuration unique to the hardware/software characteristics of the test or flight.
(i) Plans for the manufacture, assembly, inspection, test, calibration, certification and acceptance of ground system end items.

The quarterly ground system project report addresses design, acquisition, build/modification and certification activities of CEV Contractor-provided ground systems including schedules, procedures, progress to date, expenditures, and cost forecast.

The volume shall identify and include the Contractor's researched innovative technologies and methodologies for infusion into ground systems to improve safety, efficiency and life cycle costs.

3. Volume III: Ground Systems Operations and Maintenance Plan and Requirements Document
For Contractor-provided support equipment and associated software, this volume shall include:
(a) Plans and requirements necessary for safe and effective operation and maintenance, including calibration and validation intervals, for ground systems that support ground and flight operations.
(b) Plans and requirements for required maintenance intervals, techniques and implementation
(c) Preventive and predictive technologies used, including the equipment and labs required
(d) Plans and requirements for systems and equipment required to perform maintenance

4. Volume IV: Ground Systems Sustaining Engineering Plan
For Contractor-provided support equipment and associated software, this volume shall include:
(a) Planning for engineering support for problem resolution including Material Review Board (MRB) items
(b) The approach for engineering review and analysis of proposed upgrades and modifications
(c) The approach for maintaince and updates of all system documentation
(d) The approach for reviewing all FMEA-CIL and hazard analysis identified critical items for mitigation or elimination.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be incorporated by complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-S-001
3. **DATA TYPE**: 1
4. **DATE REVISED**: May 2009
5. **PAGE**: 1
6. **TITLE:** Safety and Mission Assurance (S&MA) Plan

7. **DESCRIPTION/USE**:
The Contractor shall 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 meeting CEV System requirements. Since effective S&MA is heavily process driven, this document is the agreement between Contractor and the Government for how the Contractor plans to levy and implement safety and mission assuance upon the project.
The Contractor’s Safety and Mission Assurance Plan shall includes the following functions:
(a) design and development of controls; development of contingency and pre-mishap plans for major system tests, launches, and flights;
(b) electrical, electronic and electromechanical (EEE) parts;
(c) mechanical parts; emergency preparedness; fabrication controls;
(d) flight test/ground operations; handling and shipping for flight hardware and software;
(e) human error management;
(f) identification and data retrieval;
(g) maintainability; mishap and close call reporting, recording and investigation;
(h) metrology;
(i) nonconforming articles and materials;
(j) probabilistic risk assessment;
(k) procurement;
(l) quality assurance;
(m) reliability;
(n) risk management;
(o) safety;
(p) sampling plans/statistical planning and analysis;
(q) software assurance; software engineering;
(r) software formal inspection;
(s) software independent verification and validation documentation;
(t) stamp controls;
(u) supportability;
(v) systems engineering;
(w) testing/inspection/evaluations; and
(x) range safety.

8. **DISTRIBUTION**: As determined by the Contracting Officer

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
Initial submittal of the document shall be 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 volume for each of the following disciplines:
(a) System Safety,
(b) Industrial, Environmental and Range Safety,

(c) Reliability, Maintainability, and Supportability (RMS),
(d) Quality Assurance, and
(e) Software Assurance,
as described in the 'Contents' section of this DRD.
The Contractor shall continually update the Industrial, Environmental, and Range safety volume of the S&MA plan when necessary, and submit for NASA approval.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 3.1.
Referenced from SOW Paragraph(s): 3.4, 3.5
Related DRD(s): CEV-M-005, CEV-S-002, CEV-S-003, CEV-S-004, CEV-S-009, CEV-S-010, CEV-S-011, CEV-S-018, CEV-T-005, CEV-T-006, CEV-T-019, CEV-T-021

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Contractor S&MA Plan shall address the Contractor S&MA philosophy, organization, approach, and key processes to meet various program and mission requirements. The plan shall be organized by the major functions of an 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, Industrial, Environmental and Range Safety, Reliability, Maintainability, and Supportability (RMS), Quality Assurance, and Software Assurance). The plan shall provide process details of integrating S&MA products, tasks, and results with design and systems engineering processes to optimize the safety and mission success of the CEV System.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
SO300-BT-PRO-010, Government-Industry Data Exchange Program (GIDEP) Policies and Procedures Manual

Meets/Exceeds Documents Per J3:
MPCV 70059: MPCV Program Safety and Mission Assurance

13.3 **CONTENTS**:
The Safety and Mission Assurance Plan shall meet the requirements of the applicable documents in 13.2 and consists of separate volumes for each S&MA discipline. The plan shall describe the approach, including groundrules and assumptions, for the development and review of S&MA processes and products to be applied by the Contractor and its subcontractors.

Chapter 1, S&MA Program Overview

The S&MA Overview shall contain a description of each of the other volumes to serve as a reference. This shall include a description of the overall Contractor S&MA organization including organization charts, roles, and responsibilities. Other information that shall be included:
1. Define how the Contractor will establish and implement unimpeded access and authority between S&MA, Systems Engineering, Design Engineering and the Project Management levels with full project responsibility.
2. Identify the process, techniques, databases, and sources that the Contractor will use to identify program/project risks and mitigations (risks that impact safety and mission success, and their mitigations). Explain how the Contractor intends to identify program/project risks and mitigations (risks that impact safety and mission success, and their mitigations).
3. Concurrent Engineering - Document how the Contractor will implement

product requirements through the use of S&MA standards and processes that assure system safety, reliability, maintainability, supportability and quality (including for worst case environments for all mission phases) by effectively and efficiently designing-in the key attributes as part of the design effort. Provide details on how risks due to common cause failures shall be analyzed and eliminated by design to the extent possible, and how the balance of the residual risks shall be controlled.

4. Document how the Contractor S&MA organization will contribute to the overall planning, directing, and controlling of the integration, verification, activation, operation, and disposal activities including support to logistics, life cycle costs, maintenance, facilities, support equipment, personnel and training.

5. Provide details of the process the Contractor S&MA function will use to evaluate and approve design changes and then upon their approval, update Failure Modes and Effects Analysis, Hazard Analysis, and Risk Assessments during this process.

6. Provide details on how the Contractor S&MA organization will drive the selection and quality of the components and other materials to optimize reliability and mission success, with respect to the 'Materials and Processes Selection, Implementation, and Control Plan', DRD CEV-T-019.

For software, provide details on how the Contractor S&MA function drives the selection of Consumer-Off-the-Shelf (COTS), Government –Off-the-Shelf (GOTS), and reuse/legacy software as well as how this software will be verified and validated, and optimum safety, reliability, and mission success will be assured.

7. Provide a description of the methods (including Human Reliability Assessment) that will be used by the Contractor S&MA function to analyze and manage human error in the system design, operations, and ground processing activities.

8. Provide details on how the Contractor S&MA function is involved in the design certification process to ensure a robust design of systems.

Chapter 2, System Safety Plan

The plan shall describe the Contractor’s and subcontractors approach for the development and review of safety-critical products. This plan shall include:

1. A description of the Contractor’s system safety tasks to be performed during all lifecycle phases.

2. A description of the processes that will be used to perform these system safety tasks, control the effort, accomplish the safety objectives, and verify compliance with the Constellation Program safety requirements, standards, and processes.

3. A Contractor Software Safety Plan, defining the method(s) to determine the activities and tools necessary to perform software safety activities for the CEV System lifecycle. These activities shall include:

(a) Software safety’s function in system safety analyses, including the PHA, SHA, SSHA, and software safety analyses.

(b) Software safety’s function in the change control board process.

(c) Method for clearly identifying and managing all software safety requirements. Software safety requirements shall identify the modes or states of operation which are safety critical and identify the 'must work' and 'must not work' functions during those applicable modes or states.

(d) Method for mapping the the relationship between all software safety requirements and system hazards.

(e) Method for evaluating the software production process to identify and

eliminate or control real and potential process problems which could introduce failures, including latent failures, into flight and flight support software.
(f) Method for evaluating all acquired software products to ensure that they meet the Constellation Program safety requirements.
(g) Method for tracing the flow down of software safety requirements to design, implementation, and test.
(h) Method for identifing all software safety-critical design elements.
(i) Method for evaluating all software safety-critical code.
(j) Method for ensuring that safety-critical software test plans, procedures, and results are clearly identified and implemented.
(k) Method for reviewing and incorporating changes to safety-critical software requirements, design, implementation, and test plans/procedures.
(l) Method for ensuring risks affecting software safety are captured, addressed, and managed as part of project and facility risk management processes.

4. Identification of the safety output that will result from the expected application of the effort, with provisions for documentation of specific results of the safety effort. This shall include a description of how the Contractor S&MA group will work with Contractor engineering and management to ensure that system safety products will be used to increase the overall safety of the system.
5. Schedule of the Contractor safety activities, including milestone identification, program activities, program phasing, integration, and product delivery including the phased Safety Review hazard analyses and final safety certification.

6. Implementation of a project safety review process, and support to the NASA CEV Safety Review process.

7. A description of the processes and methods the Contractor will use to achieve compliance with safety requirements for integration of System Safety across Constellation elements. The plan shall document how the Contractor plans to verify and validate key systems safety requirements (loss of crew, minimization of potential human errors, failure tolerance criteria, etc.).

8. The methods the Contractor plans to use for hazard identification, control and tracking.

Chapter 3, Industrial, Environmental, and Range Safety (IE&RS)

The Contractor IE&RS Plan shall contain sections related to Industrial Safety (such as OSHA requirements), Environmental (such as EPA requirements), and Range Safety. The plan shall define the methodology and techniques for achieving the project safety requirements. This shall include a description of how the Contractor IE&RS programs are conducted to meet requirements of the SOW and design specifications. The plan includes a definition of the Contractor's organization(s), the manager(s), and key personnel. Contractor points of contact and interfaces with other organizations having responsibility for safety of product are to be identified. The plan shall ensure that recognized hazardous conditions that may affect contract performance or progress are identified and resolved before operations begin, over the life of the CEV System.

1. The Contractor IE&RS plan shall include:
(a) A description of the Contractor IE&RS related tasks performed during the preliminary phase, system definition, design, manufacture, test, or operations that will be continued throughout the life of the system.

(b) An assessment and report the Industrial and Environmental safety impacts, the reliability and quality assurance of the flight test operations and integration facilities.
(c) A description of the methods that will be used by the Contractor to perform and audit these tasks, control the effort, accomplish the objectives, and verify compliance with requirements.
(d) Scheduling the Contractor safety effort, including milestone identification, program activities, program phasing, integration, and product delivery.
(e) Contractor Support and planning for the CEV System safety review process and NASA Facility and Range safety processes.
(f) How the Contractor will provide information and technical data required for NASA or its agent to complete its NEPA analysis, including but not limited to data concerning management processes, existing environmental permits, physical and environmental descriptions, and waste streams.

2. The industrial safety section in the Contractor IE&RS Plan shall include:
(a) Contractor Management commitment and employee involvement in the safety and health program:
* A statement of contractor management policy, commitment, and accountability to provide for the safety and health of personnel (i.e., employees, customers, and public) and property and compliance with OSHA (or State OSH) and NASA requirements.
* A provision for top-level Contractor management monthly safety and health committee meetings.
* Descriptions of Contractor safety and health awareness and motivation programs, including documented safety meeting requirements, and documented safety and health awareness training for employees.
* Means of Contractor program evaluation, identifying duties, methods and frequency for internal evaluation of the safety and health program, and identification of personnel who perform evaluations and to whom evaluations are reported and who approves corrective action.
* A flowdown of Contractor safety responsibilities between appropriate tiers (i.e., subcontractors).
* Identification of Contractor employees (by type, classification, and qualification) responsible for the implementation of the above elements.
(b) Contractor system and worksite hazard analysis:
* Methods of hazard identification and control, e.g., hazard analysis and risk assessment.
* Descriptions of OSHA (or State OSH) programs that require documented plans [e.g., Personnel Protective Equipment (PPE), Confined Space, and Lockout/Tagout, etc.]. Note: Only programs applicable to the contract need to be addressed.
* Requirements for formal safety inspections and correction of deficiencies.
* Requirements for documented safety visits.
* Schedules of the frequency and documentation requirements for inspections, plan and procedure reviews, and certifications.
(c) Hazard prevention and control:
* Methods to include clear statements of hazardous situations and necessary cautions in appropriate detail plans, procedures, and other working documents.
* Contractor Controls of the procurement, storage, issuance, and use of hazardous substances.
* Method of ensuring a documented Contractor emergency management program.
* Contractor Plan for fulfilling the requirements of DRD CEV-S-004 Mishap Plan and Safety Statistics,.
* Provisions for Contractor safety and health services such as hazardous waste disposal, emergency medical support, personnel exposure

monitoring and hazard communication.
* Provision for suspending Contractor work where safety conditions warrant such action.

(d) Safety and health training:
* Means for training each Contractor employee to recognize hazards and avoid accidents, and ensuring each employee has a clear understanding of the disciplinary program.
* Provisions for training and certification of Contractor personnel performing potentially hazardous operations. Job categories under the contracted effort that require certification shall be identified.
* Provisions for Contractor training to assist managers/supervisors and employees in their specific roles and responsibilities in safety programs

Chapter 4, Reliability, Maintainability, and Supportability (RMS) Plan

Provide full details of Contractor RMS organization, plans, processes, modeling and analysis to meet CEV System requirements and mission needs. Key Performance Parameters [KPP] for each of the Contractor RMS attributes shall be identified, designed in, and tracked from the start of the conceptual design stage and its progressive improvement throughout the life cycle of the system.

1. Provide details of the Contractor organizational structure of RMS with reference to other organizations such as Design Engineering, Systems Engineering and others, including interactions and interfaces with those disciplines.

2. Provide a list and details of Contractor RMS tasks, processes, analyses, and verification and validation of results/progress for each key milestone of the program with a roadmap to meet the operational RMS and safety requirements of development and flight system.

3. Provide details of how Contractor RMS is integrated into the design function to improve system/subsystem reliability by influencing the design as part of the systems engineering model and design engineering processes.

4. Identify groundrules and baseline design assumptions, and planned Contractor RMS tools, including those for probabilistic design analysis (PDA) and structural reliability. Identify data assumptions, attributes of the model (including level, assumed relationships, etc.), timelines modeled, and capabilities modeled (i.e., crew escape). Identify the method to be utilized in verification of the models and provide the Government with access to this material.

5. Define the scope, content, approach, ground rules and assumptions that the Contractor will utilize in the development and performance of Probabilistic Risk Assessments (PRAs) and reliability predictions and allocations for the CEV System. 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. The plan shall address the schedule and method for Baysian updating. The plan shall address the method for maintaining systems engineering models that are compatible with the risk model developed as part of the probabilistic risk assessment to estimate and allocate component, subsystem, and human reliability values throughout the development and operation of the system.

6. Provide details of how the Contractor intends to perform and document a systematic review and evaluation of all Contractor RMS aspects of hardware design, development, manufacture, operation.

7. Provide details on how the Contractor will perform and document analyses, concurrent with the design effort, to determine the maintenance concept and resulting scheduled preventative and recurring maintenance requirements necessary to maintain CEV System safety and reliability.

8. Provide roadmap of reliability growth, i.e., how the Contractor will develop and implement reliability improvements on avionics boxes, subsystems, and systems, to achieve reliability goals. The section can utilize references to internal contractor/vendor procedures, processes and controls including EEE parts selection and control, material selection and controls, data sources, studies, etc., provided the Government has access to this material.

9. Provide process details and tools planned for effective Contractor integration of closed looped problem reporting, analyzing and corrective action system and nonconformance reporting and tracking system. Provide details of Contractor planned Problem Trending System to assess risk and provide input to reliability and maintainability analyses.

10. Provide process details of compliance to verification details of key Contractor RMS tasks. This should include verification and validation of design qualification and certification testing to meet the mission profile with due consideration for worst case environments. Applicable NASA Verification and Validation requirements shall be complied with to ensure a robust design while meeting program and mission success criteria and requirements.

11. Provide process details on how the Contractor intends to perform and document Contractor internal audits and vendor/supplier surveys to evaluate the progress and effectiveness of Contractor RMS activities and effectiveness of corrective action systems/processes and to determine the need for adjustments or changes.

12. Provide process details on how the Contractor intends to perform analyses to identify and determine limited life items age life, operating life, and shelf life and which items should be listed on the Limited Life Items List.

13. Provide process details on how the Contractor intends to assure the Limited Life Items are replaced and/or refurbished.

14. Document how Contractor R&M design and operational performance requirements (qualitative and quantitative) will be established, documented, and implemented.

15. Document how CEV system maintenance concepts will be established, documented and implemented.

16. Document how Contractor R&M engineering, analysis, and testing requirements and tasks are established, documented and implemented.

17. Document how Contractor R&M Processes, analytical activities and data are integrated with systems engineering, risk management, and other processes, assessments and analyses.

18. Document how Contractor R&M activities are integrated with the associated design and operational functions and associated program/project safety, quality assurance, risk management, and logistics activities.

19. Document how a Contractor maintenance concept will be established and

how compatibility is sustained among system design, maintenance planning, and logistics support activities.

20. Document how a Contractor data collection system to support R&M performance evaluation throughout the system's life cycle will be established and maintained.

21. Identify the organizations that will maintain the Contractor R&M data for the lifetime of the system.

22. Document how Contractor R&M is implemented as part of the design.

23. Document the approach to identify the CEV System operations and maintenance cost drivers.

24. Document the approach to establish and maintain a CEV System logistics support capability to sustain delivered hardware and software systems.

Chapter 5, Quality Assurance Plan (QAP)

The Contractor Quality Assurance Plan (QAP)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. (See the Software Assurance Plan, Chapter 6 for Contractor Software assurance requirements.) The plan shall include the following:

1. An identification of each Contractor Quality task to be accomplished under the Contractor QA Program (e.g. subcontractor monitoring, allocations process, etc.), a detailed description of how each quality task will be performed or complied with, and the procedures (where applicable) to evaluate the status and control of each task.

2. Each quality element of MPCV 70059, shall be addressed to describe the philosophy and approach for Contractor implementation. This may be satisfied by reference in the Contractor's quality plan to the Contractor's existing quality manual, provided a copy of the manual is delivered with the Contractor quality plan and the associated procedures are available for review.

3. Describe how the Contractor will involve NASA or NASA's representatives in reviews and approval of Contractor quality procedures and show compliance with the Quality Management System utilized at government facilities.

4. As a minimum, the subparagraphs below must be addressed by the Contractor quality plan and details of responsibilities and controls must be included to adequately describe the specific Contractor quality assurance activities related to hardware being procured by the CEV Project:

(a) Customer quality requirements– Include Contractor 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 will perform the applicable quality activities below.

(c) Uniform Quality – Define how the Contractor intends to develop, document, and implement controls for those processes where uniform, high quality cannot be assured by inspection of articles alone.

(d) 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.

(e) Procurement – Include the Contractor 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 nonconformances monitored, etc.)

(f) Milestone Reviews – Describe how the Contractor's quality system will support milestone reviews.

(g) Configuration Assurance – Describe how the configuration of the CEV System 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.

(h) Special Process Controls – Describe special process controls implemented for in-house processes and, if applicable, for subtier supplier processes.

(i) Contamination Control - Develop, document and implement a Contractor contamination control plan to ensure that contaminant sensitive items are cleaned and controlled in accordance with documented procedures to the levels specified in the applicable technical documents and are maintained to these cleanliness levels.

(j) Inspection and Test (describe who performs what inspections where) Include how the quality of purchased items are validated at receiving inspection or at subtier 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 will be included for development of site quality plans for major end item test and flight test. Develop required inspections, inspection tools, and frequency of inspections, calibrations, and associated training for on-orbit activities as well as for manufacturing and assembly activities.

(k) Nonconformance Reporting - Define how the Contractor intends to prepare and implement a nonconformance recording system to document all nonconformances starting with initial receipt of materials or articles and continuing through all subsequent phases of the program. Investigation processes and procedures, describing how root causes are identified with high degree of fidelity shall be included.

(l) Nonconforming Product (Material Review Board (MRB) 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.

(m) Flight Operations, Refurbishment, and Reuse – When applicable, describe how the Contractor's quality assurance system will be implemented for flight operations, refurbishment and reuse.

(n) Record retention – For those Contractor records not delivered to the CEV Project, 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.

(o) Define the Contractor's Sampling and Process procedures.

(p) Define how the Contractor intends to develop, document and implement the controls for handling, storage, preservation, marking, labeling, packaging, and shipping operations.

(q) Define how the Contractor intends to Participate in GIDEP in accordance with CEV DRD-S-012, Government-Industry Data Exchange Program and NASA Advisories/ALERTS, and SO300-BT-PRO-010, Government-Industry

Data Exchange Program (GIDEP) Policies and Procedures Manual.

(r) Define how the Contractor intends to develop an Acceptance Data Package for all delivered hardware and software.

(s) Indicate how the Contractor production, installation and servicing processes will be controlled to ensure specific requirements are met. As a minimum the Contractor QA plan shall include all of the following:

* processes, procedures, and specifications
* The Process steps
* Methods to be used to monitor and control proceses and product characteristics
* Acceptability criteria for workmanship
* Use of qualified processes, associated equipment and personnel
* Tools, techniques and methods to be used to achieve specified requirements

(t) Support to Contractor fabrication operations, including assembly, to ensure that characteristic and design criteria specified in technical documents are obtained and maintained in all supplier fabricated articles. Contractor Fabrication documents shall include or refer to:

* Nomenclature and identification of the article to be fabricated
* Tooling, jigs, fixtures, and other fabrication equipment to be utilized
* Tools techniques and methods to be used to achieve specified requirements
* Characteristics and tolerances to be obtained
* Detailed procedures for controlling processes and cleaning, preservation, and packaging operations
* Special conditions to be maintained such as environmental controls, specific cleanliness levels, and precautions to be observed
* Workmanship Standards
* Inspection and test operations to be performed during fabrication
* Special handling equipment and protective devices

(u) Contractor Controls employed to ensure that only conforming articles and materials are released and used and those not required for the operation involved are removed from the work area

(v) Develop and implement a Contractor Contamination Control and Foreign Object Debris document which will consist of an index of the methods and procedures used to implement the contamination control and foreign object debris prevention and control requirements. These methods and procedures shall cover end-item hardware, equipment, personnel, and control of such areas as fabrication, assembly, inspection, and test. The cleanliness level of contamination sensitive components and assemblies beginning with acceptance at the supplier level and continuing until customer acceptance shall be referred to in this document.

(w) Document and implement controls for those Contractor processes where uniform, high quality can not be assured by inspection of article alone, including but not limited to metallurgical and chemical processes, metal joining processes, bonding processes, plastics application, plating and coating processes, and surface treating processes.

(x) Document how Contractor personnel are trained and certified for processes and NDE; how techniques and processes have been certified; how Contractor facilities, equipment and materials for process control and NDE have been installed and how their use and maintenance are controlled; how resulting documentation, feedback, and records are controlled; document how NDE coordination with the cognizant engineering funtion as been implemented and how it will be documented on the drawings; and that Contractor personnel training and process certification procedures have been documented and accepted.

(y) Describe the Contractor's integrated approach to NDE, including organizational assignments, facilities, standards, and procedures.

(z) Maintain an up-to-date listing of all Contractor process control procedures and process specifications used in fabrication, control, and inspection of the materials and articles fabricated.

(aa) Document the Contractor's plan to control and monitor articles on the vehicle which are to be installed and removed, including shipping and handling protective materials. Document how temporary installations and removals shall be recorded for each vehicle from the first temporary installation through the life of the vehicle.

(bb) Develop Contractor quality planning and procedural controls to support horizontal and vertical flight tests and associated ground operations to include as a minimum:

* Compatibility with planning and procedural controls
* Define all Contractor quality activites relating to flight test/ground operations such as checkout, servicing maintenance, and refurbishment

(cc) Develop and document specific Contractor inspection procedures and nondestructive evaluation techniques to be used during safing, transport, etc.; list the inspection and test procedures, test specifications, and processes for NDE techniques for maintenance and ground operations; define special equipment (NDE) needed to perform major inspections

(dd) Develop a Contractor internal and sub-contractor audit program of processes, procedures, and operations which implement the Contractor quality program. The audits shall include examination of all operations and documentation, evaluation of actual operations as compared with established requirements, requests for corrective and preventative action, identification of root causes, and follow-up to verify effective implementation. Include audit schedules and reporting procedures.

(ee) Document integration of the Contractor inspection methods used throughout all phases. Document an inspection flow that is in consonance with the manufacturing, processing, and test flow with significant inspection stations being identified. Allow for use of alternative technques to support manufacturing, processing, and test operations. Ensure that the results of the tests and inspections is documented and can substantiate their accomplishment.

(ff) For Contractor Inspections and tests, document how articles and materials will be controlled; inspection, test environments and equipment will be controlled; and the criteria for re-inspection and retest.

(gg) Document how unusual phenomena, occurrences, difficulties or questionable conditions will be documented for Contractor end-items intended for delivery.

(hh) Document how Contractor adjustments, modifications, repairs, replacements, or rework after completion of end-item inspections and tests shall be documented and approved by the customer.

(ii) Document conditions that require functional tests or inspections to be performed on components prior to installation into the next higher assembly.

(jj) Document Contractor Quality Assurance Actions prior to testing, during testing, and subsequent to testing.

(kk) Document the Contractor controls established to ensure the integrity of hardware and materials.

(ll) Document the Contractor control system to be used for inspection, measuring and test equipment specifically intended for use with CEV hardware.

(mm) Document specific Contractor requirements and methods for the identification of the inspecton and test status of products, documents and data, including stamp and electronic stamp control techniques, the use of electronic acceptance authority

(nn) Document how nonconforming products are identified and controlled to prevent misuse until proper disposal.

(oo) Document how records and data of all Contractor inspections and tests performed will be generated and maintained.

(pp) Document how the Contractor quality activity will review and administer controls for procedures and instructions of the controls for handling, storage, preservation, marking, labeling, packaging, packing, and shipping operations.

(qq) Document how the Contractor quality activity shall verify that manufacturing planning documents (routing sheets, operations sheets, travelers, etc.) contain handling instructions and the identification of any special handling equipment are used to prevent damage.
(rr) Document the Contractor plan and controls for control storage areas
(ss) Document how Contractor preservation instructions, including material and process defintion are verified and are accomplished as contained in the manufacturing documents.
(tt) Document how Contractor packaging operations are specified in the manufacturing documents, including sufficient detail to ensure the integrity of the packaging and the hardware, and that internal environments necessary to prevent degradation of the article or material are included in the packaging.
(uu) Document how appropriate Contractor marking and labeling for packaging, storage, and shipping of articles and materials is ensured and performed in accordance with applicable specifications.
(vv) Document how Contractor records specific to the product or project are to be controlled.
(ww) Document how training required for Contractor personnel performing a CEV System process will be identified and documented
(xx) Document required Contractor quality training activities (such as Excellence of workmanship and personnel skills, careful and safe operations, and maintenance and improvement or article and material quality) from development, maintenance and through to implementation
(yy) Document how Contractor personnel controlling critical processes and personnel performing critical operations shall be certified and how evidence of certification will be presented and maintained.
(zz) Document where specific statistical techniques are required and how they will be implemented.
(aaa) Document the Contractor process control plan (how production, installation, and servicing processes will be controlled to ensure that specified requirments are met.
(bbb) Document the duties, responsibilities, and authorities of the assigned Contractor quality assurance personnel
(ccc) Document the Contractor system which identifies hardware/software characteristics requiring verification
(ddd) Document how quality characteristics and design criteria necessary for procurement, fabrication, inspection and test operations, and post flight operations are included in Contractor specifications, procedures, drawings, fabrication and planning documents.

Chapter 6, Software Assurance Plan

The Contractor Software Assurance Plan (SAP) shall plan, document and implement a software assurance program for software development, operation, and maintenance activities. This plan shall define the software assurance procedures, processes, tools, techniques, and methods to be used. The plan shall include details of procedures, reviews, and audits. The Contractor SAP shall include as a minimum:

1. Identify the Contractor SQA project’s organizational structure, tasks, roles and responsibilities, and estimated resources.

2. Identify which Contractor software documents are to be reviewed or audited for adequacy. For each document listed, identify the reviews or audits to be conducted and the criteria by which adequacy is to be confirmed.

3. Identify how software standards (documentation, design, coding, commentary, testing, metrics) will be monitored and assured by Contractor SQA.

4. Identify Contractor SQAs role in all software, project, product, and process reviews and audits. SQA software product and process audits shall be completed against the products and processes identified in DRD CEV-T-005, Software Development Plan.

5. Identify Contractor SQAs role in problem correction and corrective action.

6. Identify the software tools, techniques, and methods used to support Contractor SQA processes. State the intended use, applicability, or circumstances under which it is to be used or not to be used, and limitations.

7. Identify Contractor SQAs role in the audit of the configuration management products and processes and software delivery processes and products. SQA software configuration management audits shall be completed against the products and processes identified in DRD CEV-T-006, Software Configuration Management Plan.

8. Identify Contractor SQAs role in assuring that the software, provided by suppliers, meets established requirements.

9. Identify the Contractor SQA documentation to be retained, secured, and the length of retention.

10. Identify Contractor SQAs role in identifying, assessing, monitoring, and controlling all software risks.

11. An identification of each software assurance task to be accomplished under the Contractor SA program per NASA-STD-8739.8, Chapters 6 and 7. This shall include all SA disciplines: software quality assurance, software safety, software reliability, software verification and validation and independent verification and validation.

12. A detailed description of how each Contractor SQA task will be performed or complied with.

13. The Contractor procedures (where existing procedures are applicable, utilize them, where no existing procedures are applicable, develop new procedures) to evaluate the status and control of each task.

14. A detailed description of how the Contractor shall interface and support the NASA IV&V Facility as well as NASA Software Assurance in their required oversight and insight activities.

15. Describe how the Contractor will perform software assurance activities for requirements, design, coding, test, and the operation of software, including assuring that requirements-to-design and requirements-to-code checks are performed, assuring that program code complies with specified conventions and standards, and assuring that software tests were independently witnessed and discrepancies and/or anomalies are reported to project management and to an independent quality and safety organization.

16. Describe how the Contractor will audit its own and its supplier’s internal software assurance activities with sufficient detail to allow evaluation of both the progress and effectiveness of software assurance tasks and the need for adjustments or changes

17. Describe how the Contractor will evaluate the software production process to identify and eliminate or control real and potential process

problems.

18. Describe how the Contractor will implement control of processes, procedures, software, and equipment, configuration control and acceptance of flight and flight support software and documentation in accordance with requirements, standards, and procedures.

19. Describe the necessary Contractor training and certification needed to perform software assurance tasks.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the individual volume of the document requiring a change is required.

KEEP CEV-S-002 AS RESEREVED

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-S-003
3. **DATA TYPE**: 1/4
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE:** Flight System Safety Hazard Analyses

7. **DESCRIPTION/USE**:

The Contractor shall perform a safety/hazard analysis per MPCV 70038, MPCV Program Hazard Analyses Requirements. The intent of the hazard analysis is to reduce safety risk and to establish the acceptable risk of the program through the iterative process. Early analysis provides insight to either allow hazards to be designed out of the spacecraft or to allow for early identification of hazards to aid in early identification of required controls for incorporation into the design. The hazard analysis shall facilitate and support a hazard control and risk management program for the MPCV Program and provide information to the Government regarding hazards identified through analysis techniques and the status of their resolution and level of control. The safety review panels will use the hazard reports to assess the design and operation of the MPCV System as well as to whether or not it meets the program requirements for safety.

The contractor will develop and maintain a Safety Verification Tracking Log (SVTL) to document the Contractor's open items from the Phase 3 safety review process, including those open hazard control verifications that are not complete at the time of the Phase 3 safety reviews, in accordance with MPCV 70038. This list will be used to track the status, completion, and the method of verification for these hazard controls.

8. **DISTRIBUTION**: As determined by the Contracting Officer

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: See Remarks

11. **REMARKS**:

EM1/EM2:
Update (type 4) at all design (or design equivalent) milestones plus 60 days.
Final (Type 1) at SAR minus 30 days. Final submission includes Safety Verification Tracking Log (SVTL).
Update as required after SAR (Type 1)
Deliveries required for EM1 and EM2 design milestones and EM1 and EM2 SAR.
EFT1: Not Applicable
AA-2: Not Applicable

The MPCV 70038, MPCV Program Hazard Analyses Requirements, document outlines the requirements for scope, content, level of maturity at each milestones review and delivery schedule for the MPCV Program hazard analyses. The hazard analyses will address the haards that arise in the design, development, manufacturing, construction, facilities, transportation, operations and disposal activities associated with the hardware, software, maintenance, operations and environments. The hazard analyses will be updated and maintained through the Program life cycle.

The results of the hazard analyses, along with the individual hazard reports, are to be documented in the System Safety Analysis Report (SSAR). The SSAR will be submitted at each milestone linked to Phase I and II (i.e., Delta PDR or equivalent milestone and CDR, respectively). For Phase III, the SSAR will be submitted 30 days prior to the System Acceptance Review (SAR) milestone.

For those hazard reports that remain open or incomplete after Phase III SAR submittal, the open work items will be tracked via the Safety Verification Tracking Log (SVTL). Submission of the SVTL shall be in accordance with MPCV 70038.

If this open work results in any new hazard reports, affects previously baselined hazard reports, or results in a hazard report to be completed after the Phase III SAR submittal, these hazard reports shall be submitted at least 30 days prior to a mission’s Flight Readiness Review.

In the event that the previously baselined hazard reports are affected and there is not adequate time for submittal prior to FRR, a Safety Issue Briefing presentation shall be prepared.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 3.2.
Related DRD(s): CEV-S-001, CEV-S-005, CEV-S-009

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
System Safety Hazard Analyses identify hazards, evaluate risk, and establish verification methods for the MPCV Program. Hazard analysis will be performed in accordance with MPCV 70038.

The Safety Verification Tracking Log is to be used to track hazard control verifications still open after the Phase III SSAR SAR SAR Submittal.

The intent of the Safety Issue Briefing is to raise awareness of the new risk(s) to MPCV Program Management prior to the flight and then allow the appropriate follow up to process any required hazard report updates.

13.2 **APPLICABLE DOCUMENTS**:
Meets/Exceeds Documents per J3:
MPCV 70038 – MPCV Program Hazard Analyses Requirements
MPCV 70059 – MPCV Program Safety & Mission Assurance Requirements

13.3 **CONTENTS**:

Hazard reports are the means of formally presenting hazards identified in the hazard analyses to the MPCV Program. The development of flight Hazard Reports involves the conveyance of basic information about the hazard, and the means of satisfying the applicable safety requirements and the identification of methods to control the risk. The analyses shall identify flight hazards, evaluate risk, and establish verification methods applicable to design, development, manufacturing and assembly, testing, inspection, integration, and the operation of the flight system. It shall provide sufficient information to allow the Program to analyze the hazard reports within the context of other aspects of the Program. Each hazard report shall describe a single hazardous condition. The contents of the hazard analysis are defined by the requirements in MPCV 70038.

For those controls that cannot be verified as complete by the Phase III

SSAR SAR Submittals, the Contractor shall document these open actions in a Safety Verification Tracking Log (SVTL). The SVTL content is defined by MPCV 70038.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the Type-1 document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-S-004
3. **DATA TYPE**: 2/4
4. **DATE REVISED**: Nov. 2013
5. **PAGE**: 1
6. **TITLE:** Mishap Plan and Safety Statistics

7. **DESCRIPTION/USE**:
The Contractor shall perform investigations, generate mishap investigation reports, and provide notification and reporting of mishaps and related information. In addition, the Contractor shall also develop a project mishap plan that is consistent with the Orion MPCV Preparedness and Contingency Plan.

8. **DISTRIBUTION**: Mishap and close call reports will be recorded in the NASA IRIS/EX3 database or by submittal of NASA form 1627 and distributed to the CEV Project and Center Safety and Mission Assurance Office.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix.

11. **REMARKS**:
Plan is Type 2 and Reports are Type 4.
The Contractor shall perform mishap investigations, generate mishap reports and provide monthly status reports documenting monthly mishaps and safety statistics starting with contract approval. The objective of mishap and close call investigations is to improve safety by identifying what happened, where it happened, when it happened, why it happened, and what should be done to prevent recurrence and reduce the number and severity of mishaps. These investigations shall be independent, unbiased, and non-punitive. These investigations shall be performed by trained investigators. The Contractor shall also support all NASA mishap and close call investigations. All mishap and close call reports are considered the property of NASA.The Contractor shall submit reports for all of the following:
(a) Notification of mishaps and closes calls.
(b) Reporting of mishaps and close calls in EX3 (NASA’s on-line reporting system) or on NASA Form 1627.
(c) Mishap reports, within 75 days of the mishap or close call.
- Monthly updates of the investigation status in IRIS/EX3 or by a revised Form 1627 or by letter to NASA JSC SR&QA.
- Monthly updates of the corrective action plan status in IRIS/EX3 EX3 or by a revised Form 1627 or by letter to NASA JSC SR&QA.
(d) Monthly status reports documenting mishap/close call and safety statistics.
The monthly statistics report format shall be NASA JSC Form 288.
(a) Quick Incident Report for Safety (into the NASA IRIS/EX3 Data Management System or by letter to NASA JSC SR&QA or using **JSC FORM 288**)
(b) Quick Incident Report for Injury & Illness (into the NASA IRIS/EX3 Data Management System or by letter to NASA JSC SR&QA or using **JSC FORM 288)**
(c) Tracking Report (into the NASA IRIS/EX3 Data Management System or by letter to NASA JSC SR&QA or using **JSC FORM 288)**

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 3.3.
Related DRD(s): CEV-S-001

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:

The Contractor's mishap plan shall include, but not be limited to, special procedures for safing, handling, or containing hazardous chemicals present in project hardware; include special procedures for emergency response personnel; include procedures to impound records, data, equipment, facilities; list national, state, and local organizations which are likely to take part in debris collection (including identifying the roles and responsibilities of each organization), and document how off-site debris will be collected, transported and stored.

The scope of the contractor team is the major Project Orion ccontractors, defined as Lockheed Martin Space Systems, Lockheed Martin Michoud Operations, Lockheed Martin Mission Systems, Aerojet, Hamilton Sundstrand, Honeywell, Orbital Sciences Corporation, and USA work on Project Orion.
The Contractor shall report unplanned events that result in at least one of the following:
(a) Injury to non-NASA personnel caused by NASA ops
(b) Damage to public or private property caused by NASA ops or NASA funded development or research projects
(c) Occupational injury or occupational illness to NASA personnel
(d) A NASA mission failure before the scheduled completion of the planned primary mission
(e) Damage or destruction of NASA property

Test failures involving damage to equipment or property as a result of testing are not considered mishaps if:
(a) The test article is not flight hardware
(b) The testing is part of an authorized research/development/qualification/certification program
(c) Damage is limited to the test article and test instrumentation
(d) Risk of damage to the test article was accepted explicitly by program/project management
(e) The test team performs a test failure analysis and generates a technical report instead of treating it as a mishap

Close Calls: An occurrence or condition of employee concern in which there is no injury or only minor injury requiring first aid and no significant equipment/property damage, but which possesses a potential to cause a mishap.

The severity of the personnel injury and the direct cost of the mishap or close call (property damage and/or mission failure) shall determine the classification level of the mishap or close call per NPR 8621.1

13.2 **APPLICABLE DOCUMENTS**:

Applicable Documents per J3:
- MPCV 72223, MPCV Program Mishap Reporting and Contingency Action Plan
- NPR 8621.1, NASA Procedures and Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping

13.3 **CONTENTS**:

The Contractor's mishap plan shall include, but not be limited to, plans and special procedures for safing, handling, or containing hazardous chemicals present in project hardware;
include procedures for notification of, reporting to, investigating, and recording to NASA;

include the procedures to appoint contractor personnel to investigative boards; include special procedures for emergency response personnel; include procedures to impound records, data, equipment, facilities; list national, state, and local organizations which are likely to take part in debris collection (including identifying the roles and responsibilities of each organization;
document how off-site debris will be collected, transported and stored; and identify personnel who shall perform and control the impounding process.
For mishap notification, notify (by phone) the NASA Center Safety Office and Project within one hour of the occurrence of the following:
(a) Type A mishaps
(b) Type B mishaps
(c) High visibility mishaps
(d) High visibility close calls
(e) Non-Occupational Fatality, Permanent or Partial Disability or Lost-Time Injury that Occurred on a NASA Center or Facility Information to include, location of the incident, time of incident, number of fatalities, number of hospitalized employees, type of injury, type of damage, contact person, contact person’s phone number, brief description of the mishap.

Within 24 hours, for all Mishaps and close calls submit an electronic report with:
(a) Author of the report
(b) Author’s phone number and mail code
(c) Location of author
(d) Date report submitted
(e) Time reported submitted
(f) Incident date,
(g) incident time
(h) incident general location
(i) exact location
(j) responsible organization
(k) organization’s point of contact
(l) point of contacts phone number and mail code
(m) mission affected
(n) program impact (if known)
(o) number and type of injuries or fatalities
(p) type of damage to equipment
(q) flight hardware
(r) flight software
(s) facilities
(t) estimate direct cost of damage
(u) brief description of mishap or close call

The contractor shall email this information to the Center Safety Office and enter this information into the IRIS/EX3 Data Management System listed in 13.4 to comply with notification, and reporting requirements

The monthly statistics report content shall include the total number of hours worked by the Project Orion major contractors during the previous month.

13.4 FORMAT:

The following formats shall be submitted electronically:
(a) Mishap Report (Microsoft Word compatible into the NASA IRIS/EX3 Data Management System and sent via email to the Center Safety Office)
(b) Corrective Action Plan
(c) Lessons Learned

(d) Mishap Completion Statement indicating that the investigation was performed, the corrective action plan was developed, implemented and closed, and the lessons learned were entered into the NASA Lessons Learned Information Systems.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-S-005
3. **DATA TYPE**: 1/4
4. **DATE REVISED**: Nov. 2013
5. **PAGE**: 1
6. **TITLE:** Ground System Safety Hazard Analysis

7. **DESCRIPTION/USE**:
The Contractor shall provide ground safety data packages, including hazard analyses, applicable to the CEV Spacecraft, CEV Flight Test Article(FTA), CEV Ground Support Equipment (GSE) designs and ground operations. The hazard analysis will be subject to the Phased Safety Review Process as defined by MPCV 70038 to assure safety risk to personnel, launch site processing facilities, and flight hardware have been mitigated as defined herein.

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

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: See Remarks

11. **REMARKS**:
EM1/EM2:
Update (Type 4) at all MPCV design (or design equivalent) milestones plus 60 days.
Final (Type 1) at MPCV SAR minus 30 days. Final submission includes the Safety Verification Tracking Log (SVTL).
Update as required after SAR (Type 1).
Deliveries required for both EM1 and EM2 missions.

EFT1:
Delivery (Type 1) required for Ground Recovery Operations. Submission dates at equivalent milestones (PTR2, PTR3, and MSCSR) and updates as required after final delivery.

AA2: The Final delivery is Type 1. All other deliveries are Type 4. Submission dates at equivalent milestones (PTR2, PTR3, and SAR) and updates as required after final delivery.

MPCV 70038, MPCV Program Hazard Analyses Requirements document outlines the requirements for scope, content, and level of maturity at each milestone review and delivery schedule for program hazard analyses. The hazard analyses will address the hazards that arise in the design, development, manufacturing, construction, facilities, transportation, operations and disposal activities associated with the hardware, software, maintenance, operations and environments. The hazard analyses will be updated and maintained throughout the program’s life cycle.

The results of the ground hazard analyses, along with the individual hazard reports and any additional data requested per this DRD are to be documented in the System Safety Analysis Report (SSAR), also known as the Safety Data Package.

The MPCV contractor ground safety data package documentation requirements and the ground phase safety reviews will be based upon the hazardous nature and degree of complexity of the MPCV Spacecraft, MPCV FTA and MPCV GSE designs and operations. When flight safety reviews and ground reviews are separate reviews, an assessment shall be made by the MPCV Program to

assure hazards identified in each package are assessed for applicability to the other; e.g., if the MPCV Contractor ground safety hazard report on inadvertent thruster firing does not exist, the flight safety hazard report must be referenced in the ground safety package and it must contain a discussion of the applicability of the flight safety controls to ground safety.
For those hazard reports that remain open or incomplete after Phase III submittal, the open work items will be tracked via the Safety Verification Tracking Log (SVTL). Submission of the SVTL shall be in accordance with MPCV 70038.

If this open work results in any new hazard reports, affects previously baselined hazard reports, or results in a hazard report to be completed after the Phase III submittal, these hazard reports shall be submitted at least 30 days prior to a mission's Flight Readiness Review.

In the event that the previously baselined hazard reports are affected and there is not adequate time for submittal prior to FRR, a Safety Issue Briefing presentation shall be prepared. The intent of the Safety Issue Briefing is to raise awareness of the new risk(s) to MPCV Program Management prior to the flight and then allow the appropriate follow up to process any hazard report updates.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 3.2;
Related DRDs: DRD CEV-S-003, DRD S-004

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:

This document supports the ground safety review and approval process required by the launch site and MPCV 70038. Documentation submitted shall be consistent with the MPCV Program phase level under review.

For the operational vehicle being processed, the hazard analysis scope applies to non-IOZ activities. It addition, it will also apply to those hazards which can result in sufficient energy to propagate beyond the Industrial Operating Zone (IOZ) physical perimeter. The analysis is limited to ground and flight hardware provided by the MPCV Program.

For ground transportation on the government facility/site the contractor will demonstrate adherence with contractually defined site requirements. Adherence for pre-DD250 operations should be demonstrated via a hazard analysis, or an equivalent contractor product/process. For post-DD250, a hazard analysis shall be provided if the contractor hardware is involved or the contractor is performing the operation, or the contractor developed Ground Support Equipment (GSE) is provided to the GSDO Program for use.

For post-flight required Contractor furnished GSE, the required hazard analysis is in within the scope of this DRD.

For MPCV Abort Flight Test vehicle processing, the hazard analysis scope includes all hazardous WSMR operations from gate arrival through post-flight processing (with the exception of the actual flight test (T-0 to landing)). Hazard analysis products are subject to the Phased Safety Review process, as tailored for Abort Flight Test

The Safety Verification Tracking Log (SVTL) is to be used to track hazard control verifications still open after the Phase 3 Safety Review.

13.2 **APPLICABLE DOCUMENTS**:

Meets/Exceeds Documents per J3:
MPCV 70038, MPCV Program Hazard Analysis Requirements

13.3 **CONTENTS**:

The CEV Contractor shall prepare ground safety data packages in accordance with MPCV 70038. These reviews (see Data Submission Matrix) align with major program milestones and provide for the delivery and presentation of safety documentation required by the Processing/Launch site prior to delivery of the CEV Spacecraft/FTA and GSE to that site or other defined Project milestone (e.g., DD250).

The ground safety data packages shall include:
1. Block diagrams, schematics, and descriptions of safety critical subsystems. This includes tables of design and operating parameters for such items such as lifting equipment, pressure systems, ordnance, and batteries.
2. Launch site processing plan including timelines for handling, storage, assembly, servicing, and checkout operations as it pertains to the ground hazard analysis..
3. A Hazardous and Key Operations List for pre-DD250 operations performed in the defined IOZ with sufficient energy to propagate beyond the IOZ, as well as any MPCV operations outside the IOZ. The List shall include:
- All hazardous or key (or major) operations to be performed at KSC
- An explanation of each operation, describing in detail the hazards that require mitigation during these operations, and the mitigation plan.

4. Summary of Program mishaps reported per S-004 tht have impact to KSC ground processing operations.
5. Ordnance storage and handling data requirements.
6. A list of all hazardous materials and physical agents. Material Safety Data sheets (MSDS’s) shall be provided for all material and agents brought by the MPCV contractor.
7. A list of all plastic films, quantity, and location of use.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be incorporated by complete reissue.

KEEP CEV-S-006 AS RESERVED

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-S-007
3. **DATA TYPE**: 1/4*
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Orbital Debris Assessment
7. **DESCRIPTION/USE**:
The debris assessment must address the potential for orbital debris generation that results from normal operations and malfunction conditions, and on-orbit collisions. The assessment must also address provisions for postmission disposal. Malfunction conditions refer to those credible failure scenarios or conditions that can result in the direct generation of orbital debris or that can disable the spacecraft to preclude postmission disposal.
8. **DISTRIBUTION**: As determined by the Contracting Officer
9. **INITIAL SUBMISSION**: Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix
11. **REMARKS**:

For flight tests which place any objects in space that remain in orbit and no longer serves any useful function or purpose or are cast off either overtly or inadverently, an integrated orbital debris assessment, which includes the launch vehicle stages or components, shall be submitted at selected flight test milestones.

For EFT-1, these reports shall be submitted by the Contractor as follows:

A Preliminary Design Review (PDR) equivalent version (Type-4), which can make use of the previously submitted ORION PDR spacecraft Orbital Debris Assessment Report (ODAR). The report shall consist of a memorandum detailing any changes between the EFT-1 spacecraft and the ORION PDR spacecraft, and their impact, if any, to the ORION PDR assessment. The ORION PDR ODAR will be included as an appendix to the submittal. This submittal shall be delivered 30 days after CIR (CIR + 30 days).

A Critial Design Review (CDR) equivalent version (Type 4), which includes complete orbital debris assessments for the spacecraft and launch vehicle. This submittal shall be delivered twelve (12) months prior to EFT-1 launch (EFT-1 launch – 12 months).

A Final ODAR (Type 1), which shall consist of a memorandum detailing any changes and impacts, if any, to the CDR equivalent ODAR. This submittal shall be delivered three (3) months prior to the Prime Contractor FRR (LM FRR – 3 months).

For EM-1/EM-2, three ODAR versions shall be submitted by the Contractor as follows:

A PDR ODAR (Type 4) delivered 30 days prior to the start of a mission PDR, or equivalent program milestone. The PDR debris assessment shall identify debris generation issues and, where possible, assess those issues.

A CDR ODAR (Type 4) delivered 45 days prior to the start of a mission CDR, or equivalent program milestone. The CDR assessment shall update and clarify any issues and changes to the PDR ODAR for any nonconformances which remain prior to beginning the launch approval process.

A Final ODAR (Type 1) delivered 60 days prior to the Flight Readiness Review (FRR), as part of the launch approval process.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 3.3.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:

The orbital debris assessment covers the following broad areas: the potential for generating debris during normal operations or malfunction conditions, the potential for generating debris by collision with space debris (natural or human-generated) or orbiting space systems, and postmission disposal.

These broad areas are broken down into five issues to be addressed in the assessment:

- Debris released during normal operations
- Debris generated by explosions and intentional breakups
- Debris generated by on-orbit collisions during mission operations
- Reliable disposal of space systems after mission completion
- Structural components impacting the Earth following post-mission disposal by atmospheric reentry

The assessment will be organized around these issues with specific guidelines associated with each. The objective is to assess whether all applicable guidelines have been met.

13.2 **APPLICABLE DOCUMENTS**:

Applicable Documents per J3:
NASA Procedural Requirements (NPR) 8715.6A, NASA Procedural Requirements for Limiting Orbital Debris
NASA Standard (NASA-STD) 8719.14, Process for Limiting Orbital Debris

Meets/Exceeds Documents per J3:
MPCV 70059: MPCV Program Safety and Mission Assurance

13.3 **CONTENTS**:

The Contractor shall provide the orbital debris assessment reports in accordance with the requirements and methods specified in NASA-STD-8719.14, Process for Limiting Orbital Debris.

13.4 **FORMAT**:

Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-S-008
3. **DATA TYPE**: 1
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Safety and Health Plan

7. **DESCRIPTION/USE**:
NASA policy requires that contractors submit safety and health plans as part of the proposal. The plan will demoinstrate the seriousness of the offeror's intent to excel in its implementation of its safety and health program as a early indicator of its safety culture. The requirements captured below emulate the elements of OSHA's Voluntary Protection Program and as such represent all the elements of a successful safety and health program. Many NASA centers have been certified as OSHA VPP sites, indicating that a VPP star-level program is an asset to the safety and health of personnel and property.

8. **DISTRIBUTION**: After the plan is approved by NASA, the Contracting Officer will retain the plan in the contract file. The contractor will send additional copies to each of the following:
NS/Safety and Test Operations Division (2 copies)
SD13/Occupational Health Officer (1 copy)
JE / Environmental Services (1 copy)
Contracting Officer's Technical Representative (1 copy)

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
NOTE: UPON NASA APPROVAL, THE CONTRACTOR'S SAFETY, HEALTH, and ENVIRONMENTAL COMPLIANCE PLAN ('The Plan') BECOMES A CONTRACTUAL REQUIREMENT.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 3.3.

13. **DATA PREPARATION INFORMATION**:

13.1 **<u>SCOPE</u>**:
Establishes Safety, Health, and Environmental Compliance Plan for contractors providing support to NASA Centers.

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

Meets/Exceeds Documents per J3:
- JPR 1700.1: JSC Safety and Health Handbook
- JSC 17773: Preparing Hazard Analyses for JSC Ground Operations
- OSHA TED 8.4: Voluntary Protection Programs (VPP): Policies and Procedures Manual

13.3 **<u>CONTENTS</u>**:
1. MANAGEMENT LEADERSHIP AND EMPLOYEE PARTICIPATION.
1.1. Policy. Provide the contractor's safety, health, and environmental compliance policy statement with the plan. Compare the contractor's policy statement with those of NASA and OSHA and discuss any differences.
1.2. Goals and Objectives.

1.2.1. Describe specific safety and health goals and objectives to be met. Discuss status of safety program using the 'Performance Evaluation Profile' as safety performance criteria. Describe the contractor’s approach to continuous improvement (including milestone schedule) using level 5 of the Performance Evaluation Profile as a guideline.

1.2.2. Describe Environmental Goals & Objectives to be met for the following:

a. Pollution Prevention and Source Reduction of:

(1) Hazardous and Industrial Solid Wastes
(2) Solid Wastes (trash, refuse)
(3) Wastewater Discharges (sanitary sewerage)
(4) Air Emissions
(5) Medical & Radiological Discharges

b. Affirmative Procurement (Purchase of Environmentally Preferable Materials IAW Executive Order)

c. Hazardous Materials Handling/Purchasing/Reduction/Replacement

d. Elimination from Specifications and Standards requirements for the use of Hazardous/Toxic Substances & Materials

e. Use of an Environmental Planning Checklist to review & document Impacts of New and Modified Programs, Projects, Activities and Operations.

f. Life cycle analysis and costing

g. Incorporating Environmental Requirements in Subcontracts

h. Participation in Recycling

i. Outreach programs

1.3. Management Leadership. Describe management’s procedures for implementing its commitment to safety, health, and environmental compliance through visible management activities and initiatives including a commitment to exercise management prerogatives to ensure workplace safety and health. Describe processes and procedures to making this visible in all contract and subcontract activities and products. Include a statement from the project manager or designated safety official indicating that the plan will be implemented as approved and that the project manager will take personal responsibility for its implementation.

1.4. Employee Involvement. Describe procedures to promote and implement employee (e.g., non-supervisory) involvement in safety, health, and environmental compliance program development, implementation and decision-making. Describe the scope and breadth of employee participation to be achieved so that approximate safety and health risk areas of the contract are equitably represented.

1.5. Assignment of Responsibility. Describe line and staff responsibilities for safety and health program implementation. Identify any other personnel or organization that provides safety services or exercises any form of control or assurance in these areas. State the means of communication and interface concerning related issues used by line, staff, and others (such as documentation, concurrence requirements, committee structure, sharing of the work site with NASA and other contractors, or other special responsibilities and support.) As a minimum, the contractor will identify the following:

1.5.1. Safety Representative - identify by title the individual who will be trained and certified to be responsive to the Center-wide safety, health, environmental, and fire protection concerns and goals, and who will participate in meetings and other activities related to the Center’s Safety and Health program.

1.5.2. Company Physician/Occupational Injury/illness case manager - identify a point of contact who is responsible for the transfer or receipt of company medical data and who will be the primary contact for the company in the event any employee suffers a work related injury or illness (such as the company physician) by name, address, and telephone number to the the Center’s Clinic. This will facilitate communication of medical data to contractor management. Prompt notification to the

Occupational Health/ Clinic shall be given of any changes that occur in the identity of the point of contact. A letter to the Occupational Health Office can accomplish initial identification of point of contact and subsequent updates with a copy sent to the Contracting Officer. The initial letter is to be received by the Government prior to contract start.

1.5.3. Building Fire Wardens - provide a roster of fire wardens (their names, phone numbers and pagers, and mail codes). Contractor fire wardens are needed to facilitate the Center's fire safety program, including coordination of related issues with NASA facility managers and emergency planning and response officials and their representatives. The roster shall be maintained by letter to Center's Occupational Safety Office, with copies to the Contracting Officer and Contracting Officer's Technical Representative. The initial letter shall be received by the Government not later than 15 days after contract start.

1.5.4. Designated Safety Official - identify by title the official(s) responsible for implementation of this plan and all formal contacts with regulatory agencies and with NASA.

1.6. Provision of Authority. Describe consistency of the plan for compliance with applicable NASA and Center's requirements and contractual direction as well as applicable Federal, state, and local regulations and how compliance will be maintained throughout the life of the contract.

1.7. Accountability. Describe procedures for ensuring that management and employees will be held accountable for implementing their tasks in a safe and healthful and environmentally compliant manner. The use of traditional and/or innovative personnel management methods (including discipline, motivational techniques, or any other technique that ensures accountability) will be referenced as a minimum and described as appropriate.

1.8. Program Evaluation. The program evaluation consists of:

1.8.1. Participation in a Performance Evaluation Profile (PEP) survey at the request of the Government. The PEP survey normally will be scheduled and administered at the discretion of the Government. If the Government chooses not to do the PEP in a given year, the contractor may at its option initiate its own PEP by contacting Center's Occupational Safety Office, for assistance. The contractor will not be required to take two or more PEP surveys in any contract year.

1.8.2. [Reserved.]

1.8.3. A written self-evaluation report to be delivered by Sept 30 of each year. The self-evaluation shall follow the VPP program evaluation report format found in OSHA TED 8.4, Voluntary Protection Programs (VPP) Policies and Procedures Manual, AppendixD, 'Annual Submissions', as mandated by the cognizant OSHA regional office. Contractors who have submitted a written self-evaluation as a VPP site may submit their original report to OSHA in lieu of writing a new self -evaluation provided that all action plans and status are updated. The self evaluation shall as a minimum cover the elements of the approved safety and health plan.

1.8.4. Miscellaneous Reports. The contractor will acknowledge the following as standing requests of the Government and to be handled as described below.

a. Roster of Terminated Employees. Identify personnel terminated by contractor. Send to the Center's Occupational Health Officer, no later than 30 days after the end of each contract year or at the end of the contract, whichever is applicable. At the contractor's discretion, the report may be submitted for personnel changes during the previous year or cumulated for all years. Information required:

(1) Date of report, contractor identity and contract number.

(2) For each person listed, provide name, social security number, and date of termination.

(3) Name, address, and telephone number of contractor representative to be contacted for questions or other information.

b. Material Safety Data. The contractor shall prepare and/or deliver Material Safety Data for hazardous materials brought onto Government property or included in products delivered to the Government. This data is required by the Occupational Safety and Health Administration (OSHA) regulation, 29 CFR 1910.1200, 'Hazard Communication', EPA 'Emergency Planning and Community Right-to-Know (EPCRA, ref. 40 CFR 302, 311, 312); and Federal Standard 313 (or FED-STD-313), 'Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities', as revised. 1 copy of each MSDS will be sent upon receipt of the material for use on NASA property to the Center's Central Repository, Occupational Health and Test Support, along with information on new or changed locations and/or quantities normally stored or used. If the MSDS arrives with the material and is needed for immediate use, the MSDS shall be delivered to the Central Repository by close of business of the next working day after it enters the site.

c. Hazardous Materials Inventory. The contractor shall compile an inventory report of all hazardous materials it has located on Government property not less than annually, and which is within the scope of 29 CFR 1910.1200, 'Hazard Communication'; and Federal Standard 313 (or FED-STD-313), 'Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities', as revised. The call for this annual inventory and instructions for delivery will be issued by the Center's Occupational Health and Test Support Office. This information shall use the format used by the Center for chemical inventory compilation to provide the following:

(1) the identity of the material;
(2) the location of the material by building and room;
(3) the quantity of each material normally kept at each location
(4) peak quantity stored
(5) actual or estimated rate of annual usage of each chemical

1.9. Government Access to Safety and Health Program Documentation. The contractor shall recognize in its plan that it will be expected to make all safety, health, and environmental documentation (including relevant personnel records) available for inspection or audit at the Government's request. Electronic access by the Government to this data is preferred as long as Privacy Act requirements are met and Government safety and health professionals and their representatives have full and unimpeded access for review and audit purposes. For contractor activities conducted on NASA property, the contractor will identify what records it will make available to the Government in accordance with the Voluntary Protection Program criteria of OSHA. For the purpose of this plan, safety, health, and environmental compliance documentation includes but is not limited to logs, records, minutes, procedures, checklists, statistics, reports, analyses, notes, or other written or electronic document which contains in whole or in part any subject matter pertinent to safety, health, environmental protection, or emergency preparedness.

1.10. The contractor may be requested to participate in the review and modification of safety requirements that are to be implemented by the Government including any referenced documents therein. This review activity will be implemented at the direction of the NASA Contracting Officer's Technical Representative in accordance with established NASA directives and procedures.

1.11. Procurement. Identify procedures used to assure that procurements are reviewed for safety, health and environmental compliance considerations and that specifications contain appropriate safety criteria and instructions. Set forth authority and responsibility to assure that safety tasks are clearly stated in subcontracts.

1.12. Certified Professional Resources. Discuss your access to certified professional resources for safety, health, and environmental protection. Discuss their roles in motivation/awareness, worksite analysis, hazard prevention and control, and training.

2. WORKSITE ANALYSIS. Hazards shall be systematically identified through

a combination of surveys, analyses, and inspections of the workplace, investigations of mishaps and close calls, and the collection and trend analysis of safety and health data such as: records of occupational injuries and illnesses; findings and observations from preventive maintenance activities; reports on hazardous substance spills and inadvertent releases to the environment; facilities related incidents related to partial or full loss of systems functions; etc. Hazards identified by any of the techniques identified below shall be ranked and processed. All hazards on NASA property, which are immediately dangerous to life or health, shall be reported immediately to the Occupational Safety Office. All safety engineering products that address operations, equipment, etc., on NASA property will be subject to Center S&MA review and concurrence unless otherwise waived by the Center's Occupational Safety Office.

2.1. Industrial Hygiene. Describe your industrial hygiene program and how it will be coordinated with the Center's government provided resources for industrial hygiene. In the event corporate resources are used to determine workplace exposures, copies of all monitoring data shall be provided to the Center's Occupational Health within 15 days of receipt of results.

2.2. Hazard Identification. Describe the procedures and techniques to be taken to compile an inventory of hazards associated with the work to be performed on this contract. This inventory of hazards shall address the work specified in this contract as well as operations and work environments in the vicinity or in close proximity to contract operations. The results will be reported to the Government in a manner suitable for inclusion in facilities baseline documentation as a permanent record of the facility. Specific techniques to be considered include:

2.2.1. Comprehensive Survey – A 'wall to wall' engineering assessment of the work site including facilities, equipment, processes, and materials (including wastes – (TNRCC/EPA solid & hazardous, radioactive, explosives, medical-infectious-biological)). The comprehensive survey will establish a baseline of hazards that may put contract assets at risk as early as is feasible, preferably at contract start, and maintained throughout the life of the contract..

2.2.2. Change (Pre-use) Analysis – Typically addresses modifications in facilities, equipment, processes, and materials (including waste); and related procedures for operations and maintenance. Change analyses periodically will be driven by new or modified regulatory and NASA requirements.

2.2.3. Hazard Analysis – may address facilities, systems/subsystems, operations, processes, materials (including waste), and specific tasks or jobs. Analyses and report formats will be in accordance with the Center's, 'Instructions for Preparation of Hazard Analyses for Ground Operations.'

2.2.4. The contractor's safety plan will describe the flow of the findings of the comprehensive survey of hazards into hazard analyses and job hazard analyses and subsequently into controls such as design, operations, processes, procedures, performance standards, and training. The contractor will discuss its approach to notify NASA and other parties external to the contract work of its identified hazards and subsequent analyses and controls.

2.3. Inspections.

2.3.1. Routine Inspections. Includes assignments, procedures, and frequency for regular inspection and evaluation of work areas for hazards and accountability for implementation of corrective measures. The contractor will describe administrative requirements and procedures for control of and regularly scheduled inspections for fire and explosion hazards. The contractor has the option, in lieu of this detail, to identify policies and procedures with the stipulation that the results (including findings) of inspections conducted on NASA property or involving Government furnished property will be documented in safety program evaluations or the monthly Accident/Incident Summary reports. Inspections will identify

a. Discrepancies between observed conditions and current requirements, and

b. New (not previously identified) or modified hazards.

2.3.2. Protective Equipment. Set forth procedures for obtaining, inspecting, and maintaining all appropriate protective equipment, as required, or reference written procedure pertaining to this subject. Set forth methods for keeping records of such inspections and maintenance programs.

2.4. Employee Reports of Hazards – identification of methods to encourage employee reports of hazardous conditions (e.g., close calls) and analyze/abate hazards. The contractor will describe steps it will take to create reprisal-free employee reporting with emphasis on management support for employees and describe methods to be used to incorporate employee insights into hazard abatement and motivation / awareness activities.

2.5. Accident and Record Analysis.

2.5.1. Mishap Investigation – identification of methods to assure the reporting and investigation of mishaps including corrective actions implemented to prevent recurrence. The contractor will describe the methods to be used to report and investigate mishaps on NASA property and on contractor or third party property. The contractor will describe its procedures for implementing use of NASA forms as specified and alternate forms used by contractor with emphasis on timely notification of NASA; investigation procedures; exercise of jurisdiction over a mishap investigation involving NASA and other contractor personnel; follow up of corrective actions; communication of lessons learned to NASA; and solutions to minimize duplications in reporting and documentation including use of alternate forms, etc. The contractor will discuss its procedures for immediate notification requirements for fires, hazardous materials releases, and other emergencies. The contractor will include appropriate details to address the use of NASA Form 1627, 'Mishap Report' (or equivalent), including 24-hour and ten-day mishap reports to the Center's Occupational Safety Office. Note: the NASA Form 1627 is not attached since it is a three part carbonless form not conducive to reproduction.

2.5.2. Trend Analysis – describe approach to performing trend analysis of data (occupational injuries and illnesses; facilities, systems, and equipment performance; maintenance findings; etc.) Discuss methods to identify and abate common causes indicated by trend analysis. In support of site-wide trend analysis to be performed by the Government, the contractor will discuss method of providing data as follows:

a. Accident/Incident Summary Report. The contractor shall prepare and deliver Accident/Incident Summary Reports as specified. All new and open mishaps, including vehicle accidents, incidents, injuries, fires, and close calls shall be described in summary form along with current status. Negative reports are also required monthly. Report frequency is monthly; Date due is the 10th day of the month following each month reported. Report to be delivered to the Center's S&MA Directorate through the Safety and Test Operations Division.

b. Log of Occupational Injuries and Illnesses. For each establishment on and off NASA property that performs work on this Contract, the Contractor shall deliver to the Government a copy of its annual summary of occupational injuries and illnesses (or equivalent) as described in Title 29, Code of Federal Regulations, Subpart 1904.5. Copy of all summaries as required above under Contractor's cover letter. If contractor is exempt by regulation from maintaining and publishing such logs, equivalent data in contractor's format is acceptable (such as loss runs from insurance carrier) which contains the data required. Data shall be compiled and reported by calendar year and provided to the Government within 45 days after the end of the year to be reported (e.g. not later than February 15 of the year following.)

3. HAZARD PREVENTION AND CONTROL. Identified hazards must be eliminated or controlled. In the multiple employer environment of the center, it is required that hazards including discrepancies and corrective actions be collected in a center wide information system (Hazard Abatement Tracking System (HATS) for risk management purposes. Describe your approach to implementing this requirement.

3.1. Appropriate Controls. Discuss approach to consideration and selection of controls. Discuss use of hazard reduction precedence sequence. Discuss approach to identifying and accepting any residual risk. Discuss implementation of controls including verifying effectiveness. Discuss scope of coverage (hazardous chemicals, equipment, discharges, waste, energies, etc.). Discuss need for coordination with safety, health, environmental services, and emergency authorities at NASA.

3.2. Hazardous Operations and Processes. Establish methods for notification of personnel when hazardous operations and processes are to be performed in their facilities or when hazardous conditions are found to exist during the course of this contract. JPR 1700.1 will serve as a guide for defining, classifying, and prioritizing hazardous operations; 29 CFR 1910.119 will be the guide for hazardous processes. Develop and maintain a list of hazardous operations and processes to be performed during the life of this contract. The list of hazardous operations and processes will be provided to JSC as part of the plan for review and approval. NASA and the Contractor will decide jointly which operations and processes are to be considered hazardous, with NASA as the final authority. Before hazardous operations or processes commence, the Contractor will develop a schedule to develop written procedures with particular emphasis on identifying the job safety steps required. NASA will have access on request to any contractor data necessary to verify implementation. For all identified operations or processes that may have safety or health implications outside contract operations, the contractor shall identify such circumstances to the Center’s Safety and Test Operations Division and Occupational Health and Test Support Office who will provide additional instructions for further NASA management review and approval.

3.3. Written Procedures. Identification of methods to assure that the relevant hazardous situations and proper controls are identified in documentation such as inspection procedures, test procedures, etc., and other related information. Describe methods to assure that written procedures are developed for all hazardous operations, including testing, maintenance, repairs, and handling of hazardous materials and hazardous waste. Procedures will be developed in a format suitable for use as safety documentation (such as a safety manual) and be readily available to personnel as required to correctly perform their duties.

3.4. Hazardous Operations Permits. Identify facilities, operations and/or tasks where hazardous operations permits will be required, (such as confined space entry, hot work, etc.) Set forth guidance to adhere to established NASA procedures. Clearly state the role of the safety group or function to control such permits.

3.5. Operations Involving Potential Asbestos Exposures. Set forth method by which compliance is assured with the Center’s Asbestos Control Program.

3.6. Operations Involving Exposures to Toxic or Unhealthful materials. Such operations must be evaluated by the Center’s Occupational Health Office and must be properly controlled as advised by same. The Center’s Occupational Health Office must be notified prior to initiation of any new or modified operation potentially hazardous to health.

3.7. Environmental Operations & Activities

3.7.1. Operations Involving Hazardous Waste. Identify procedures used to manage hazardous waste from point of generation through disposal. Clearly identify divisions of responsibility between contractor and NASA for hazardous waste generated throughout the life of the contract. Operations that occur on site at NASA Facilities must be evaluated by theCenter's Environmental Services Office and must be properly controlled as advised by same. The Center's Environmental Services Office must be notified prior to initiation of any new or modified operations, equipment, systems, or activities generating new hazardous wastes or where the chemicals change or there are volume increases of 25% or more on site.

3.7.2. Operations Involving New or Modified Emissions/Discharges to the Environment. Set forth methods for identifying new or modified emissions/discharges and coordinating results with the Environmental Services Office. Set forth a plan of procedures to conduct pollution prevention, waste minimization or source reduction/elimination of environmental pollution. Address management and continuous improvement for the reduction of hazardous materials; substitution of non-hazardous or less hazardous materials for hazardous materials; proper segregation of hazardous wastes from non-hazardous wastes; and other methods described by NASA , EPA, , GSA, and Executive Order recycled content / affirmative procurement purchases . The Environmental Office is the single point of contact for coordinating all Center environmental permits Emphasis shall be placed on providing for sufficient lead time for processing permits through the appropriate state agency and/or the Environmental Protection Agency.

3.8. Discuss your responsibilities for maintaining facilities baseline documentation in accordance with Center's requirements. The contractor will implement any facilities baseline documentation tasks (including safety engineering) as provided in the contractor's plan approved by NASA or as required by Government direction.

3.9. Preventive Maintenance. Discuss approach to preventive maintenance. Describe scope, frequency, and supporting rationale for your preventive maintenance program including facilities and /or equipment to be emphasized or de-emphasized. Discuss methods to promote awareness in the NASA community (such as alerts, safety flashes, etc.) when preventive maintenance reveals design or operational concerns in facilities and equipment (and related processes where applicable).

3.10. Medical (Occupational Healthcare) Program. Discuss your medical surveillance program and injury /illness case management to evaluate personnel and workplace conditions to identify specific health issues and prevent degradation of personnel health as a result of occupational exposures. Discuss approach to Cardiopulmonary Resuscitation (CPR), first aid, and , return to work policies and the use of government provided medical and emergency facilities for the initial treatment of occupational injuries/illnesses.

3.11. Hazard Correction and Tracking. Discuss your system for correcting and tracking safety, health, and environmental hazards with particular emphasis on integration with the Center's Hazard Abatement Process. (The scope is restricted to establishments at the various Centers) This includes the following:

3.11.1. Personnel awareness of hazards. Discuss your approach to communicate unsafe conditions and approved countermeasures to your employees. Discuss your approach to communicating such conditions to the Government and other contractors whose personnel may be exposed to such unsafe conditions. Discuss communications with facility managers. Discuss use of the NASA Lessons Learned Information System for both obtaining lessons from other sources and as a repository for lessons learned during performance of the contract.

3.11.2. Interim and Final Abatement Plans. Describe how you will approach interim and final abatement of hazards. Describe how you will provide data to the Center’s Hazard Abatement Tracking System for all hazards that are not finally abated (all interim and final abatement actions completed) within 30 days of discovery. Discuss your approach to posting such plans. Discuss compatibility of your system with the role of facility managers in abatement planning, implementation, and verification.

3.12. Disciplinary System. Describe your system for ensuring safety and health discipline in your personnel (including subcontractors). Describe your approach to modifying personnel behaviors when personnel are exhibiting discrepant safety and health performance.

3.13. Emergency Preparedness. Discuss approach to emergency preparedness and contingency planning which addresses fire, explosion, inclement weather, environmental spill /releases, etc. Discuss compliance with 29 CFR 1910.120 (HAZWOPER) and role in the Center’s Incident Command System. Discuss methods to be used for notification of JSC emergency forces including emergency dispatcher, safety hotline, director’s safety hotline, etc. Discuss establishment of pre-planning strategies through procedures, training, drills, etc. Discuss methods to verify emergency readiness.

4. SAFETY AND HEALTH TRAINING. Describe the contractor's training program including identification of responsibility for training employees to assure understanding of safe work practices, hazard recognition, and appropriate responses for protective and/or emergency countermeasures, including training to meet federal, state, and local regulatory requirements. In doing so, the contractor will factor parallel requirements found in other mandates such as environmental protection [example: 29 CFR 1910.38 for emergency action plans and fire prevention plans versus EPA Resource Conservation & Recovery Act (RCRA) for Emergency Planning and Community Right-to-know (EPCRA).] Describe approach to identifying training needs including traceability to exercises such as job safety analyses, performance evaluation profiles, hazard analyses, mishap investigations, trend analyses, etc. Describe approach to training personnel in the proper use and care of protective equipment (PPE). Discuss tailoring of training towards specific audiences (management, supervisors, and employees) and topics (safety orientation for new hires, specific training for certain tasks or operations). Discuss approach to ensure that training is retained and practiced. Discuss personnel certification programs. Certifications should include documentation that training requirements and physical conditions have been satisfied (examples include physical examination, testing, and on-the-job performance). Address utilization of JSC safety and health training resources (such as asbestos worker training/certification, hazard communication, confined space entry, lockout/tagout, etc.) as appropriate with particular emphasis on programs designed for the multiple employer work environment on NASA property. All training materials and training records will be provided to NASA, and other federal, State, and local agencies for their review upon request. If the contractor wishes to train their personnel in any regulatory mandated training, an agreement will be secured with the Occupational Safety Branch and Occupational Health and Test Support office prior to beginning training. The agreement will ensure that safety and health training resources available from NASA are utilized where appropriate and to ensure that contractor-supplied training is in agreement with the Center’s safety and health processes.

13.4 **FORMAT**: 1. Cover page - to include as a minimum the signatures of Contractor's project manager and designated safety official (if different); NASA COTR; The Center’s Occupational Safety Branch; and the NASA Contracting Officer. Other signatures may be required at the discretion of the Government.

2. Table of Contents. See content below.

3. Body of plan - as required. Contractor's format is acceptable but should be traceable to the elements of the content below.

4. When preparing its plan, the offeror/contractor is expected to review all the items below and tailor its plan accordingly. Certain requirements set forth in this DRD may be specific for contractor operations performed at NASA Centers; tailoring of the plan to the requirements of specific establishments is acceptable. The plan will clearly identify those resources to be provided by the contractor and provided by the Government. This review and supporting rationale is to be made available to the Government as part of this plan. It can be documented as a checklist or outline, inserted directly in the body of the plan, or in any format developed by the contractor that clearly conveys the results of this review including the basis for any underlying assumptions.

13.5 **MAINTENANCE**: Subsequent revisions to the plan. The contractor may revise the plan at any time or at the direction of the Government. Revisions are subject to Government review and approval. Distributions of approved revisions will be as described above.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-S-009
3. **DATA TYPE**: 3/4*
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Failure Modes Effects Analysis & Critical Items List (FMEA/CIL)
7. **DESCRIPTION/USE**:

The Failure Modes Effects Analysis and Critical Items List is a design and operations tool and will be used to aid design engineering, operations, and manufacturing of the MPCV Spacecraft. Specifically, the analysis will be used to support the following at a minimum:

1) Additional design action
2) Safety analysis
3) Test planning
4) Mission Planning
5) Preparation of mandatory inspection points
6) Fault detection and isolation
7) Maintainability Design Characteristics
8) Maintenance Planning
9) Logistics Planning.

The contractor shall perform Failure Modes and Effects Analysis (FMEA) and the Critical Items List in accordance with MPCV 70043, MPCV Program Failure Modes and Effects Analysis/Critical Items List (FMEA/CIL) Requirements.

The purpose of the Critical Items List (CIL) is to identify those items or hardware that do not meet failure tolerance requirements and, in addition, those items that do not pass the redundancy screens (screening to determine if an item's redundant path can be functionally verified or if a redundant path failure can be detected prior to use, or if all redundant paths can be lost as a result of single credible common failure cause) that require special attention when establishing hardware specifications and qualification requirements.

Each CIL item, via its documented 'retention rationale' drives the development and implementation of inspection, process control, and test and verification requirements for the critical items. The CIL item also influences operations planning (including mission planning, procedure development, and logistical and maintenance support requirements), and includes failure history.

8. **DISTRIBUTION**: As determined by the Contracting Officer

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

At System Definition Review (SDR)the following level of maturity is required:
(a) Master logic diagrams, functional failure modes defined, preliminary high level (System and Spacecraft level) failure effects identified.

At Preliminary Design Review (PDR) or equivalent Program milestone the following level of maturity is required (as Type-4):

(a) Failure mode effects will describe the out-of-spec outputs (including higher level spacecraft and System effects) required to support failure propagation assessments.
(b) Lowest level effects (subsystem and component level) accurately propagated to the high level (System and spacecraft) effects.
(c) Failure causes sufficiently developed to a level commensurate with the design.
(d) Failure effects developed to a level consistent with design detail, for both hardware and software.

At CDR Sub-System Design Reviews (SSDR)or equivalent Program milestones the Contractor shall make available the data required to meet the entrance and exit critirea for the CDR SSDR. This data will be at the level of maturity defined for the Critical Design Review (CDR) in the next paragraph.

At Critical Design Review (CDR) or equivalent Program milestone the following level of maturity is required (as Type-3):
(a) Component Level FMEA/CIL complete..
(b) FMEA/CIL completed analysis to the deepest level of indenture (component level) for the analysis.
(c) Failure mode effects complete to the lowest level (component level).
(d) Failure Causes sufficiently developed to a level commensurate with the design.
(e) CIL retention rationale has been completed to a level of detail agreed to at the MPCV R&M Working Group.

Following CDR or equivalent Program milestone, updates shall include the following (Type 3):
(a) Identification of CIL retention rationale that has not been verified.
(b) Updated analysis addressing changes to the design.
(c) Changes to previous submittals

At the EFT1 milestone, the Contractor shall make available the FMEAs that have been performed to support the Range Safety Data Package and the EFT-1 design development. NO delivery of S-009 is required.

At the AA-2 milestones, the Contractor shall make available the FMEAs that have been performed to support the Range Safety Data Package and the unique AA-2 design development (Type 4).

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 3.4.
Related DRD(s): CEV-S-001, CEV-S-003, CEV-S-010, CEV-S-011, CEV-S-015, CEV-O-007

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The FMEA is an analysis for the MPCV Flight System and Flight Critical Ground Support Equipment (GSE) to determine possible modes of failure and their effects on the crew, spacecraft and mission success, with the provisions for identifying each failure mode by its Criticality category number. A FMEA shall be prepared for each MPCV Flight System, subsystem, and Flight Critical GSE to the component level (described in 13.3).
The CIL is a list of hardware identified in the FMEA categorized as being 'Critical', i.e., those items whose failure could result in a loss of life, the vehicle, and the mission.

13.2 **APPLICABLE DOCUMENTS**:

Meets/Exceeds Documents per J3:

MPCV 70043, MPCV Program FMEA/CIL Requirements Document
MPCV 70059, MPCV Program S&MA Requirements Document

13.3 **CONTENTS**:
The contractor shall follow MPCV 70043 with the following additions/clarifications:

a. FMEA/CIL worksheets shall be prepared as appropriate (with regard to Criticality) with 'retention rationale' that contains data that supports the premise that the risk presented by inclusion of the item in the assembly/subsystem/spacecraft/System/MPCV has been minimized by proper design controls, inspections, tests, critical processes and maintenance controls, and that no adverse failure history exists. The rationale shall also contain data, which describes operational constraints caused by occurrence of the failure, and describe the measures taken to ensure that the function is restorable. The contractor shall also prepare as part the verification activity, an entry on the worksheet, that lists the methods for verifying CIL 'retention rationale' and hazards control activity.
b. The fidelity of the FMEA/CIL shall reflect the latest hardware and software designs and identify risks for all flight software and hardware and its interactions during various phases of the program per the scope as listed in par. 13.1. If the contractor determines that future FMEA/CIL submissions should separate hardware and software, this can be accomplished by separate chapters within the analysis, however, there must be a final system FMEA/CIL that ties the hardware and software interactions together as often the two are used in concert to obtain adequate fault and failure tolerance.
c. A 'single point' failure summary shall be provided as a section of the CIL. An independent redundant items failure analysis shall be done for Critical Items to evaluate the potential effects for latent defects and other process issues including potential human errors. Common Cause Failures (CCF) as identified in the FMEA/CIL shall be designed out to an acceptable risk level (as approved by the MPCV Program) and residual risks shall be documented and controlled.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. The contractor shall also make available a "flat file" format of the FMEA/CIL worksheets that can be uploaded into a database.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Only changes or updates to the baselined FMEA and CILs shall be resubmitted for NASA approval.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-S-010
3. **DATA TYPE**: 2/4
4. **DATE REVISED**: Nov. 2013
5. **PAGE**: 1

6. **TITLE**: Probabilistic Risk Assessment Results

7. **DESCRIPTION/USE**:
To define and document the contractor's data and findings in implementing and performing a Probabilistic Risk Assessment (PRA) per the MPCV Program Probabilistic Requirements Document, MPCV 70017.

8. **DISTRIBUTION**: As determined by the Contracting Officer

9. **INITIAL SUBMISSION**: See Remarks

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

Preliminary PRAs are due at System Definition Review to current design level of detail. Event trees, fault trees, model integration & quantification, and uncertainty analysis shall be under development. Included with the PRAs, ground rules, mission success criteria, end states shall be ready to baseline.

At Preliminary Design Review (PDR) or equivalent Program milestone the following level of maturity is required for the EM-2 Loss of Crew (LOC) Model (Type 4):
(a) Event trees, fault trees, model integration & quantification.
(b) Initiating events updated to PDR level of detail using available hazard analysis.
(c) Loss of Mission (LOM) assessment for EM-2, developed in accordance with contractor tools and methodologies
(d) Loss of Vehicle (LOV) assessments for EM-1, developed in accordance with contractor tools and methodologies

At Critical Design Review (CDR) or equivalent milestone the following level of maturity is required (Type 4):
(a) Initiating events updated to CDR level of detail using available hazard analysis.
(b) Event trees, fault trees, model integration & quantification, and uncertainty analysis development continued.
(c) Changes to previous submittals addressed.

At SAR minus 30 days, the updates shall include the following (Type 2):
(a) Analyses complete and should be high level of detail and maturity with accurate test-supported input data.
(b) Update with changes to the design.
(c) Changes to previous submittals addressed.

Type 4 Reports shall be delivered every 6 months after the EM-1 PDR or equivalanet Program milestone delivery. The Type 4 Reports are "interim" status deliveries, which shall contain the following:

- List of model changes from previous delivery (software, common cause methodology,uncertainty, etc.)

- List of upcoming PRA components for the next delivery (software, common cause methodology, uncertainty, etc.)
- Updates to the model from the previous delivery.
- Identification of data and assumption changes.
- Updated schematics and design information

At the EFT-1 milestones, the contractor shall make available the quantitative risk assessments performed to support the Range Safety Data Package and the Loss of Test Vehicle/Loss of Data calculations. NO delivery of S-010 is required.

At the AA-2 milestones, the Contractor shall make available the quantitative risk assessments that have been performed to support the Launch Abort Vehicle (LAV)Range Safety Data Package and the LOTV calculations. This will be in support of the integrated AA-2 PRA that will be conducted by the MPCV Program. This data will be a subset of the data required in this DRD. The details of this reduced scope will be worked through the MPCV PRA working group.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 3.4.
Referenced from SOW Paragraph(s): 1.4.
Related DRD(s): CEV-S-001, CEV-S-009, CEV-S-011, CEV-O-007

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:

The Contractor shall develop the MPCV PRA per MPCV 70017, MPCV Probabilistic Risk Assessment Requirements Document. The MPCV Probabilistic Risk Assessment Results shall include the models, basis for the models, analysis results, detailed descriptions of the analysis, justifications for assumptions, data, and basis for the data.

(a) Probabilistic Risk Assessments (PRAs) shall be used to model potential accident scenarios for the EM-2 mission to determine the reliability and risk of the EM-2 design.

(b) Perform comprehensive function analysis to identify all system functions necessary for the system to achieve its operational objectives for the EM-2 Missions in the specified mission environments. Function analysis should include functions that will be performed by hardware and software.

(c) PRA models shall be graphically illustrated in top-level fault trees called Master Logic Diagrams (MLD), in which the top level blocks are the end states (or FOM), the intermediate blocks represent the chain of events necessary to produce the end states, and the bottom blocks are the initiating events.

(d) The MPCV PRA shall identify important initiating events that can trigger failures/events for each series of end states. Initiating events shall include hardware failures, software failures, human errors, and naturally occurring phenomena. Internal initiators as well as external initiators (e.g., MMOD) shall be considered.

(e) The MPCV PRA analyses shall include an evaluation and description of quantitative uncertainties.

(f) Uncertainty analysis shall be performed on the MPCV PRAs to provide the decision maker with a full appreciation of the overall degree of uncertainty bounding the PRA results and an understanding of which sources of uncertainty are critical to the results that guide decisions.

(g) Results and Insight from the MPCV PRAs shall be utilized to update the design,operating, and implementation plans.

(h) The MPCV PRA models shall be maintained throughout the system life cycle.

13.2 **APPLICABLE DOCUMENTS**:

Meets/Exceeds Documents per J3:
MPCV 70017 MPCV Program Probabilistic Risk Assessment Requirements Document
MPCV 70059 MPCV Program Safety & Mission Assurance Requirements Document

13.3 **CONTENTS**:

1) The contractor shall document the MPCV PRA to include the following:
   a) Groundrules and assumptions including at a minimum:
      i) "Go/No-Go" or flight rules used
      ii) List of driving assumptions for each system/subsystem
      iii) List of assumptions used concerning SLS and GSDO programs (i.e., ground recovery mitigations)
   b) Data sources for each system/subsystem/phenomenological event to include at a minimum:
      i) Base failure rate
      ii) Data type (exponential, lognormal, etc.) and associated parameters
      iii) Uncertainty parameters
   c) Missions, Phases Analyzed, including phase dependency matrix.
   d) Values calculated.
   e) Any "off-line" models used to develop basic event data
   f) Assessment results including uncertainty analysis.
   g) Risk estimates.
   h) Risk breakdown with relative contributions.
   i) Sensitivity analyses.
   j) Excluded initiating events and justification for exclusion.
   k) System/subsystem schematics, functionality and success criteria

2) The Contractor shall identify the major contributors to risk as determined by the MPCV PRA.

3) The Contractor shall perform uncertainty analysis on their PRA as part of their reporting of the PRA results and identify those sources which are critical to Program risk decisions.

4) The MPCV PRA shall identify and evaluate accident sequences leading to undesired consequences.

5) The MPCV PRA shall evaluate the failure (type and probability) of each event in the accident sequences leading to undesired consequences.

6) The Contractor shall supply all data in support of the quantification of the MPCV PRA in enough detail so that the analysis can be reproduced. This includes system schematics, assumptions, data analyses, etc..

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-S-011
3. **DATA TYPE**: 4
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE:** Reliability and Maintainability Report

7. **DESCRIPTION/USE**:
The Contractor shall design-in Reliability and Maintainability (R&M), as part of the design process for the MPCV System throughout the system's design cycle. The Contractor shall present the results of R&M system analysis that integrate the various quantitative and qualitative system level activities within reliability and maintainability with other data and system analyses. R&M analyses includes processes and tools to predict, allocate, evaluate, analyze, track, and integrate R&M parameters with design and other data and system analyses throughout all phases of the Program. The purpose of the R&M analysis process is to assess the extent of meeting the Program goals, requirements for safety and mission success, as well as provide input for systems supportability and life cycle cost, throughout all phases of the Program.

The R&M Report shall consist of an executive summary and two volumes, one each for Reliability and Maintainability, and various appendices containing supporting data. Each volume shall include tool and analyses descriptions as well as the specific requirements as listed in section 13 of this DRD. The appendices listed in Section 13.4of this DRD shall be made available every six months starting with EM-1 PDR as a Type 4 deliverable.

8. **DISTRIBUTION**: As determined by the Contracting Officer

9. **INITIAL SUBMISSION**: See Remarks

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
Initial draft of this report shall be submitted prior to Systems Requirements Review, providing high-level system Reliability and Maintainability allocations. At System Definition Review, Preliminary Design Review, and Critical Design Review or equivalent EM1/EM2 milestones,, updates shall be provided incorporating increasing detail as design becomes firm. At SAR-30 days, the Final delivery shall be made available. All deliveries are Type 4.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 3.4.
Related DRD(s): CEV-S-001, CEV-S-002, CEV-S-009, CEV-S-010, CEV-T-009, CEV-T-011, CEV-T-012, CEV-T-014, CEV-T-027, CEV-T-030, CEV-T-047, CEV-T-059, CEV-T-061, CEV-T-063, CEV-T-065, CEV-T-071, CEV-T-072, CEV-T-073, CEV-T-074, CEV-T-075, CEV-T-076, CEV-T-078, CEV-T-081.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The R&M Report shall be performed in accordance with Section 13.2 to provide the following:

(a) Details of both quantitative and qualitative reliability analyses and summary of associated trade studies

(b) Details of both quantitative and qualitative maintainability analyses and summary of associated trade studies.
(c) Description and discussions of R&M analyses results including applicable sensitivity analyses.
(d) Integration of R&M activities with design engineering, systems engineering and cost analyses.
(e) Impacts of R&M analyses results on system design in improving R&M goals while optimizing the system safety and mission success.
(f) Reference data sources and modifications.
(g) Validation of R&M models and data.
(h) Verification activites.

13.2 **APPLICABLE DOCUMENTS**:

Meets/Exceeds Documents per J3:
MPCV 70059: MPCV Program Safety & Mission Assurance Requirements

13.3 **CONTENTS**:

1. Executive Summary
This volume will contain a summary of the R&M Report including the relationships between the Reliability and Maintainability volumes. The following shall be included in the Executive Summary:
(a) A table of contents for the report
(b) Description of each volume and attached appendices
(c) General description of the baseline vehicle design used in the forumulation of the report.
    a. Identify areas in the report where there are deltas to the baseline design
(d) Description of any integrated issues between the Reliability and Maintainability volumes that are contained in the report.

2. Reliability Volume

The Reliability volume shall document the reliability data, tools, and analyses (including pertinent groundrules and assumptions) used to show concurrence or deviation with the applicable MPCV Systems Requirements at each step in the design cycle. The data generated from the reliability analyses shall provide input to the systems maintainability, supportability, logistics, and availability analyses. Details of the Reliability volume shall include the following:
(a) Quantitative reliability allocations from the given upper level system allocation down to the LRU and/or component level.
(b) Quantitative reliability predictions based on the best available reliability data (e.g., demand rate, MTBF, or failure rate data) from vendors, prior test information, generic sources, heritage equipment history, or similarity to other existing items along with a traceable documentation of data source information, failure rate estimation factors, models or processes used.
(c) Comprehensive equipment list of the flight hardware delineating the items and/or components for which reliability analyses and predictions are performed.
(d) Limited life items (limited operating-life items and limited shelf life items) which require control from equipment date of manufacture throughout operational use, including storage.
(e) Definition of the quantitative reliability parameter data and adjustments (e.g., failure mode definitions and distributions) made for use by the Probabilistic Risk Assessment and other supporting reliability analyses.

3. Maintainability Volume

The Maintainability volume shall document the maintainability data, tools, and analyses (including pertinent groundrules and assumptions) used to show concurrence or deviation with the applicable MPCV System requirements at each step in the design cycle. This volume shall reflect the maintenance concept required by MPCV 70059, MPCV Program S&MA Requirements Document. The data generated from the maintainability analyses shall provide input to the reliability, supportability, logistics, and availability analyses.. Details of the Maintainability volume shallinclude the following:

(a) Line Replaceable Units (LRUs) and Orbital Replacement Units (ORUs) subject to maintenance, repair or replacement based on the Program's maintenance concept.
(b) Maintainability allocations to the system, subsystem, LRUs, and below to the component level if necessary to correspond with the level at which repair/replacement is to occur for both corrective and preventive maintenance.
(c) Maintainability predictions at the levels for which repair/replacement may be expected involving corrective and preventive maintenance.
(d) Provide maintainability assessment results for each applicable mission phase including Mean-Time-To_Repair (MTTR), Mean-Down-Time (MDT), Maximum-Time-To_Repair (MaxTTR), Mean-Corrective-Maintenance (M_{CT}) and Mean-Preventive-Maintenance-Time (M_{PT}) (as applicable) for each Maintenance Significant Item, LRU, subsystem or system along with a traceable documentation of source information, models or processes used.
    (1) For LRUs and ORUs replaceable on the pad, Mean-Time-To-Repair (MTTR) and Mean-Down-Time (MDT) predictions are required.
    (2) For ORUs during flight, the Maximum-Time-To-Repair (MaxTTR) and the Mean-Preventive-Maintenance (M_{PT}) times to comply with the HSIR are required.
(e) Basis, decision process, engineering rationale and trade studies to decide the number of LRUs and ORUs and the justification of that number for each subsystem.
(f) Provide Mean-Time-Between-Maintenance-Events (MTBME)information (as applicable)for each LRU and SRU.
(g) Details of Reliability Centered Maintenance and optimum levels of maintenance along with necessary justification.
(h) Provide details of spares optimization based on the unique requirements of each Design Reference Mission (DRM).

4. Appendices

Appendices will be included in the R&M Report to support the Reliability and Maintainability volumes. These appendices shall be made available as Type 4 data every six months starting with EM-1 PDR. The appendices will include:

(a) An appendix containing an accessible data file of the Orion R&M database. This data file will be a "snaphsot" of the database based on the date that the report is being developed. The Reliability and Maintainability Data Architecture dataset shall include:
    (1) Reliability performance parameters (e.g., MTTF, MTBF)
    (2) Failure mode and failure mode distributions for each reliability performance parameter
    (3) Maintainability performance parameters (e.g, MTTR, MDT, MaxTTR, M_{CT}, M_{PT})
    (4) Supportability performance parameter (e.g., MTBME)
(b) Listing of the Limited Life Items along with provisions delineating the replacement or refurbishment and criteria that is used to determine when the items will be replaced or refurbished.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-S-012
3. **DATA TYPE**: 1/3*_
4. **DATE REVISED**: May 2009
5. **PAGE**: 1
6. **TITLE**: Government-Industry Data Exchange Program and NASA Advisories/ALERTS

7. **DESCRIPTION/USE**:
To provide a controlled method for MPCV Program and Contractor ALERT initiation, investigation, resolution, and response. The types of data include:
(a) Contractor and subtier implementation procedures.
(b) Preperation and submittal of GIDEP documents.
(c) Preparation and submittal of NASA Advisories in coordination with the NASAS-JSC Advisory Coordinator.
(d) Task management, control, and tracking status.
(e) Special investigations and cost data on special problems (including criminal investigations).

8. **DISTRIBUTION**: As determined by the Contracting Officer

9. **INITIAL SUBMISSION**: See Submission Frequency

10. **SUBMISSION FREQUENCY**: Data shall be submitted as follows:
a) Contractor and subtier implementation procedures (60 days after contract award)
b) Release of GIDEP documents (in compliance with S0300-BT-PRO-010, GIDEP Operations Manual)
c) Release of NASA Advisories (in coordination with the NASA-JSC Advisory Coordinator per NASA policy)
d) Problem data assessment in accordance with NASA policy as defined in Table 1.

Table 1 – GIDEP/NASA Advisory Documents Response

Launch Minus (Calendar Days)	Response Time (Calendar Days)
>90	Quarterly
≥30≤90	5
21-30	4
8-20	3
3-7	2
2	1
1	Immediate

11. **REMARKS**:
Contractor must provide to NASA the name and contact details of the Contractor's GIDEP Representative/Coordinator, within 30 days of contract award and as changes occur thereafter.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 3.4.
Related DRDs: CEV-S-001

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:

The Contractor and its subcontractors shall participate in the Exchanging Parts, Materials, and Safety Problem Data Utilizing the Government Industry Data Exchange Program (GIDEP) and ensure that all applicable GIDEP ALERTS, GIDEP SAFE-ALERTS, GIDEP Problem Advisories, GIDEP Agency Action Notices, and NASA Advisories are:
1) reviewed and dispositioned,
2) ensure that all significant parts, components, materials, specifications, software, facilities, manufacturing processes or test equipment, and safety problems of a general concern are identified and corresponding data are exchanged with this system, and 3) present the status of all applicable items for review at program milestones and readiness reviews in accordance with the S&MA Plan (DRD CEV-S-001).

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
S0300-BT-PRO-010: Government-Industry Data Exchange Program (GIDEP) Operations Manual

Meets/Exceeds Documents per J3:
MPCV 70059, MPCV Program S&MA Requirements Document

NOTE: GIDEP Operations Manual identifies the GIDEP Requirements Guide as Appendix E.

13.3 **CONTENTS**:

GIDEP ALERTs and NASA Advisories shall be prepared and responded to in accordance with the GIDEP Operations Manual, NASA Policies, and include:

(a) Contractor initiated GIDEP Documents – The proposed GIDEP Document shall include, but not be limited to:

1. Essential details required identifying problem by types and/or manufacturer's name, special requirements and environments, the problem situation (condition) and cause, actions taken and recommendations. Such data shall be restricted to objective, factual information.
2. Names of responsible individuals and organizations that may be contacted for further technical details.
3. Upon MPCV Program approval, contractor initiated ALERTs that are of general concern shall be coordinated with NASA (JSC NASA Advisory Coordinator). When identified as a GIDEP document the Contractor or its subcontractor shall complete the appropriate GIDEP document and submit to GIDEP, in accordance with the GIDEP Operations Manual.
4. If it is determined in coordination with NASA (JSC NASA Advisory Coordinator) that this information is limited to NASA only, the contractor will be provided JSC NASA Advisory Form, JSC Form 1159 for completion. The NASA JSC Advisory Coordinator will coordinate for NASA for concurrence (i.e., legal counsel and export control) in accordance with NASA policies.

(b) Response reports for GEDIP/NASA Advisory documents disseminated by the MPCV Program (JSC NASA Advisory Coordinator):

1. The contractor shall respond to GIDEP Documents and NASA Advisories disseminated by the CEV Program (JSC NASA Advisory Coordinator) with one of the following three categories:
   (a) No Impact
   (b) Usage with No Impact
   (c) Usage with Impact
   (d) Open, on-going investigation, undetermined or suspected usage
2. Follow-up reports provide results of investigations, analyses,

etc. may be extended beyond the allowed working days for the initial report; GIDEP/NASA Advisory documents may be closed out if no corrective action required.

3. GIDEP Document status shall be provided to the MPCV Program (NASA-JSC Advisory Coordinator) via reports with agreed upon frequency coordinated with the MPCV Program, NASA-JSC Advisory Coordinator and Contractor GIDEP Coordinator.

4. No response required on NASA Advisories marked 'Information Only' unless an impact is identified.

13.4 **FORMAT**: (a) The Contractor's format is acceptable for their internal implementation procedures.
(b) GIDEP docuements are to be prepared on the appropriate GIDEP form in accordance with the GIDEP Operations Manual.
(c) NASA Advisories are to be prepared on the JSC NASA Advisory Form, JF 1159 and coordinated by the NASA-JSC Advisory Coordinator.
(d) The contractor's format is acceptable for providing the 'Task Management, Control, and Tracking Status' as long as it includes all the necessary information (GIDEP/NASA Advisory document number, disposition status, part numbers affected, the system affected, a risk analysis along with a mitigation plan for acceptance of continued usage, and/or corrective/preventive action).
(e) Cost data are to be provided as required by the financial management reporting system and as necessary to substantiate the data being submitted in support of criminal investigations
(f) Contractor initiated ALERT- The proposed GIDEP ALERT Document shall be submitted to the MPCV S&MA representative with a copy to the JSC NASA Advisory Coordinator. When immediate NASA community notification is identified as urgent but time and/or complete technical detail is being gathered, a NASA Advisory, NASA Form 1159 may be utilized by coordinating with the NASA JSC Advisory Coordinator. Upon completion of technical detail, the Contractor initiator shall follow-up with the appropriate GIDEP Document in accordance with the GIDEP Policies for dissemination to all GIDEP participants.

13.5 **MAINTENANCE**: Data shall be maintained as required to:
(a) Document the current implementation procedures and GIDEP and NASA Advisory Policies.
(b) Ensure that the released GIDEP information is complete, factual, accurate and up to date.
(c) Ensure that the released NASA Advisory information is complete, factual and up to date.
(d) Tracking status provided periodically to demonstrate complete accomplishment of the task.
(e) Stay current and accurate or as requested to support management activities.
(f) Substantiate submitted costs or to include additional costs as they are intended.

KEEP DRD CEV-S-013 AS RESERVED

KEEP CEV-S-014 AS RESERVED

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-S-015
3. **DATA TYPE**: 2/4
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Critical Processes

7. **DESCRIPTION/USE**:
The Contractor shall document the controls that they shall use for those manufacturing processes where uniform high quality cannot be ensured by inspection or test alone and the failure would be of a critical nature.

8. **DISTRIBUTION**: As determined by the Contracting Officer

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: See Remarks:

11. **REMARKS**:
The Contractor should demonstrate and verify control of the quality of the operation by employing process controls throughout all phases of hardware manufacture at all supply levels. The intent of this standard is to ensure that manufacturing quality requirements are defined and that designs permit and facilitate the quality considerations of producibility, repeatability, and refurbishability/maintainability.

Submission shall be as follows:
EM1/EM2:
Final at EM1 CDR (or equivalent milestone) as Type 2. Update, if required, for EM2 CDR. Type 2 applies to the general procedures and processes.
Critical processes are to be identified at the applicable component and subsystem CDRs (SSDRs)in accordance with design milestone entrance criteria.

At the EM1 CDR (or equivalent milestone), the compilation of critical processes shall be provided as Type 4. The list shall be maintained and updated, if required, for the EM2 CDR (or equivalent milestone) as Type 4.

EFT1: Not Applicable

AA-2: Not Applicable

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 3.5.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:

Any manufacturing or assembly process that cannot be verified by inspection or test of the production article, and if not precisely applied and controlled within its defined limits, could result in hardware failure (regardless of redundancy) that results in loss of human life or serious injury/illness to the flight crew, ground crew, or general public; or results in loss of mission, or loss of a significant mission resource.

The assessment of Critical Processes shall encompass a review of those Critical Items List failure modes that do not have physical test or inspection as the retention rationale. Inspection or test of a product specimen does not constitute test or inspection of the production article.

The requirements established in this DRD shall apply to production flight hardware and deliverable Ground Support Equipment (GSE). While this DRD is not applicable to Abort Flight Test (AFT) production, consideration should be given to identify AFT production processes that would be applicable to flight production for inclusion into the Critical Process list.

13.2 **APPLICABLE DOCUMENTS**:

Meets/Exceeds Documents per J3:
MPCV 70059, MPCV Program Safety and Mission Assurance Requirements Document

13.3 **CONTENTS**:
The Critical Processes document (Type 2) shall include as a minimum:
1. Process controls:
(a) Applicable manufacturing processing requirements with detailed performance and control provisions.
(b) Process preparation requirements.
(c) Detailed processing operations.
(d) Conditions to be maintained during each phase of the process including environmental controls.
(e) Methods for verifying the adequacy of the processing materials, solutions, equipment, environments, and their associated control parameters.
(f) Required records for documenting the results of the process inspection, test, and verification.

2. Equipment certification:
(a) Manufacturing equipment tests and their results shall be recorded, certified, and maintained.
(b) Plans for recertifying equipment as required by quality surveys, inspections or tests, or when changes are made which may affect process integrity.

A listing of all critical processes shall be submitted and maintained as Type 4.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-S-016
3. **DATA TYPE**: 2
4. **DATE REVISED**: May 2009
5. **PAGE**: 1
6. **TITLE:** Mechanical Parts Management Plan

7. **DESCRIPTION/USE**:
To define and document the contractor's plan for acquisition, testing, handling, packaging, storing, and maintaining traceability for Mechanical Parts (including fasteners, bearings, studs, pins, rings, shims, valves, springs, brackets, clamps, and spacers) for flight and critical ground support equipment.

8. **DISTRIBUTION**: The contractor's Mechanical Parts Control Plan shall be provided to the NASA CEV S&MA organization as a minimum for approval.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
Final @ post-Orion PDR.
EM1/EM2:
Update at EM1 and EM2 CDR (or equivalent milestone) as required.
EFT1: Compliance to S-016 required for part lots that cannot be isolated to EFT1
AA-2: Update as required

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 3.5.
Related DRD(s): CEV-T-019, CEV-T-069

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Mechanical Parts Management Plan defines the contractor's approach for acquisition, testing, handling, packaging, storing and maintaining the traceability of mechanical parts Fasteners shall be subject to additional requirements per NASA-STD-6008.

13.2 **APPLICABLE DOCUMENTS**:

Meets/Exceeds Documents per J3:
- MPCV 70059: MPCV Program Safety and Mission Assurance
- NASA-STD-I-6016: Standard Materials and Processes Requirements for Spacecraft
- NASA-STD-5019: Fracture Control Requirements for Spaceflight Hardware
- NASA-STD-6008: NASA Fastener Management and Control Practices

13.3 **CONTENTS**:
The Contractor's Mechanical Parts Management Plan shall include the following:

1. Acquisition:
   - Plan shall define a process that specifies which mechanical parts must be procured from an approved manufacturer or a distributor.

- Plan shall define a process for certifying manufacturers and distributors of mechanical parts.
- Plan shall define a process to avoid procuring defective mechanical parts as identified in a NASA Advisory or Government-Industry Data Exchange Program (GIDEP) Alert.
- Plan shall define a process for identifying replacements for mechanical parts that become obsolete.
- Plan shall define a process for tracking the usage of limited life items.
- Plan shall define a process for identification and disposition of mechanical parts that have exceeded their life limit.

2. Testing:
   - Plan shall define a process for acceptance testing of mechanical parts.
   - Plan shall define how nonconforming mechanical parts shall be dispositioned according to the contractor's quality management system (QMS).
   - Plan shall define a process to report generic nonconformances and/or counterfeit part issues to GIDEP.
3. Handling, Packaging and Storage:
   - Plan shall describe how mechanical parts will be maintained in the appropriate environment and controlled access storage.
   - Plan shall describe how reuse of mechanical parts will be controlled.
   - Plan shall describe how mechanical parts will be issued and returned to storage for proper accounting.
4. Traceability:
   - Plan shall describe how commingling of mechanical parts, and specific lots of mechanical parts (when lot control requirements are required) will be prevented.
   - Plan shall describe when Manufacturer's Tset Reports (MTRs) or equivalent are required. MTRs are always required for fracture-critical items per NASA-STD-5019. MTRs are always required for fracture-critical, low-risk, and fail-safe fasteners per NASA-STD-6008.
   - Plan shall describe when Certificates of Compliance or equivalent are required.
5. Compliance:
   - Plan shall, for fasteners, define an implementation approach consistent with the applicable sections of NASA-STD-6008.
   - Plan shall define an approach consistent with MPCV 70059, Appendix A, to verify compliance with this Mechanical Parts Control Plan at the contractor and subcontractor level.

13.4 **FORMAT**: Electronic format per section J-2 2.3.21

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

KEEP CEV-S-017 AS RESERVED

KEEP CEV-S-018 AS RESERVED

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-001
3. **DATA TYPE**: 2/3/4
4. **DATE REVISED**: Nov 2013
5. **PAGE**: 1
6. **TITLE**: Models, Simulations, and Integrated Support Plan

7. **DESCRIPTION/USE**:
This DRD defines the periodic delivery of analysis models to support design and analysis activities and integrated software simulations to support Test Beds. The DRD includes:
    1. A Modeling and Simulation Support Plan
    2. Analytical models and data that support design and analysis
    3. Integrated simulations that support Orion Test Beds
    4. Tabular listing of the analytical models and Orion Test Bed Simulations

The Modeling and Simulation Support plan provides a definition of the analysis models and the integrated software simulations used by the program and also defines how the models and simulations that are used in hardware and software testing are validated and shown to be credible.

The analysis models consist of the analytical tools utilized by the program in support of engineering design and verification activities. These models include engineering models of the MPCV system, modules, subsystems, and components. These models are typically discipline (e.g. aerothermal, structural loads, trajectory, environments) oriented and are implemented using many different tools and data formats.

The integrated software simulations are used to support integrates software and hardware tesing in the various Orion Test Beds. These integrated simulation are delivered per the Software Development Plan CEV-T-005(J-1 para. 6.5.1) and are included as an appendix in this DRD.

The delivery of the models and simulations provide NASA with the capability to generate key engineering data in support of the program and are used by NASA to support the development of models and simulations for Mission Operations, such as training simulators.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix.

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix.

11. **REMARKS**: The Modeling and Simulation Support Plan is a Type-2 DRD. The final/baseline deliveries of the analysis models and integrated test bed simulations are Type-3. The M&S tabular report as specified in the M&S Support Plan is Type-4.

NOTE: Informal deliveries of models (e.g., models transferred to NASA between the formal deliveries identified in the M&S Support Plan) may be treated as Type-4.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.4.
Referenced from SOW Paragraph(s): 2.3.(c), 6.1.5, 10.3.7

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:

The Modeling and Simulation Support Plan and associated model and simulation deliveries includes a definition of the analytical models and simulations utilized to support contractual analyses and documentation of the processes used to ensure validity/credibility of the analysis results. The Support plan also defines the processes to ensure that the simulation models utilized in test are validated and deemed credible.

13.2 **APPLICABLE DOCUMENTS**:

Meets/Exceeds Documents per J3:
NASA-STD-7009 NASA Standard for Models and Simulations

13.3 **CONTENTS**:

Coverage: Delivered models shall represent all MPCV subsystems listed in SOW section 6.2 plus (a) any ground systems and communications models required to simulate intended system function, and (b) any relevant vehicle environment models (e.g. gravitational, thermal, electromagnetic, radiation) utilized to evaluate nominal and off-nominal system performance.

The models will emulate nominal performance over a range of inputs corresponding to design parameters to support trade studies as well as off-nominal operations to support safety analysis and flight software testing.

The Modeling and Simulation Support Plan shall include the following content:

1. The contractor's approach for the management of models and simulations over the program life cycle.
2. The contractor's approach for configuration management of M&S tools and data management of input and output data.
3. The contractor's approach for verification and validation of analysis models, test bed simulations, and input and output data used to support program decisions (meets or exceeds NASA-STD-7009).
4. The contractor's approach for defining and implementing practices, procedures, and mechanisms to ensure the credibility of results from M&S.
5. Specify the contractor's M&S standards and protocols to support reuse and data exchange among M&S tools.
6. Specify the contractor's approach for providing NASA access to the models and simulations, source code, data files, and build files via a contractor-specified common respository.
7. Specify the contractor's approach for NASA to obtain M&S-related data such as: input and output data, runs-for-record, and model parameters in an identified controlled location.
8. A definition of the analytical models and simulations used to support contractual analyses including a tabular listing of the simulations, a brief description of each planned model and simulation, the analysis it supports, and the contractor specified locations of the source information that define the models and simulations.

The Contractor can include additional sections that further describe their modeling and simulation support process or can substitute a document used internally or another DRD if it contains this information.

Each delivery for this DRD shall consist of:

1. A revision of the Modeling and Simulation Support Plan, if required.
2. A tabular listing of each model included in the delivery along with the model version.
3. The Orion Test Bed Integrated Simulation Models
4. The Analytical Models
5. The documentation for each model per the M&S support plan
6. The source code, data files and build files for each model
7. The compiled versions of each model that runs under Windows, Macintosh, Linux or another Unix distribution.
8. Any unique source code created for tools used to create data used by or included in the models.
9. A comprehensive list of file formats for the simulation data
10. System diagrams that define inputs and outputs between individual models

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.
NOTE: MSDB report will be delivered in Excel or HTML, or web-accessible database file

13.5 **MAINTENANCE**: All models shall be utilized for MPCV system maturation through operation and therefore maintained to the as-built configuration.

KEEP CEV-T-002 AS RESERVED

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-003
3. **DATA TYPE**: 3
4. **DATE REVISED**: 1 July 2010
5. **PAGE**: 1
6. **TITLE**: CEV CAD Models
7. **DESCRIPTION/USE**:
CEV CAD models will include all solid models, surface models and associated construction references, such as coordinate systems and datum planes, used by the contractor in the design, layout, manufacturing, assembly, testing, certification and flight hardware processing of the delivered CEV System and associated Contractor-provided ground systems. The level of detail presented in the 2-D and 3-D CEV CAD models will progress from the system, module, and sub-system level to the component level over the course of the CEV Project lifecycle. The end state will be such that all CAD models utilized by the Contractor and their subtiers shall be delivered to NASA. The aggregate set of models and drawings, as defined in CEV-T-004, shall define every dimension of the CEV.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.4, 6.1.3.8, 6.1.3.14, 6.1.6.1, 6.2.6.1, 6.4.6.1.
Referenced from SOW Paragraph(s): 2.7.2.(c); 6.1.2 (and subparagraphs), 6.2.2 (and subparagraphs), 6.4.2 (and subparagraphs), 6.1.3 (and subparagraphs), 6.2.3 (and subparagraphs), 6.4.3 (and subparagraphs).

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
This document covers 2-D and 3-D CAD model developed by the Contractor for any CEV and Contractor-provided ground system, module, subsystem, and component. This specifically includes wiring, piping, ducting, all outer mold lines and mechanisms. All models must include material properties, identification and composition information for all parts represented by the model.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
Detailed solid models shall be provided for the design, layout, manufacturing, assembly, testing, certification and flight hardware processing of the delivered CEV Systems acording to the scope outlined in this DRD. The detailed solid models shall be 2-D and 3-D and shall include the parameters, coordinate systems(s), datum planes, surfaces, axes, points used for model construction and reference purposes. In addition, simplified graphical representations of components, subassemblies and assemblies shall be provided, when such representations are not generated by the ICE system.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: All CAD models shall be maintained to reflect the spacecraft and ground systems as-built configuration.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-004
3. **DATA TYPE**: 3
4. **DATE REVISED**: 1 8/2010
5. **PAGE**: 1
6. **TITLE**: CEV Drawings

7. **DESCRIPTION/USE**:
CEV Drawings includes released manufacturing, layout, assembly and installation drawings (including Outer Mold Line),and schematics for all modules, subsystems, and components of the CEV System. The level of detail presented in CEV drawings will progress from the system and sub-system level to the component level over the course of the CEV Project lifecycle. The end state will be such that all drawings utilized by the Contractor and their subtiers shall be delivered to NASA. The aggregate set of drawings and models, as defined in CEV-T-003, shall define every dimension of the CEV.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.4, 6.1.3.8, 6.1.3.14, 6.1.6.1, 6.2.6.1, 6.4.6.1, 6.2.6.1, 6.2.6.1, 6.4.6.1.
Referenced from SOW Paragraph(s):6.1.2 (and subparagraphs), 6.2.2 (and subparagraphs), 6.4.2 (and subparagraphs), 6.1.3 (and subparagraphs), 6.2.3 (and subparagraphs), 6.4.3 (and subparagraphs).

13. **DATA PREPARATION INFORMATION**:

13.1 **<u>SCOPE</u>**:
This document covers all drawings developed by the Contractor for any CEV or ground system, subsystem, or component. This specifically includes wiring, piping, ducting, all outer mold lines and mechanisms. All drawings must include material properties, identification and composition information for all parts represented by the drawing.

13.2 **<u>APPLICABLE DOCUMENTS</u>**:
Meets/Exceeds Documents per J3:
ASME Y14.100: Engineering Drawing Practices
ASME Y14.24: Types and Applications Of Engineering Drawings
ASME Y14.34M: Associated Lists
ASME Y14.35M: Engineering Drawings and Associated Documents

13.3 **<u>CONTENTS</u>**:
All released manufacturing, assembly, installation and layout drawings and schematics of the CEV System, modules and subsystems including all components, subassemblies and assemblies to include:
a) Manufacturing drawings
b) Assembly drawings
c) Installation drawings
d) Layouts
e) Schematics

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. The Contractor shall deliver the native, working file regardless of format plus a searchable PDF output for each drawing. All drawings shall be directly derived from solid CAD models when CAD models exist.

13.5 **MAINTENANCE**: CEV drawings and schematics shall be maintained to reflect the spacecraft and ground systems as-built configuration.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-005
3. **DATA TYPE**: 2
4. **DATE REVISED**: Dec 2010
5. **PAGE**: 1

6. **TITLE**: Software Development Plan

7. **DESCRIPTION/USE**:
A plan for conducting the software development effort. This DRD develops and records the plans for all software development activities.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
The term 'software development' is meant to include new development, modification, reuse, reengineering, maintenance, and all other activities resulting in software products.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 6.5.2.
Referenced from SOW Paragraph(s): 6.5.3
Related DRD(s): CEV-O-008, CEV-S-001,CEV-T-006

13. **DATA PREPARATION INFORMATION**:

13.1 **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.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)

Meets/Exceeds Documents per J3:
CxP 70065, Constellation Program Computing System Requirements, Appendix C (Software Types by Classification Matrix)
IEEE/EIA 12207.0-1996: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes
IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207; 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data

13.3 **CONTENTS**:
In accordance with NPR 7150.2, NASA Software Engineering Requirements, and using IEEE/EIA 12207.1-1997 as guidance, the Software Development Plan shall consist of seven volumes.

***Volume 0 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)).
(b) Engineering environment (for development, operation or maintenance, as applicable), including test environment, library, equipment, facilities, standards, procedures, and tools.
(c) Work Breakdown Structure (WBS) of the life cycle processes and activities, including the software products, software services, and non-deliverable items to be performed. The WBS also includes budgets, staffing, physical resources, software size, and schedules associated with the tasks.
(c) Management of safety, security, privacy, and other critical requirements of the software products or services.
(d) Subcontractor management, including subcontractor selection and involvement between the subcontractor and the acquirer, if any.
(e) Quality assurance.
(f) RESERVED
(g) Verification and validation, including the approach for interfacing with the independent verification and validation agent.
(h) Acquirer involvement.
(i) User involvement.
(j) Risk management.
(k) Security policy.
(l) Approval required by such means as regulations, required certifications, proprietary, usage, ownership, warranty and licensing rights.
(m) Process for scheduling, tracking, and reporting.
(n) Training of personnel.
(o) Software life cycle model including description of development methodology and approach, software integration and hardware/software integration processes, software delivery, and maintenance/regression testing.
(p) Configuration management process of all software products, including this document.
(q) Software documentation tree.
(r) Peer review/inspection/walkthrough process of all software work products.
(s) Process for early identification of testing requirements that drive software design decisions, e.g., special system level timing requirements/checkpoint restart.
(t) Content of software documentation to be developed on the project.
(u) Justification for reuse of existing software, modification of existing software, and the development of new software. For reuse of existing software, a map must be developed which shows the original requirements associated with the existing software matrixed against the CEV requirements to demonstrate that the reuse is appropriate.
(v) Plan for performing continuous process improvement of the software development, configuration management, test and verification, build and release management, and maintenance processes used to produce, control, and maintain the software products and artifacts.

Volume 2 Software Measurement Plan (SMP)
The software measurement plan defines the software measurements, or metrices, that will be collected and reported. The plan will also include the process used to collect software metrics and the relationship to software metrics collected by subcontractors.

The Software Measurement Plan shall contain:
a. Purpose and scope of document volume

b. Introduction/overview of software metrics and collection process
c. Relationshipt to other software and project plans
d. Description of the software measurement process, goals and objectives, organization, roles and responsibilities, planning and collection activites
e. Description of the relationship of the software measurement plan to the project performance and measurement plan
f. Description of software metrics to be collected, including (but not limited)
    i) Metric collection category
    ii) Metric name
    iii) Purpose/scope of metric
    iv) Collection frequency
    v) Collection method
    vi) Analysis criteria

Volume 3 Software Development Plan Tailoring

The software development plan tailoring describes the process tailoring that has been approved by CEV software management. It shall also describe any approved subcontractor tailoring of the standard processes described in the Software Development or Configuration Management Plans. It shall also describe any NPR 7150.2 waivers approved by the NASA Independent Technical Authority.

The Software Development Plan Tailoring shall contain:

a. Purpose and scope of document volume
b. Introduction/overview of software reconfiguration process
c. Relationship to other software and project plans
d. Description and guidelines for SDP tailoring
e. Separate section for each project orgainizational unit or subcontractor providing SDP tailoring to include:
    i) Descriptions of each tailored process or product to the equivalent level of detail contained in the SDP
    ii) List of all tools used that are not part of the standard software development tool chain as listed in the SDP
    iii) List of all additional programming languages and associated programming language coding standards used

Volume 4 Software Reconfiguration Process Plan

The software reconfiguration process plan provides a description of the plans to to collect, process, validate/verify, and produce reconfiguration data products.

The Software Reconfiguration Process Plan shall contain:

a. Purpose and scope of document volume
b. Introduction/overview of software reconfiguration process
c. Relationship to other software and project plans
d. Descriptions of the following software reconfiguration process areas:
    i) Flight Software Mission reconfiguration
    ii) Ground Software Mission reconfiguration
    iii) Simulation software reconfiguration
e. Description of the tools and support software developed used to produce the reconfiguration products for each of the above areas (d.)
f. Description of the review process for reconfiguration products produced by each of the above areas (d.)

Volume 5 Software Classification and NPR 7150.2 Mapping

The Software Classification and NPR 7150.2 Mapping shall contain:

a. Purpose and scope of the document

b. Introduction/overview of NPR 7150.2 software classification activites and process mapping
c. Relationship to other documents

In accordance with NPR 7150.2, NASA Software Engineering Requirements the contractor shall

d. Provide a table that lists the following:
    i) Classification all software developed or used by the project at a level that allows appropriate process rigor to be applied
    ii) Determination of the safety criticality of the software (yes/no)
    iii) Assessment of the appropriate level of software assurance based on classifaction and safety criticality
e. Provide a set of tables that map the appropriate processes to each requirement in the NPR 7150.2 for each software classification level

Provide additional tables, based on software classification, for any approved tailoring or waivers from 7150.2 for a specific software classification level.

CxP 70065, Constellation Program Computing System Requirements, Appendix C (Software Types by Classification Matrix) shall be used as information in preparing the software classification section of this volume.

Volume 6 Software Build Plan

The Software Build Plan shall contain:

a. Scope, including system identification, system overview, and relationship to other plans.
b. Project organization structure showing authority and responsibility of each organization unit, including external organizations, and any organization unique to a software build.
c. Software build planning process applied to all software builds.
d. Mapping of software components (CSCI/CSC) to software builds.
e. Traceability between software builds and the software requirements being implemented.

For each software build, the following contents shall be provided:

f. A description of the software build.
g. Assumptions and ground rules.
h. Necessary process tailoring from the SDP or SCMP.
i. An integrated software load schedule including major milestones, external dependencies, and customers who need the software load.
j. A list of the software components in terms of CSCI/CSC incorporated in the software load, including flight software, ground software, simulation software, and data service software.
k. A list of COTS/GOTS/MOTS incorporated into the software build.
l. A description of the evolution of software components of the software load, including capability addition and deletion for each software component, and software classification and criticality changes of software components.
m. Software load building instructions and procedures.
n. A list of all Change Requests (CRs), Software Problem Reports (SPRs) incorporated into the SW build.
o. A list of deliverable products of the build, or a reference to the deliverable list. The deliverable products shall include the build software package and the associated documentation.
p. A description of the software build delivery mechanism and a description of the maintenance of the software build prior to the next software build.
q. Lessons learned.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Changes shall be identified and complete re-issue of the document is required

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-006
3. **DATA TYPE**: 2
4. **DATE REVISED**: 12/20/2005
5. **PAGE**: 1
6. **TITLE**: Software Configuration Management Plan

7. **DESCRIPTION/USE**:
To describe a plan for performing Software Configuration Management (SCM).

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 6.5.2.
Referemced from SOW Paragraph: 1.2.(a)
Related DRD(s): CEV-M-003, CEV-S-001

13. **DATA PREPARATION INFORMATION**:

13.1 **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 full term of performance of the contract. This plan identifies the required coordination of software configuration management activities with other activities of the project.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)

Meets/Exceeds Documents per J3:
IEEE/EIA 12207.0-1996: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes
IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207; 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data

13.3 **CONTENTS**:
In accordance with NPR 7150.2 NASA Software Engineering Requirements, and using IEEE/EIA 12207.1-1997 as guidance, the Software Configuration Management Plan shall contain:
(a) Introduction information, including the purpose of the Plan, the scope, the definition of key terms and references.
(b) SCM management, including the project organization(s) within which SCM is to apply, SCM responsibilities of these organizations, and references to the SCM policies and directives that apply to the project.
(c) SCM activities information, which identifies all functions and tasks required to manage the configuration of the software, including

configuration identification, configuration control, status accounting, and configuration audits and reviews.
(d) SCM schedule information, which establishes the sequence and coordination for the identified SCM activities and for all events affecting the Plan's implementation.
(e) SCM resource information, which identifies the software tools, techniques, and equipment necessary for the implementation of the specified SCM activities.
(f) SCM Plan maintenance information, which identifies the activities and responsibilities necessary to ensure continued SCM planning during the lifecycle of the project.
(g) Software release management and delivery.
(h) Software problem reporting and corrective action process.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Changes shall be identified and complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-007
3. **DATA TYPE**: 5
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Software Development Folder

7. **DESCRIPTION/USE**:
A repository for material pertinent to the development of a given software unit or set of related units, collected as the requirements and design mature and testing progresses. This information will be used by NASA to provide additional insight into the contractor's flight, ground, and test software effort and products. Each folder shall be 'mirrored' in ICE on a weekly basis.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 6.5.2, 6.5.4.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
Software Development Folders (SDFs) should be used to consistently document each Computer Software Configuration Item (CSCI) and the corresponding Computer Software Components (CSCs) and Computer Software Units (CSUs), to aid in their integration, and to ensure that all required tests have been completed for all CSCs and CSUs. A SDF shall be maintained at the functional software level (i.e. at least one per CSCI, and perhaps one per CSC, dependent upon software complexity and hierarchical structure of the software). Contents include the requirements, design, technical reports, code listings, test plans, test procedures, test results, inspection results, problem reports, change requests, schedules, and notes related to the CSCIs, CSCs, and CSUs. The SDFs also serve as repositories for preliminary and interim software requirements, design rationale, documentation of prototyping efforts, project review documentation, test plans for, and results of, unit and integration tests, notes, and preliminary versions of user documentation.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
Each SDF shall contain:
(a) CSCI/CSC/CSU description, including a brief overview of the function of the CSCI/CSC/CSU, a list of CSCI-to-CSCI, CSC-to-CSC, CSU-to-CSU interfaces, a list identifying any subtier CSCs (for a CSCI SDF) or CSUs, (for a CSC SDF) and identifies the hardware in which the CSCI/CSC/CSU is embedded and any hardware interfaces.
(b) Detailed schedule, showing when each major milestone (i.e., preliminary design review, critical design review, etc.) occurs and how the CSCI/CSC/CSU schedule relates to the review cycle.
(c) Review comments and status, providing status on action items given

during each design, code, and test inspection, and for each major life cycle milestone related to this CSCI/CSC/CSU. For Peer Reviews, information shall include:

(1) Identification Information (including Item Being Inspected, Inspection type, and Inspection Time and Date).
(2) Summary on total time expended on each inspection/peer review (including total hour summary and per reviewer summary).
(3) Participant Information (including total number of participants and participants area of expertise).
(4) Total number of defects found (including major defect/minor defect breakdown and issues classification breakdown).
(5) Inspection results summary (i.e., pass, re-inspection required, etc.).
(6) Listing of all inspection defects.
(7) Electronic copy of item being inspected

(d) Design notes, including a current copy of any preliminary and detailed design presentations, informal design ideas and notes, design drivers and rationale, and notes on any informal interface agreements between CSCIs/CSCs/CSUs.
(e) Software Models of CSCI/CSC/CSU (in modeling tool format)
(f) Software source listing - either a current electronic listing of the source code or a reference to the directory path and file name, as reflected/mirrored on the ICE, where the code can be found. Source code shall be available starting when the code reaches the unit testing stage.
(g) Unit, CSC, and CSCI integration and test data, including all data pertaining to the integration and testing of each CSU, CSC, and CSCI. The information includes the test procedure, the test environment and configuration (i.e. hardware configuration identification or emulated/simulated configuration), the version ID of the tested software, the date the test was performed, a summary of the test results, printouts of the test data, test notes, source listings of any drivers or stubs, and programmer and/or management certification that the test was completed successfully.
(h) Discrepancy Reports/Change Requests/Problem Reports, including all discrepancy reports and change requests currently open against this CSCI/CSC/CSU.
(i) Preliminary user documentation and notes.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: N/A

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-008
3. **DATA TYPE**: 2/4
4. **DATE REVISED**: Nov. 2013
5. **PAGE**: 1
6. **TITLE:** MPCV System Analysis Plan

7. **DESCRIPTION/USE**:
The purpose of this document is to describe the overall plan/approach the contractor shall implement for completing all analyses and trade studies required for the development and delivery, as an end product, of the MPCV to NASA. The plan should be formulated based on defined analysis cycles that tie directly to major milestones, major events (e.g., verification tests), etc. of the MPCV development/delivery. This plan is updated prior to each defined analysis cycle to define the specific integrated analyses and trade studies.

Note, this plan should include assessments for the operational use of the MPCV, but does not include studies/updates to be completed after delivery of the MPCV which will be addressed in another product.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
Contractor may propose the use of task sheets or other formats inclusive to the plan.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.4.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
See 13.3 Contents below.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The Systems Analysis Plan consists of two parts. The first part defines the overall management approach and the second part defines the content for each defined analysis cycle.

1) The minimum content for the overall management approach shall include:
   a) A description of the contractor’s methodology for managing and implementing analysis cycles including; the analysis and trade study approval and change process, data exchange process with external entities (e.g., SLS, GSDO, SCAN), issue resolution process, and the analysis closeout process.
   b) A descripiton of the contractors approach for managing and implementing verification analyses. Note, this can include required reviews/concurrences of the plan and updates, required information exchange/dependencies, contractual obligations, verification approval, etc.

c) The plan shall also contain a definition of the NASA accessible locations for the analysis reports defined in CEV-T-009.

2) The minimum content for each defined analysis cycle shall include:
   a) A description and schedule of the analyses and trade studies to be completed as a part of this cycle. Note, the description may include the fidelity of the product to be provided (e.g., draft, initial baseline, update).
   b) A description or matrix of the data interdependencies among the analyses.
   c) An identification of which products are to be provided by the contractor versus NASA personnel.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Updates to the plan must be provided for each cycle, and presented at the milestone reviews (i.e. POD ERB) prior to the analysis cycle for approval.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-009
3. **DATA TYPE**: 3/4
4. **DATE REVISED**: Nov. 2013
5. **PAGE**: 1
6. **TITLE**: CEV Analysis Reports

7. **DESCRIPTION/USE**:
To document results of analyses performed in support of the Contractor and NASA's System Analysis Plans.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
Verification Analysis Reports are Type-3
All other Analysis Reports are Type-4

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.4.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The CEV Analysis Reports document the results of the Contractor's analyses performed as described in their CEV System Analysis Plan.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The CEV Analysis Reports shall document the contractor's decision rationale and address the requirement definition and validation, design definition, and verification analyses performed, ground rules and assumptions used, and decision criteria, Figure of Merits (FOMs), and rationale for each trade performed in support of the System design analysis. The cost estimation methodology shall also be described.

Each report shall include sections for Executive Summary, Study Objectives, Study Requirements and Constraints, Ground-rules, Assumptions, Initializing Data, Analytical Tools and Models Used (including delivery of Physical Concept Models and Simulations, and Internal Verification and Validation Results, if applicable), Detailed Results and Key Findings/Recommendations.

13.4 **FORMAT**: The contractor shall document the linkage of the trade study results that validate CEV System Level requirements within the requirements traceability capability. The documents shall be MS Word, MS Powerpoint, or PDF format and placed in a NASA accessible location that is defined in DRD-CEV-T-008. Documentation of each individual analysis is acceptable (compilation of analysis reports in a single document is not required).

13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

KEEP CEV-T-010 AS RESERVED

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-011
3. **DATA TYPE**: 2
4. **DATE REVISED**: 12/20/2005
5. **PAGE**: 1
6. **TITLE**: Integrated Logistics Support Plan

7. **DESCRIPTION/USE**:
To describe support concepts, requirements and plans to include maintenance and logistics for CEV Project supportability. This includes life cycle plans for design-in-supportability, hardware processing and definition of logistics support resources.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
The following document(s) may be used as Informational per J3:
- CXP-02011: Constellation Systems Supportability Strategy

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.7.2.
Referenced from SOW Paragraph(s): 92.7.2.(e), 6.1.6.1, 6.2.6.1, 6.4.6.1
Related DRD(s): CEV-O-002, CEV-S-011, CEV-T-012, CEV-T-014

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Integrated Logistics Support Plan (ILSP) identifies the maintenance and support concepts and the requirements and plans for implementing these concepts for the CEV's life cycle. When the Contractor has specified delivery of another plan that contains aspects of the required information, the ILSP should summarize these aspects and refer to the other plan.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
NPR 6000.1G: Requirements for Packaging, Handling, and Transportation of Aeronautical and Space Systems, Equipment, and Associated Components

13.3 **CONTENTS**:
The Integrated Logistics Support Plan (ILSP) shall include as a minimum the following elements as separate appendixes:

1. Logistics Management Plan
(a) Supportability management and interface with other disciplines, such as reliability maintainability, and design engineering.

2. Maintenance and support concept:
(a) Maintenance levels and maintenance sites.
(b) Maintenance functions per level.
(c) Maintenance environment (i.e., organization and resources available at each level/site).
(d) Repair/sparing policy.
(e) Maintenance item and line replaceable unit (LRU/ORU) selection criteria.

(f) Storage Requirements (long and short term, if different)

3. Logistics Support Analysis Plan (LSAP)

4. Facility plan.

5. Test and support equipment plan
(a) Including ground support equipment (GSE) maintenance.

6. Supply support plan.

7. Packaging, Handling, Storage, and Transportation Plan. Detailed individual transportation plan shall be developed in time to support each upcoming move.

8. Provisioning plan.
(a) Approach for determining the types and quantities of spares, repair parts, and materials.
(b) Phasing and schedule to procure using spares acquisition integrated with production and meeting availability, supportability, and lifecycle cost requirements.
(c) Process for conducting provisioning conferences to review contractor procurements.

9. Shop and lab support plan.

10. Standardization/commonality policy and plan.

11. Technical Documentation plan
(a) Technical document critieria
(b) Technicaldata/database

12. Computer resources plan.

13. Training plan

14. Support personnel plan

15. Contingency plan.

16. Obsolescence plan.

17. Post-production support plan
(a) i.e., logistics, maintenance, and sustaining engineering.

18. Depot/manufacturing facility certification plan.

19. Logistics Management Information (LMI) strategy and plan.
(a) The LMI strategy shall define the integration of the CEV LMI within the Exploration LMILMI.

20. Transitio, Retirement, and Disposal Plan

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-012
3. **DATA TYPE**: 2
4. **DATE REVISED**: Dec 2010
5. **PAGE**: 1
6. **TITLE**: Logistics Support Analysis
7. **DESCRIPTION/USE**:
To document the results of the analysis performed to support the design-for-supportability process and to determine the total resources necessary to support the maintenance of the system over its operational life cycle. Data generated will be used as input into other system analyses such as cost, recommended spare parts lists and maintenance procedures development.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
The following document(s) may be used as infomational per J3:
- CXP-02011: Constellation Systems Supportability Strategy

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.7.2.
Referenced from SOW Paragraph(s): 2.4.2.(e), 6.1.6.1, 6.2.6.1, 6.4.6.1
Related DRD(s): CEV-S-011, CEV-T-011, CEV-T-014

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Logistics Support Analysis will address the total support resources required for the maintenance of the CEV System over its operational life.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The Logistics Support Analysis shall provide a Logistics Support Analysis Records (LSAR) database and analyses under the following categories:
1. Operational Requirements Analysis implications for LSA.
   (a) Interface between operations and maintenance.
2. Functional Analysis/Allocation.
3. Repair Level Analysis.
4. Maintenance Task Analysis.
   (a) Including GSE maintenance.
5. Test and Support Equipment Requirements.
(a) Concise description of each end item.
(b) Short description of the general requirements to be met (i.e., purpose, function, unique requirements, usage location, if known, and safety category).
(c) Identification of those end items that are common for use with other launch and test sites.
(d) National Stock Number (NSN) if already cataloged:
  * Government Furnished Equipment (GFE).
  * Modified GFE.
  * Commercial.
  * Modified commercial.

* Manufacture (new).

6. Facility Requirements.
7. Manpower, Personnel and Training Requirements.
   (a) Logistics support analysis shall include contractor labor by function.
8. Provisioning and Supply Support Analysis.
9. Standardization/commonality analysis.
10. Recommended Spares Parts List (RSPL)
   (a) The RSPL submittals shall include statement of scope, selection criteria, and groundrules.
11. Packaging, Handling, Storage and Transportation (PHS&T) requirements and documentation as required by NPR 6000.1G.
12. Technical documentation requirements.
13. Post-Production Support
14. Source Data and Documentation (SD&D) Index:

Tables of source data provided for use in the preparation of maintenance procedures. Tables to be arranged by maintenance level of task being performed. Source data may include:

(a) Maintenance tasks as documented in the LSAR database. LSAR database (LSA Control Number (LCN) & task code) will be referenced within the SD&D indexes. Using this as a guide, pertinent task data will be extracted for the use in preparation of maintenance instructions and in-flight maintenance procedures.

(b) Engineering data such as drawings (as-built), illustrations, specifications, schematics (electrical, mechanical, and fluid), and associated parts lists that depict hardware features and physical characteristics at the component level consistent with the maintenance concept for Line Replaceable Unit (LRU), Shop Replaceable Unit (SRU). Drawings, specifications, schematics, and other documentation shall be provided in its native file format. This information includes equipment dimensions, location, attaching hardware, interfaces, alignment features, nomenclature, markings/placarding, test points and etc.:

Engineering data will be primarily generated by the hardware provider but other types such as government, military, commercial, and vendor documentation can also be utilized.

(c) Imagery (photographic and video data) developed during the manufacture, assembly, checkout, and final close-out of flight hardware and Support Equipment (SE) to support on-orbit operations, ground processing and maintenance (Reference DRD CEV-T-088, CEV Imagery Plan/Imagery Deliverables):

Photographs to document CEV configuration to support maintenance procedures development and execution. Video is not required, but if the Contractor makes video of their hardware as normal course of buisness, access to the video is requested.

(d) Acceptance Test Procedures (Reference CEV-T-039, Acceptance Test Plans and Procedures).

(e) Acceptance Data Package (ADP) (Reference CEV-T-040, Acceptance Data Package): ADP includes several types of data as defined in CEV contractural documentation.

(f) Operations procedure source data including Operational Sequence Diagrams (OSD): Element/system specific mission scenarios containing Functional Flows, Requirement Allocation Sheets, and Timelines.

(g) Test procedures used at the Contractor facility.

(h) Manufacturing Documentation: Manufacturing documentation in the form of hardware build and assembly integration and checkout records can be referenced within the SD&D indexes. This type of documentation would be primarily used for depot level procedures, but also could support ground processing of flight hardware and support equipment (SE). Also includes PRACA-type data.

(i) Illustrated Parts Breakdowns (see item 15)

(j) Commercial Off-The-Shelf data and manuals (see item 17)

(k) Depot maintenance procedures (see item 17)

15. Illustrated Parts Breakdown (IPB):
Exploded views of flight hardware and support equipment depicting their assemblage. The IPB will illustrate the level of maintenance identified within the Logistics Support Analysis (LSA) process.
16. Validation status report:
The validation status report provides the validation records and status summary for ILS applicable documents.
17. List of Commercial Off-The-Shelf (COTS) data and manuals and depot maintenance procedures in technical data library on ProjectLinkanalysis

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-013
3. **DATA TYPE**: 3
4. **DATE REVISED**: Dec 2010
5. **PAGE**: 1

6. **TITLE**: Launch Site CEV Propellants, Fluids, and Gases Forecast

7. **DESCRIPTION/USE**:
To provide input to the Launch site fluids budget requirements for propellants and to forecast liquids, gases, and chemical requirements to be used in CEV processing.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
See Content for the types of propellants, liquids, gases, and chemicals that may be provided by the launch site. Form can be found at 'http://propellants.ksc.nasa.gov/documents/interimforecastform.xls'.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.7.2.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The launch site CEV Propellants, Fluids, and Gases Forecast provide inputs to the KSC fluids budget requirements for propellants, cryogenics, fluids, gases, bulk chemicals, and commodities required for use at the launch site.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The launch site CEV Propellants, Fluids, and Gases Forecast provide forecasted requirements annually for a three-year period for all propellants, fluids and gases required by the Contractor in support of CEV processing. Forecasts shall be based upon documented CEV requirements, past experience, anticipated test requirements and scheduled launch requirements with consideration given to such factors as lead time and storage losses.

Forecast defines requirements for the next three (3) year period, starting on July 1. The first six-month period is forecasted monthly, periods thereafter by quarter.

Types of Propellants, Liquids, Gases, and Chemicals provided by KSC

Classification:	Description:
Cryogens	Air, Liquid
	Argon, Liquid
	Helium, Liquid
	Hydrogen Liquid
	Neon, Liquid
	Nitrogen, Liquid

	Oxygen, Liquid
Hypergols	Hydrazine
	Hydrogen Peroxide
	Monomethyhydrazine
	Nitrogen Tetroxide
	Aerozine-50
	Nitric Oxide
Compressed Gas	Air
	Helium
	Hydrogen
	Nitrogen
	Oxygen
	Gaseous Mixtures
Petroleum Fuels	JP-8/RP-1
Bulk Chemicals	Acids
	Alcohols
	Ammonia
	Bases
	Fire Extinguishing Agents
	Hydraulics
	Neutralizers
	Refrigerants
	Scrubber Solutions
	Solvents
Other Fluids	Water/Ethylene-Glycol
	Water Distilled/Hi Purity 5
	Various Mixed Liquids/Gases
	Contaminated Fluids
	Hazardous Chemical Wastes
	Other as Negotiated

13.4 **FORMAT**: Data shall be submitted via NASA Form 558, or electronic equivalent per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Forecasts shall be updated and submitted annually (March 1). In addition, supplemental forecasts shall be submitted at any time that significant additions or changes to previous forecasts become evident.

KEEP CEV-T-014 AS RESERVED

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-015
3. **DATA TYPE**: 2/4
4. **DATE REVISED**: Nov. 2013
5. **PAGE**: 1
6. **TITLE:** Master Verification Plan (MVP)

7. **DESCRIPTION/USE**:
The MVP documents the verification planning and implementation activities that will provide evidence that the MPCV System (Spacecraft and Ground systems) meets the identified system, module, subsystem, and component requirements.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
The following document(s) may be used as information per J3:
- NASA-HDBK-7005: Dynamic Environmental Criteria
- CXP-72097: Crew Exploration Vehicle Master Verification Plan

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.1.7.
Referenced from SOW Paragraph(s): 6.1.54, 6.2.5, 6.4.5
Related DRD(s): CEV-T-052, CEV-T-031, CEV-T-037, CEV-T-039, CEV-T-016

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Master Verification Plan shall address the approach, processes, activities, and supporting data required for the verification of MPCV hardware: spacecraft system, subsystem, component, and ground support equipment.

Note: While software verification plans are captured in the Software Test Plan, CEV-T-052, MVPs shall address integrated verification with flight software configurations.

13.2 **APPLICABLE DOCUMENTS**:
The following applicable documents per J3: MPCV-70135 and NASA-STD-5017 apply to the static/strength test plan and dynamic test plan volumes only.
- CXP-70135: Constellation Program Structural Design And Verification Requirements
- NASA-STD-5017: Design and Development Requirements for Mechanisms, Sections 1-4

Meets/Exceeds Documents per J3:
- CxP 70036: Constellation Enviromental Qualification and Acceptance Testing Requirements (CEQATR)

13.3 **CONTENTS**:
The MVP structure shall provide the flexibility in product development while maintaining configuraton control of the end product.

The MVP structure for management and process control shall inlcude as a minimum the following volumes, and shall be Type 2. LM has the latitude to expand the documents set as required to meet the Verification Objectives.

- Volume I: Verification Process and Groundrules
- Volume II: Environmental Test Requirements
- Volume III: Structural Verification Plan

This MVP shall define the verification planning and implementation activities that provide evidence that the system built meets design and performance requirements. Component, subsystem, module, and system testing shall be planned as an integrated program; i.e., test plans for an individual element shall be tailored to that element's operational requirements, considering all testing to be performed from development through System acceptance testing and integrated testing per Qualification Test Plans and Procedures CEV-T-037 and Acceptance Test Plans and Procedures CEV-T-039. These plans shall be subject to NASA approval and be configuration controlled in accordance with DRD CEV-M-003, Configuration Management Plan and Reports.

The Master Verification Plan shall address the acceptance and qaulification process for the design, functional, interface and specialty engineering requirements for MPCV hardware at the end-to-end system, subsystem assembly and component levels.

The verification plan shall include the tests, demonstrations, analyses, and inspections required to meet Critical Items List (CIL) retention rationale and to control hazards.

The MVP will define the roles and responsibilites of joint NASA/LM forums (e.g., VEWG, RVWG, DIMS, etc.) to facilitate the review and approval of verification products (success criteria, etc.)for spacecraft systems, subsystems, and components. Documents such as the Master Test plan, Requirement Verification Traceability Matrix, and Verification Information Sheets are examples of Type 4 documents that shall be empowered by the joint NASA/LM forums.

The Master Verification Plan shall include:

Volume I Verification Process and Groundrules:

1. Overview of the MPCV Program verification strategy (i.e., verification of spares, refurbishment/reverification/recertification plans, configuration variances.)
2. Description of the MPCV Program's review and signoff authority for compliance data.
3. Identify the processes and products that assure specification requirements are met and that quality control is implemented to provide assurance against workmanship or material deficiencies.
4. Identify that there are ground-rules assuring qualification test (or demonstration) hardware test articles shall be of the same configuration and manufacturer, and be manufactured under the same production processes as the flight hardware, unless variances are approved formally by the contractors and NASA and adequately documented according to the test article supplier's established configuration management procedures.
5. Identify that qualification re-verification analysis shall be required and formaly documented when any of the following occur:
   a. Design or manufacturing process changes have been made which affect function or reliability.

b. Inspection, test, mission change, or other data indicate that a more severe environment or operating condition exists than that to which the hardware was originally qualified.
c. Changes are made in procurement source.
d. Changes are made in specification, manufacturing processes or procurement sources for fluids or other materials used in processing or operating the hardware.
e. Software changes occur that affect requirements or flight software capabilities.
f. Based on the results of the analyses, re-verification type and scope shall be subject to government approval.

6. Identify that a retest analysis will be performed and formaly documented for those activities in the Acceptance Phase when any of the following occur:
   a. A previously mated and verified interface has been de-mated
   b. Modification, repair, replacement, or rework occurs after inspection or testing
   c. The article or material is subject to drift or degradation during storage or handling
   d. Software changes occur that affect requirements or flight software capabilities.

   Based on the results of the re-test analyses, re-verification type and scope will be established and shall be subject to government approval.
7. Identify the processes by which verification schedules are developed and maintained.
8. Identification of the resources required to perform the required verification activities as well as resource owners and/or providers. These resources (e.g., facilities, software, simulators) include those that do not currently exist or existing resources that need to be upgraded.
9. Acceptance and qualification plans for ground systems.
10. Describe the content of a Requirement Verification Traceability Matrix (RVTM) and how it is developed and maintained in the requirements database. The RVTM will clearly documents the verification method or methods employed for each System level requirement and each allocated requirement.
11. Identify that the Master Test Plan (Type 4) contains a description of all the test control processes and products to assure verification by test is controlled and monitored.
12. Identify the processes and products required to assure external and internal interfaces are verified.
13. The MVP will describe the content of the Verification Information Sheets (VISs)(type 4), and how they are developed and maintained in the Requirements database.

<u>Volume II Environmental Test Requirements:</u>

Provides the baselined environmental test tolerances and margins to be used for the MPCV Program that combines the requirements of the LM Test Requirements Standard (TRS, N2.3.8-T1-Test-.1.0-S4) and the NASA MPCV Program Environmental Qualification and Acceptance Testing Requirements (CEQATR, CxP 70036) into a single source document.

1. The requirements established shall represent the Project Orion Baseline, and are not tailored for specific implementation. Any tailored Orion implementation plans for Units and Major Assemblies shall be documented in the Master Verification Plan (MVP) or its associated Type-4 reports (RVTM, CTM, VIS) and may differ from the baseline based on approved tailoring and option selections that

are documented via the change process administered by an approved and charted Joint NASA/LM forum per Volume I.

Volume III Structural Verification Plan:

A structural Verification Plan (SVP) shall be developed and maintained. The SVP shall document the full structural analysis, test, and assessment program.

As a Minimum, the content and format of the SVP should include the following

1. **A** requirements applicability matrix that identifies which requirements are applicable to the system or hardware being delivered and rationale for exclusion if not levied.
2. A list of applicable requirements documents.
3. A brief description and sketches of hardware primary and secondary structure.
4. The proposed method for verification of the primary and secondary structure items. Include proposed factors of safety, stress analysis methodology (i.e., hand or computer analysis), verification approach for the analytical models that will be used for stress calculations, and the proposed strength testing. Rationale must be provided if no strength testing is planned.
5. Description of special materials (e.g., composites, beryllium, and glass) and the corresponding special measures which will be taken to verify their strength according to the requirements of this or other applicable requirements documents.
6. Brief description of the source of material allowable which will be used for the strength analysis for each primary and secondary structure item.
7. Specific implementation of fastener and preloaded joint requirements as defined in CxP 70135.
8. Derivation of design loads for primary structure, secondary structure, and components or experiments as described in CxP 70137.
9. Proposed method for dynamic math model verification of the primary and significant secondary structural hardware as defined in CxP 70135. Rationale must be provided if no dynamic testing is planned.
10. Summary and schedule of all loads and stress analyses, planned tests (includes strength, pressure, dynamic, random vibration, and acoustic tests), and math model correlation activities as described in this document and other relevant specifications.

The following information shall be included in the static/strength test plan portion of the SVP:

1. Description and sketches of the structure.
2. Identification of materials that are used, material allowables which will be used for strength analysis, and a description of manufacturing processes that are used.
3. Comparison of the test article, including boundary conditions, to the flight article. Explain and provide justification as to why any differences are acceptable for static testing.
4. Discuss the derivation of the static test loads and their comparison to the design/flight loads.
5. Description and sketches of test setup, including load application techniques, load magnitudes and locations, instrumentation layout, and data recording system.
6. Provide the pretest analysis for deflections, internal loads and stresses of the test configuration to predict critical deflections, and stress regions for test measurement locations.
7. Planned correlation analysis to verify the static math model.

8. Describe plans for vehicle handling and transportation.
9. Description of special materials (i.e., composites, beryllium, and glass) and the corresponding measures which will be taken to verify their strength and reliability.

The following information shall be included in the dynamic test plan portion of the SVP:

1. Description of test article in relation to the flight article. Include a summary of dummy masses that will not be included in test and components that will not be included in test.
2. Comparison of test and flight article mass properties.
3. Description and sketches of test setup including:
   a. Description and sketches of the instrumentation location on the test article and test fixture.
   b. Description of and rationale for selection of excitation method, levels, and application points.
4. Description of test article boundary conditions:
   a. For the test article support structure, provide evidence that the support structure does not participate in the test frequency range. Otherwise, describe how a 'test verified' model of the support structure will be obtained, as well as how it will be instrumented during testing.
   b. For 'free-free' test, describe how the interface modes will be verified. Describe the suspension system and predicted suspension modes.
5. Summary of steps which will be taken to investigate linearity.
6. Derivation of test specimen math model which will be used for correlation analysis.
7. Summary of pretest analysis and results including:
   a. Identification of the target modes and the rationale for their selection.
   b. Description and plots of the target mode shapes.
   c. Assessment of the test fixture/test article interaction including work done in correlating the test fixture itself.
   d. Comparison of the test article modes installed in the test fixture with the flight article modes.
   e. Evaluation of the instrumentation locations including a comparison of the full model modes to the modes from the model reduced to the instrumentation locations (cross-orthogonality comparison).
8. Description of the planned correlation analysis.
9. Describe plans for vehicle handling and transportation.

Structural Test Reports that are delivered as part of the product certification package and not part of this DRD:

- A test report showing the results of each unique structural test shall be prepared and included/delivered as part of the product certification package.

- The structural test report shall include stresses and forces developed during test and a summary of test data which is applicable to the structural verification. The report should also include a comparison of the test results to the analysis of the test configuration, demonstrating that the test objectives were met.

MVP Type 4 Deliverables:
LM shall provide the following information that is developed per the processes and guidelines that are described in Volume 1.

1. Requirements Verification Traceability Matrix (RVTM) – Maps requirements to success criteria (pass/fail) and verification activities (tests, analyses, demonstrations, inspections).
2. Verification Information Sheets (VISs) shall include success criteria that are specific to performance and operational parameters. These success criteria will be satisfied using the methods of test, analysis, inspection or demonstration for compliance.
3. Component Verification Closure Matrices (CVCMs) – Maps component requirements requirements to success criteria (pass/fail) and verification activities (tests, analyses, demonstrations, inspections).
4. Component Test Matrix (CTM) – Maps out the environmental qual and acceptance tests planned for each component.
5. Orion Master Test Plan (OMTP)- identifies the Test processes and products used for verification by Test as well as providing a description of each major test campaign.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to Type-2 portion of the MVP shall be submitted to NASA for approval. Only volumes with content changes require a complete re-issue. If utilized, appendices with content changes require a complete re-issue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-016
3. **DATA TYPE**: 2
4. **DATE REVISED**: May 2009
5. **PAGE**: 1
6. **TITLE**: Certification Plan(s)

7. **DESCRIPTION/USE**:
To document the plans for certifying the capability of flight hardware and software. Each certification plan describes the work to be performed to create the certified capability baseline for the spacecraft system, subsystem, or component flight hardware or software it addresses.

8. **DISTRIBUTION**: As determined by the Contracting Officer

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
Informational Documents per J3:
CxP-72097 : Crew Exploration Vehicle *Master Verification Plan*

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 10.2.1. 10.2.2.
Referenced from SOW Paragraphs: 2.7.2
Related DRD(s): CEV-T-017

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
A Certification Plan provides the detailed description of spacecraft system, subsystem, or component flight hardware or software certification requirements, work plans, source and product documentation, and data to be supplied for establishing an as-certified baseline and informing subsequent integration, operation, and problem resolution activities.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
A Certification Plan shall include the following:

a. A description of the spacecraft system, subsystem, or component flight hardware or software covered by the plan. For assemblies, include a list of items integrated into the assembly which are individually certified.
b. A description of the characteristics, capabilities, and limits that will be addressed in the certification record(s) produced in accordance with the plan.
c. A discussion, reference, and example of requirements and standards (including verification matrix) that will be fully or partially verified using the plan.
d. A discussion, reference, and example of detailed requirements for tests, analyses, etc., that will be performed to verify the design's compliance with specifications, qualify the design for its intended purpose, and create the certification records needed to baseline the certified capabilities and limits of the flight hardware or software.
e. A discussion, reference, and example of accessible, version-controlled, engineering data or reports used to derive, define, or

predict the detailed functions, performance ranges, service (non-operating, operating, and test) environments and operating behaviors of the design that will be certified by the plan.
f. A discussion, reference, and example of test articles, support equipment, software, facilities, or models to be used.
g. A discussion, reference, and example of safety and quality provisions applied in the plan.
h. An undated Program Evaluation and Review Technique (PERT) schedule for implementing the plan identifying the critical path and any prerequisites, constraints or dependencies in the plan.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

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

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-017
3. **DATA TYPE**: 2/4 (Type 2 for Spacecraft, *Module and Subsystem, Type 4 for* Components)
4. **DATE REVISED**: September 2012
5. **PAGE**: 1

6. **TITLE**: Certification Data Package

7. **DESCRIPTION/USE**:
To provide the objective evidence and audit trail required by NASA to establish an as-certified baseline for the MPCV and it's components, and to confirm that verification activities indicate all requirements were met, and to provide an abstract summary of the certified operational baseline that establishs, amends, revises, or replaces the certified capability baseline for flight hardware and software under which the MPCV vehicle can be expected to perform.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
Certification data are produced in accordance with the certification plans to create a record of qualification and integration activities that together create a certified capability description. A Certificaton Abstract Record (CAR) is delivered in support of design certification milestone.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 10.2.1, 10.2.2.
Referenced from SOW Paragraph(s): 2.6, 6.1.5, 6.2.5, 6.4.5, 6.5.4, 10.2.2, 10.3.1
Related DRD(s): CEV-T-016

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Certification Data Package contains the elements of documentation required to establish that all requirements have been met by the integrated systems, hardware, and/or software. A CAR may cover one or more flight hardware and software items at the same level of assembly covered by the certified capability baseline description and the supporting certification records.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
A Certification Data Package shall contain the following:

1. Current version of the spacecraft system, module, subsystem, or component requirements document for the integrated system, hardware, or software that is being certified.

2. Current version of the certification plan for the spacecraft system, module, subsystem, or component.

3. Verification compliance report, including the verification matrix mapped to all verification data. This report shall include or contain a reference to a previoulsy delivered DRD that includes:
(a) Qualification report, including test, analysis, inspection, and demonstration reports.
(b) Acceptance report for the qualification unit or the first flight unit.
(c) Summary of and references to Failure Mode and Effects Analysis (FMEA), hazard analysis and controls reports, and Critical Items List (CIL) rationale for retention, including residual risk information.
(d) List of approved operational controls
(e) Verification tracking log

4. A certification data summary, which contains the following:
(a) All engineering drawings as defined and delivered in CEV-T-004 defining every dimension of the spacecraft system, subsystem, or component. As built drawings can either be provided with the data packages or point to the delivery of the final drawings. Final drawing tree may be delivered in lieu of actual drawings.
(b) Operational information and relevant documentation
(c) Materials information
(d) Electrical information
(e) Electromagnetic compatibility information
(f) List of critical EEE parts information previously delivered under CEV-T-027
(g) Natural and induced environment reports
(h) Software/firmware Version Description Document (VDD)

5. Manufacturing and acceptance testing standards, procedures and processes now qualified

6. Waivers, deviations, non-conformance reports and problem closure reports

7. Limits on run time, idle time, age, cycle, or storage shelf life

A Certification Acceptance Record shall provide a complete abstract or summary of the certified capability baseline – the detailed description and recognized definition of equipment capabilities, limits, and constraints for the purposes of establishing flight rules/crew procedures, documenting and resolving non-conformances, and sustaining equipment design. Qualification margins are not be intruded upon by production hardware in service and should not be reflected by the certified baseline.capability.

A CAR shall include:
1. A definition of the flight hardware and software covered by the request, including
   a. Supplier
   b. Part numbers
   c. Drawing references
   d. Used-on location(s) (next higher assemblies)
2. Reference to a description of the performance capabilities, behaviors, limits and constraints being certified, including
   a. Operational signatures
   b. Order of operations requirements
   c. Limits on operating time, cycles, age or shelf life.

Capabilities, limits, behaviors, etc. shall be expressed in terms of measurable, observable indications available to operators and data evaluators.
3. A list of the Certification Data Packages supporting the CAR

4. Reference to the Certification Plan(s) implemented for this certification

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval for System and Subsystems. Changes to the Certification Data Package shall be made with a Certification Approval Record detailing the portions of the current version that is ammended, revised, or replaced with new certification data.

KEEP CEV-T-018 AS RESERVED

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-019
3. **DATA TYPE**: 2
4. **DATE REVISED**: Nov. 2013
5. **PAGE**: 1

6. **TITLE**: Materials and Processes Selection, Implementation, and Control Plan

7. **DESCRIPTION/USE**:
Each organization responsible for the design and fabrication of spacecraft flight hardware shall provide a Materials and Processes Selection, Control, and Implementation Plan. This plan shall document the degree of conformance and method of implementation for each requirement in NASA-STD-(I)-6016 Standard Materials And Processes Requirements For Spacecraft, identifying applicable 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.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.1.9.1, and 3.5.
Related DRD(s): CEV-S-001, CEV-T-020, CEV-T-021, CEV-T-022, CEV-T-023

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Materials and Processes Selection, Implementation, and Control Plan defines the objectives, procedures, logic, reporting, and management controls for materials and processes selection, implementation, verification, and control for use in the production of space flight hardware, support hardware, and associated ground support equipment. In addition, this plan shall be used to tailor the requirements identified in NASA-STD-(I)-6016. This plan shall also capture the workmanship standards and specifications used in the production of flight hardware and deliverable ground support equipment.

13.2 **APPLICABLE DOCUMENTS**:
Meets/Exceeds Documents per J3:
NASA-STD-(I)-6016: Standard Materials And Processes Requirements For Spacecraft
MPCV 70059, MPCV Program Safety and Mission Assurance Requirements, Section 6.2

13.3 **CONTENTS**:
The 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. 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:

1. 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, the 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.

2. 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.

3. 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 & Process Identification and Usage List DRD (CEV-T-022).

4. Testing - Logic, procedures and data documentation for any proposed test program to support the certification of materials/processes for use in spaceflight hardware shall require prior NASA approval.

5. Material 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. MUA shall be contained in the Materials Usage Agreement DRD (CEV-T-020).

6. 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.

7. 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.

8. Workmanship – The plan shall document the Contractor’s compliance to the workmanship standards specified in MPCV 70059 or the justification for use of alternate workmanship standards which meet or exceed the standards specified in MPCV 70059 for the polymeric applications, electronic assembly and solderings for surface mount technology, soldering, crimping, interconnecting cables and harness assemblies, fiber optics, printed wiring board design and acceptance and electrostatic discharge control.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. For each paragraph in sections 4 and 5 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.”

13.5 **MAINTENANCE**: Contractor-proposed changes to document to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. 1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-020
3. **DATA TYPE**: 3 (Category I & II MUAs)
5 (Category III MUAs)
4. **DATE REVISED**: Nov. 2013
5. **PAGE**: 1
6. **TITLE**: Materials Usage Agreements (MUA)

7. **DESCRIPTION/USE**:
MUAs shall be submitted for all materials and processes that are technically acceptable but do not meet the technical requirements of NASA-STD-(I)-6016, as implemented by the approved Materials and Processes Selection, Implementation, and Control Plan (DRD CEV-T-019). [The use of materials and processes that do not comply with the technical requirements of this standard may be technically acceptable if hardware reliability and vehicle safety are not affected.]

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
The DRD type is dependent on the nature of the MUA being submitted. Category I & II MUAs are Type-3 and Category III MUAs are Type-5.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.8.4
Related DRD(s): CEV-T-019, CEV-T-022

13. **DATA PREPARATION INFORMATION**:

13.1 **<u>SCOPE</u>**:
MUAs shall be approved as described below.

Category I MUAs – Category I MUAs are those that involve material/processes usage that could affect the safety of the mission, crew, or vehicle or affect the mission success, but must be used for functional reasons. Approval by the responsible NASA Materials and Processes organization and the MPCV Program Office shall be required. After approval the contractor shall deliver the MUA package as Type-3.

Category II MUAs - Category II MUAs are those that involve material/processes usage that fails a screening of Material and Processes requirements and is not considered a hazard in its use application but for which no Category III rationale code exists. Approval by the responsible NASA Materials and Processes organization shall be required. After approval the contractor shall deliver the MUA package as Type-3.

Category III MUAs - Category III MUAs are those that involve materials or processes that have not been shown to meet these requirements but have an approved rationale code listed in Appendix B of NASA-STD-(I)-6016. They are evaluated and determined to be acceptable at the configuration/part level. Category III MUAs shall be reported in the Materials Identification and Usage List (MIUL, DRD CEV-T-022) system or electronic data system utilizing the approved rationale codes in Appendix B. A key may be provided to correlate contractor Category III MUA database codes to the codes in Appendix B. No MUA form is required.

MUAs shall be revised and resubmitted whenever design modifications affect the part numbers identified on the MUA or the MUA rationale.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:

Meets/Exceeds Documents per J3:
- NASA-STD-(I)-6016: Standard Materials And Processes Requirements For Spacecraft (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)
- MSFC-STD-3029: Guidelines for the Selection of Metallic Materials for Stress Corrosion Cracking Resistance in Sodium Chloride EnvironmentsNASA-STD-(I)-5019: Fracture Control Requirements For Spaceflight Hardware

13.3 **CONTENTS**:
The MUA package shall include all technical information required to justify the application. MUAs for stress corrosion shall include a Stress Corrosion Cracking Evaluation Form per MSFC-STD-3029 (see NASA-STD-(I)-6016) and a stress analysis.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. 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 searchable format; the MUA data shall also be provided in a format that is compatible with the NASA Materials and Processes Technical Information System (MAPTIS) database. The Category 1 MUA data shall be delivered to ICE in accordance with Appendix 2.

13.5 **MAINTENANCE**: Contractor updates to the Category I MUAs shall be submitted to NASA MPCV Program Office for approval. Category II MUAs shall be brought to the M&P IWG for approval. Complete re-issue of the MUA is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-021
3. **DATA TYPE**: 2
4. **DATE REVISED**: May 2009
5. **PAGE**: 1
6. **TITLE**: Contamination Control Plan (CCP)

7. **DESCRIPTION/USE**:
The contamination control plan defines implementation measures to control contamination of flight hardware/GSE and fluid systems during manufacturing, assembly, test, transportation, launch site processing, during the mission and post-flight refurbishment.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.8, 2.8.4.
Related DRD(s): CEV-S-001, CEV-T-019

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The contamination control plan shall be generated in accordance with the CxP 70145 using 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 Foreign Object Debris (FOD) control plan to prevent damage to flight hardware/GSE and injury to the flight and ground crews by 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, for general CEV flight hardware and GSE, internal and external surfaces, and airborne particulate. 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. Gases are included under fluid systems.

c. The contamination control plan shall also comply with the requirements in CxP 70145. Although it is the responsibility of the contractor to identify required hardware cleanliness levels, cleanliness level definitions shall be consistent with CxP 70145 (i.e., visual and precision cleanliness levels shall be selected from the levels defined in CxP 70145).

13.2 **APPLICABLE DOCUMENTS**:

- Applicable Documents per J3:CxP 70145: Constellation Program Contamination Control Requirements

Meets/Exceeds Documents per J3:

- NASA-STD-(I)-6016: Standard Materials And Processes Requirements For Spacecraft
- NAS 412: Foreign Object Damage/ Foreign Object Debris (FOD)Prevention
- ASTM E1548: Standard Practice for Preparation of Aerospace Contamination Control Plans (Informational)

13.3 **CONTENTS**:

The CCP shall include:

1. The FOD control plan.

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.
(i) Updates to plan based on results of Metric and lessons learned.

2. Cleanliness level acceptance limits definition and verification methods.

The document shall define cleanliness level acceptance limits and verification methods for fluid systems, for general CEV fight hardware and GSE, internal and external surfaces, and airborne particulate. The document shall also include 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. Gases are included under fluid systems. Update document as required based on any updated limits,verification methods, flight hardware changes, GSE changes, and environmental changes.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-022
3. **DATA TYPE**: 4
4. **DATE REVISED**: Dec 2010
5. **PAGE**: 1
6. **TITLE:** Materials Identification and Usage List (MIUL)

7. **DESCRIPTION/USE**:
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.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.1.9.1.
Related DRD(s): CEV-T-019, CEV-T-020

13. **DATA PREPARATION INFORMATION**:

13.1 **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).

13.2 **APPLICABLE DOCUMENTS**:
Meets/Exceeds Documents per J3:
NASA-STD-(I)-6016: Standard Materials And Processes Requirements For Spacecraft

13.3.1 **CONTENTS:**
The MIUL shall identify the following information:
For all items:

- System/Subsystem
- Detail drawing and dash number
- Next higher assembly and dash number
- Drawing change letter designation
- Drawing design authority CAGE code or name
- Environment
    - Max/Min temp
    - Max/Min pressure
    - Fluid exposure/type
- MUA if applicable (either MUA number or rationale code per 4.1.3.3
- Remarks (comments field)

For Materials and Standard Mechanical Parts

- Material Form/designation
- Material specification
- Material manufacturer
- Material manufacturer's designation, Standard/Commerical Part #
- Material type (metal, nonmetal)
- MAPTIS material code
- MAPTIS rating
- Cure code if applicable for nonmetals
- Usage life if applicable for nonmetals
- Condition for metals
- Chemical fingerprinting if applicable

For processes:

1. Process Specification Number
2. Process Specification Title
3. Process Specification Owner
4. Process Specification Revision Level

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. However, Contractor format for electronic submittal of MIUL data shall be compatible with the NASA Materials and Processes Technical Information System (MAPTIS) database. MIUL data shall be delivered to ICE in accordance with Appendix 2.

13.5 **MAINTENANCE**: Contractor updates to the MIUL shall be submitted to NASA for approval. Complete re-issue of the document is not required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-023
3. **DATA TYPE**: 2
4. **DATE REVISED**: May 2009
5. **PAGE**: 1
6. **TITLE:** Nondestructive Evaluation Plan

7. **DESCRIPTION/USE**:
The Nondestructive Evaluation (NDE) plan shall address the NDE requirements necessary to assure the health and integrity of the CEV System including Flight and GSE hardware throughout its life cycle. This plan shall identify all NDE and nondestructive testing procedures and specifications employed in the inspection of materials.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2. 1.9.1.
Related DRD(s): CEV-T-019, CEV-T-069, CEV-T-070

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The NDE Plan shall address the process for establishment, implementation, execution and control of NDE. The plan shall meet the intent of MIL-HDBK-6870A, Inspection Program Requirements, Nondestructive for Aircraft and Missile Materials and Parts and NASA-STD-5009, Nondestructive Evaluation Requirements for Fracture Control Programs as specified by NASA-STD-(I)-6016.

13.2 **APPLICABLE DOCUMENTS**:
Meets/Exceeds Documents per J3:
- NASA-STD-(I)-6016: Standard Materials And Processes Requirements For Spacecraft
- MIL-HDBK-6870A: Inspection Program Requirements Nondestructive for Aircraft and Missile Materials and Parts
- NASA-STD-5009: Nondestructive Evaluation Requirements for Fracture Control ProgramsNASA-STD-(I)-5019: Fracture Control Requirements For Spaceflight Hardware
- NAS 410: Certification and Qualification of Nondestructive Test Personnel

13.3 **CONTENTS**:
13.3.1 NDE Specifications and Standards: The NDE plan shall address the selection and the order of precedence of applicable Government, Industry and prime contractor NDE specifications and standards and how the requirements contained therein are implemented through internal procedures and how-to documents. The oversight of subcontractor implementation and flow down of the NDE requirements shall also be addressed. The plan shall address commonly used aerospace industry NDE methods including, but not limited to, dye penetrant, radiographic (film radiography, digital radiography, computed tomography), ultrasonic ,

neutron radiography, magnetic particle, eddy current, infrared thermography, and visual inspection. The plan shall address how all NDE specifications and standards for thMPCV Program will be approved by the appropriate government authority.

13.3.2 NDE Requirements During Hardware Design: The NDE plan shall address how the processes are implemented to ensure that all designs are reviewed to establish NDE inspection requirements and to ensure that the parts are inspectable. The plan shall address how the areas or zones of the part to be inspected are identified on the drawing. The plan shall address how the operations and maintenance NDE requirements will be integrated in the design of the hardware.

13.3.3 Part Classification: The plan shall address appropriate flight hardware and GSE part classification in accordance with MIL-HDBK-6870A and NASA-STD-(I)-5019. .

13.3.4 NDE Sensitivity Levels: NDE sensitivity levels shall be classified as Standard NDE, Special NDE, Custom NDE and Visual Inspection in the NDE plan. The plan shall address minimum detectable flaw size for Standard NDE for each material group of MPCV hardware in compliance with NASA-STD-5009 where applicable. The plan shall address procedures for defining NDE acceptance criteria for each of the sensitivity levels and identify organizations and their responsibilities in establishing NDE acceptance criteria, NDE drawing call outs, NDE Operations and Maintenance criteria. Note: Custom sensitivity level refers to an NDE sensitivity level that is not covered under the other three NDE sensitivity levels and is applicable to non-fracture critical parts.

13.3.5 NDE Acceptance Criteria: The plan shall address how NDE acceptance criteria are determined and implemented for each sensitivity level. For flight hardware, the plan shall require rejection of any cracklike flaw irrespective of the sensitivity level of the inspection. The plan shall address how significant flaw indications, irrespective of the acceptance criteria, will be dispositioned.

13.3.6 NDE During Manufacturing: The plan shall address establishment of minimum NDE acceptance requirements in terms of NDE sensitivity level, methods of inspection (dye penetrant, ultrasonic etc.), sampling frequency, NDE inspection coverage (e.g. 100% surface area or selected area) for manufactured hardware as grouped by classification of the part, material type and form. The NDE plan shall address how NDE is sequenced such that inspection reliability is optimized by performing NDE before manufacturing processes that may significantly reduce flaw detection capability. The requirements for etching of metal parts prior to penetrant inspection shall be specifically addressed in the plan.

13.3.7 NDE Material Compatibility: The plan shall address compatibility of NDE materials and processes with the MPCV and other Exploration System hardware especially liquid oxygen systems.

13.3.8 Fracture Critical Parts: The Plan shall address how the listing of all Fracture Critical parts, created according to the Fracture Control Plan, will be integrated with NDE requirements. The plan shall address Special NDE and Standard NDE methods in accordance with NASA-STD-5009.

13.3.9 NDE During Operations and Maintenance: The NDE plan shall address the NDE requirements necessary to assure the health and integrity of the MPCV hardware throughout its life cycle. The NDE plan shall address NDE requirements during operations and maintenance of those parts that are susceptible to damage such as impact, corrosion, material degradation and wear, etc. The NDE plan shall address NDE requirements for inspecting repaired parts. The plan shall address the NDE procedures and physical standards required to perform the operations and maintenance NDE inspections.

13.3.10 NDE Reporting and Record Retention: The NDE plan shall describe the NDE nonconformance reporting system, record retention and traceability.

13.3.11 Process Audit: The plan shall address periodic auditing of NDE processes at prime contractor, vendors and subcontractors to verify compliance with the NDE requirements established in the plan.

13.3.12 Personnel Training: The NDE plan shall identify formal training and certification requirements for NDE Inspection in accordance with NAS 410.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-024
3. **DATA TYPE**: 2
4. **DATE REVISED**: 12/21/2005
5. **PAGE**: 1
6. **TITLE**: Corona Design Criteria
7. **DESCRIPTION/USE**:
To define and document the contractor's design criteria for avoiding damage due to corona, partial discharge or plasma interactions.
8. **DISTRIBUTION**: As determined by the Contracting Officer.
9. **INITIAL SUBMISSION**: Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix
11. **REMARKS**:
12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.8, 2.8.4.
13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Corona Design Criteria describes the design methods that the contractor will employ for the control of corona, partial discharge and plasma events.

13.2 **APPLICABLE DOCUMENTS**:

Meets/Exceeds Documents per J3:
MSFC-STD-531: High Voltage Design Criteria

13.3 **CONTENTS**:
The corona design guide criteria shall include the following:

a. Scope
b. Introduction
c. Applicable environments
d. Cabling Criteria
    1. Materials
    2. Separation, routing and placement
e. Connectors
    1. Bulkhead and feed through connectors
    2. Terminations
    3. Standoffs
f. Electrical/Electronic Components
    1. High Voltage Conformal Coating
    2. Encapsulation (potting)
    3. Insulation Life
g. Testing.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-025
3. **DATA TYPE**: 1
4. **DATE REVISED**: May 2009
5. **PAGE**: 1
6. **TITLE**: CEV Electromagnetic Compatibility Control and Verification Document

7. **DESCRIPTION/USE**:
To define the plans, processes, procedures and test data the CEV System Contractor will use to ensure that the design, construction, and verification of CEV System will result in the delivery of a System which satisfies the specified Electromagnetic Compatibility (EMC) requirements.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
This DRD incorporates Electromagnetic Environmental Effects (EME) information which must be addressed to design, develop, assemble and deliver a CEV which is electromagnetically compatible.

NASA will use the information in this DRD to integrate other Exploration System space elements to the CEV.

The following document(s) may be used as informational per J3:
- SSP 30240: Space Station Grounding Requirements
- SSP 30242: Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility
- MIL-STD-464A: Electromagnetic Environmental Effects Requirements for Systems

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.8.5.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The CEV Electromagnetic Compatibility Control and Verification Document includes all of the planning and effort necessary to for the Contractor to control the generation and absorption of electromagnetic energy in every part of the CEV for the complete life cycle of its components. The Contractor is expected to use this DRD as a management document to the meet the overall EMC requirement to be electromagnetically compatible.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
MIL-STD-1576: Electro Explosive Subsystem Safety Requirements and Test Methods for Space Systems
MIL-STD-461F: Requirements for the Control of Electromagnetic Interference (EMI) Characteristics of Subsystems and Equipment

ML0303-0014: Electrical Wire Harnesses and Coaxial Cables, Installation Requirements for Electromagnetic Compatibility

NASA-STD-4003: Electrical Bonding for NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment

Meets/Exceeds Documents per J3:
CxP 70080:Constellation Program Electromagnetic Environments Effects Requirements
ANSI/ESD S20.20-2007: ESD Association Standard for the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
RTCA/DO-160D: Environmental Conditions and Test Procedures for Airborne Equipment (Section 22: Lightning Induced Transient Susceptibility and Section 23:Lightning Direct Effects)
SAE-ARP-5412: Aircraft Lightning Environment
SAE-ARP-5413: Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning
SAE-ARP-5414: Aircraft Lightning Zoning
SAE-ARP-5415: Users Manual for Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning
SAE-ARP-5416: Aircraft Lightning Test Methods
SAE-ARP-5577: Aircraft Lightning Direct Effects Certification

13.3 **CONTENTS**:
The CEV Electromagnetic Compatibility Control and Verification Document shall consist of 7 Sections:

SECTION 1: The Electromagnetic Environmental Effects Control Plan

SCOPE:
The Electromagnetic Environmental Effects Control Plan defines the approach for implementation of an electromagnetic compatibility (EMC) control program. It describes the Contractor control program organization and responsibilities. It also includes interpretation of EMC requirements and a description of additional EMC requirements levied by the Contractor on subsystems and equipment to meet CEV Project EMC requirements. Additionally, this section addresses specific design measures to meet EMC requirements as well as addressing EMC design, test, and analysis requirements.

CONTENTS:
The Electromagnetic Environmental Effects Control Plan shall document the Contractor’s approach for implementation of an EMC control program for the CEV System. General and detailed requirements for systems EMC are contained in MIL-STD-464A. The detailed plan shall include:
(a) Internal organization and responsibility
(b) System compatibility
(c) Subsystem compatibility
(d) Subsystem and equipment requirements
(e) Electromagnetic interference safety margins for critical equipment. Critical equipment is defined as that equipment of which the loss of normal or expected functionality would result in loss of life or vehicle.
(f) Interference and susceptibility control
(g) Degradation criteria
(h) Subsystem interconnection and routing
(i) Electrical power and electrical interface, transients, and ripple
(j) Power frequency leakage current
(k) Bonding
(l) Grounding and Isolation
(m) Static electricity, both ESD and vehicle charging
(n) Personnel hazards
(o) Pyrotechnics and bridge wire actuated devices (BWAD's)
(p) Spacecraft charging controls

(q) EMC analysis methods and techniques
(r) EMC verification planning and methodology (verification flow to lower level specifications)

The plan shall include design and test approach that will ensure compatibility within the CEV System as well as with all external interfaces. This includes modification of equipment level requirements to be compatible with special element requirements and the EMC sections of applicable Interface Control Documents (ICD's).

SECTION 2: Electromagnetic Environmental Effects Requirements for Systems

SCOPE:
This section establishes the Contractor’s requirements for Electromagnetic Environmental Effects Requirements for Systems.

CONTENTS:
The requirements and considerations of MIL-STD-464A shall be tailored by the contractor for use on the CEV Project to meet the contractual EMC Requirements. The Contractor’s tailored version shall include the following sections:
(a) Contents
(b) Scope
(c) Applicable Documents
(d) Definitions
(e) General Requirements
(f) Detailed Requirements
(g) Notes
(h) Tables
(i) Figures

SECTION 3: Cable/Wire Design & Control Requirements Section for Electromagnetic Compatibility (EMC)

SCOPE:
The Cable/Wire Design and Control Requirements Section for Electromagnetic Compatibility (EMC) shall provide uniform specifications and methodologies for cabling and wiring requirements to ensure the electromagnetic compatibility of subsystems, equipment, and the overall CEV Project. These requirements minimize the effects of electric and magnetic field coupling between the wiring and circuits associated with the wiring.

CONTENTS:
The Cable/Wire Design and Control Requirements Section for Electromagnetic Compatibility (EMC) section shall provide detailed information regarding cable and wire design characteristics necessary to ensure electromagnetic compatibility. The tailoring of ML0303-0014, 'Electrical Wire Harnesses and Coaxial Cables, Installation Requirements for Electromagnetic Compatibility', SSP 30242 'Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility', and SSP 30240 'Space Station Grounding Requirements' will assist in establishing the Contractor’s requirement to meet the overall EMC requirements for CEV. These tailored requirements shall be documented in this section and shall also address as a minimum, the following:
(a) Circuit Classification
   1. Operating Frequency and/or Rise and Fall Times
   2. Loop and/or Circuit Impedance
   3. Loop and/or Circuit Voltage and Current
   4. Loop and/or Circuit Susceptibility
   5. Signal and Wire Type
   6. An installation specification that complies with either ML0303-

0014, or a NASA-accepted alternative that will achieve quality consistent with ML0303-0014, Electrical Wire Harnesses and Coaxial Cables, Installation Requirements for Electromagnetic Compatibility.
(b) Classification and Wiring Procedure
(c) Determination of Interface Wiring Requirements
(d) Signal and Wire Types
(e) Shield Termination
(f) Implementation of Signal/Circuit Type Coding
(g) Implementation of Harness Installation
   1. Physical Separation Requirements
   2. Shield Termination
   3. Breakouts
   4. Pyrotechnic Devices.
(h) Circuit Grounding

SECTION 4: Electromagnetic Environmental Effects Design Analysis Reports

SCOPE:
This section of the CEV Electromagnetic Compatibility Control and Verification Document defines the content that will be delivered in the Electromangetic Environmental Effects Design Analysis Reports that will be delivered in accordance with other DRDs for the delivery of CEV evaluation, verification and certification documents. The Electromagnetic Environmental Effects (E3) Design Analysis Reports describes the design, analyses, tests and results of efforts to ensure individual equipment meets the E3 requirements and the entire system is compatible.

CONTENTS:
The Electromagnetic Environmental Effects (E3) Design Analysis Reports shall describe the approach taken to ensure E3 requirements are met in accordance with Electromagnetic Environmental Effects (E3) Control Plan and the results of that effort. The reports are delivered in accordance with requirements to provide evaluation, verification and certification data for developed and integrated hardware. Reports shall include the following informational items (where applicable) for hardware:
(a) Electrical bonding
(b) Circuit grounding and isolation
(c) Cable design and routing
(d) Connector separation and shield termination
(e) Frequency management
(f) Emission and susceptibility control
(g) Critical circuit identification
(h) Lightning protection
(i) Electrostatic discharge protection
(j) Analyses results
(k) Test results

SECTION 5: Requirements for the control of Electromagnetic Interference (EMI) characteristics of subsystems and equipment intended for use by the CEV Project

SCOPE:
This section establishes interface and associated verification requirements for the control of electromagnetic interference (emissions and susceptibility) characteristics of hardware procured for use by the CEV Project. Such hardware may be used independently or as an integral part of other hardware. This section is directly applicable to items such as electronic enclosures and electromechanical systems and electrical interconnections composed of discrete wiring harness between enclosures.

CONTENTS:
MIL-STD-461E shall be tailored to describe the interface and associated

verification requirements for the control of electromagnetic interference (emissions and susceptibility) characteristics of electrical, electronic, and electromechanical equipment and subsystems designed or procured for use by the CEV Project. As a minimum the following sections of MIL-STD-461E shall be addressed:
(a) Scope
(b) Applicable Documents
(c) Definitions
(d) General Requirements
(e) Detailed Requirements

SECTION 6: Electrostatic Discharge (ESD) Control Plan

SCOPE:
The Electrostatic Discharge Control Plan defines the tasks, activities and procedures necessary to protect CEV Project ESD sensitive items at or above the ESD sensitivity levels defined for the CEV Project. The Plan outlines strategies for meeting administrative and technical requirements, and shall include information about organizational responsibilities, methods for measuring ESD control effectiveness, and the approach to be used for utilization of CEV Project data and documentation. The Plan shall address training, compliance verification, facility grounding & bonding, personnel grounding, protected areas, packaging, marking, and handling.

CONTENTS:
The Electrostatic Discharge Control Plan establishes methods and procedures to be implemented for system, subsystem, and component protection from the deleterious effects of ESD, and shall address the following areas as a minimum:

(a) Administrative Requirements
1. ESD Control Program Plan
   (a) Scope
   (b) Tasks, Activities and Procedures Necessary for Protection of ESD Sensitive Items
   (c) Organizational Responsibilities
   (d) Methods Used to Determine ESD Sensitivity assessment
2. Employee Training
   (a) Initial Training
   (b) Recurrent Training
   (c) Procedures for Recording Training
3. Compliance Verification Plan
   (a) Identifies Requirements to be verified
   (b) Frequency of Verification

(b) Technical Requirements
1. Grounding/Bonding Systems
2. Personnel Grounding
3. Protected Areas
4. Packaging
5. Marking
6. Equipment
7. Handling Procedures
8. Implications for other system elements

SECTION 7: CEV Project Lightning Protection

SCOPE:
This Section specifies the CEV lightning protection evaluation and design requirements, and defines the analysis and testing used to demonstrate CEV systems meet their performance requirements while operating in the defined external lightning environment.

CONTENTS:

A) The CEV Lightning Protection Plan (LPP): The LPP describes the considerations that must be addressed by the Contractor in carrying out overall design, planning, demonstration, and management of lightning protection for the CEV spacecraft, modules, subsystems, and components. The LPP provides means for NASA evaluation and judgment of acceptability of the Contractor's proposed lightning protection program and shall contain the following elements:

(a) Management control
(b) Lightning zone identification
(c) Vehicle lightning environment
(d) Lightning criticality
(e) Hazards assessment
(f) Direct effects protection
(g) Indirect effects protection
(h) Vehicle Lightning Detection Instrumentation
(i) Cumulative effects
(j) Electrical bonding and corrosion control
(k) Design analysis/development testing
(l) Verification criteria
   1. Applicable documents
   2. Description of test articles
   3. Pass/fail criteria
   4. Test hardware definition
   5. Pertinent test/analysis details
   6. Set up details
   7. Test schedule
(m) Life cycle aspects
(n) Configuration/documentation control
(o) Protection of facilities and ground support equipment
(p) Lightning protection survey

B) The CEV Lightning Protection Verification Plan (LPVP): The LPVP shall include the test/analyses data and methods to be used as well as the pass/fail definitions for each subsystem/component to verify lightning protection designs for those designated as Catastrophic, Hazardous/Severe-Major, or Major. The plan shall contain the following:

(a) Applicable documents.
(b) Description of test articles.
(c) Pass/fail criteria.
(d) Test hardware definition.
(e) Pertinent test/analysis details.
(f) Set-up details.
(g) Test schedule.
(h) Final Lightning protection survey

C) Lightning Protection Verification Report (LPVR): The CEV Electromagnetic Compatibility Control and Verification Document shall define the data content required in the LPVR that is delivered in accordance with with requirements to provide verification and certification data for developed and integrated hardware. The LPVR presents the results of analyses, tests, and other data needed to verify the adequacy of lightning protection designs for all systems, subsystems, and/or components whose failure is designated as Catastrophic, Hazardous/Severe-Major, or Major. The LPVR provides the means for NASA evaluation and judgment of the acceptability of the contractor's lightning protection designs and hardware/software.

The report shall contain the following:

(a) Description and photographs of test set-up, including associated load impedances.
(b) Date, personnel performing test, and location of test.

(c) Test current amplitude and waveforms.
(d) Conducted and induced voltages and currents measured.
(e) Measurement records of the instrumentation noise level.
(f) Test results.
(g) Statement of qualification.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Maintained through formal Program change process after initial baselining.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-026
3. **DATA TYPE**: 2
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE:** Spectrum Management Documents

7. **DESCRIPTION/USE**:
Spectrum Management documentation is required to request frequency authorization for each communication link in accordance with NTIA Manual of Regulations & Procedures for Federal Radio Frequency Management (May 2003 Edition, May 2005 Revisions) Chapter 10. NASA will use this information to request frequency authorization for all RF/optical devices. Authorization is requested by NASA with contractor's participation.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
These documents shall be consistent with the MPCV Program's integrated plans such as CXP-70022, MPCV Command, Control, Communication, and Information (C3I) Interoperability Specification (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List).

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.6.3.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
Spectrum Management documentation is required for all RF/Optical devices in the Crew Exploration Vehicle.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Docuemtns per J3:
MPCV 70022-1 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 1: Interoperability Specification (and associated Children documents as specified in Attachment J-3, Applicable, Meets/Exceeds, and Informational Documents List)

MPCV 70022-2 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 2: Spectrum and Channel Plan

MPCV 70118-01, Volume 1: MPCV to Communications and Tracking Networks Interface Requirements Document, Volume 1

MPCV 70028, Multi-Purpose Crew Vehicle (MPCV) to Ground Systems Development and Operations (GSDO) Interface Requirements Document

MPCV 70029, Multi-Purpose Crew Vehicle (MPCV) Program: Orion to Mission Systems (MS) Interface Requirements Document

NTIA Manual: National Telecommunications and Information Administration (NTIA) Manual of Regulations & Procedures for Federal Radio Frequency Management (May 2003 Edition, May 2005 Revisions) Chapter 10

13.3 **CONTENTS**:
The Spectrum Management Report shall include:
Forms NTIA-33 - Transmitter Equipment Characteristics, NTIA-34 -Receiver Equipment Characteristics, & NTIA-35 -Antenna Equipment Characteristics shall be completed by the contractor for each RF system for operational vehicle.
RF link compatibility analyses – Documents the RF compatibility between CEV communication links and between CEV communication links and other interfacing elements.
Power Flux Density analysis – Analysis that shows that all modes of operation meet Interdepartmental Radio Advisory Committee flux density requirements according to NTIA Manual: NTIA Manual of Regulations & Procedures for Federal Radio Frequency Management (May 2003 Edition, May 2005 Revisions) Chapter 8 (paragraph 8.2.36) for RF radiation impinging on the Earth.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required, with changes clearly identified.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-027
3. **DATA TYPE**: 2
4. **DATE REVISED**: septermber 2012
5. **PAGE**: 1
6. **TITLE:** Electrical, Electronic, and Electromechanical Parts Management and Implementation Plan

7. **DESCRIPTION/USE**:
To define and document the contractor's requirements, system and implementation plan for controlling the selection, acquisition, traceability, testing, handling, packaging, storage and application of Electrical, Electronic and Electromechanical (EEE) Parts for flight and critical ground support equipment..

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.8.6.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The EEE Parts Management and Implementation Plan defines Contractor's approach to accomplishing the electrical, electronic, and electromechanical parts control requirements and tasks. This DRD also includes the ionizing radiation control plan for all CEV EEE Parts.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
SLS-SPEC-159: SLS Program Design Specification for Natural Environments

13.3 **CONTENTS**:
The contractor's EEE Parts Management and Implementation Plan shall include the following:

1. Parts Selection: The Parts Management and Implementation Plan shall describe a concurrent engineering process, integrated with hardware design, in which parts are selected for use on the basis of suitability for the intended application. The plan shall identify application grades, parts that are considered standard for each grade (i.e. 'class B), the up screening requirements to use a lower grade part in a higher grade application, and how other (nonstandard) parts will be evaluated, approved for flight and controlled. The plan shall describe how EEE parts selection shall be driven by the performance demands, environmental and circuit applications, reliability (necessary for the satisfactory performance of the systems in which they are used) and maintenance allocations defined by the equipment specifications, how EEE parts shall be selected based on the suitability for their applications and proven qualifications to the requirements of their specifications.

2. Non-standard EEE Parts Documentation: The EEE Parts Management and Implementation Plan shall document the process for non-standard parts requests. This process shall include supporting documentation including specifications, and shall be submitted for NASA approval prior to procurement Non-standard parts requests shall identify and provide rationale for non-standard EEE part selections, clearly documenting justification for use, suitability for the application and environment, and qualification status.

3. EEE Parts Obsolescence Management: The EEE Parts Management and Implementation Plan shall address the Contractor's approach to mitigating EEE parts obsolescence.

4. Audits and Survey's: The EEE Parts Management and Implementation Plan shall include a process for surveying suppliers and manufacturers for the value-added services or products. In addition, a process documenting pre-award surveys shall be included. Pre-award survey shall, as a minimum, include sites performing :
a. Screening and testing,
b. Destructive Physical Analysis (DPA),
c. Failure analysis,
d. Radiation laboratories.

5. Destructive Physical Analysis: The EEE Parts Management and Implementation Plan shall describe the requirements for performing Destructive Physical Analysis (DPA) on EEE parts to qualify or screen batches of parts to be utilized. This plan shall define when DPA will be performed, the DPA requirements by part type, and the process to disposition parts with anomalies.

6. Part Stress Analysis: The EEE Parts Management and Implementation Plan shall document the derating criteria for worst case environments, operating conditions, and duty cycle, by part type (i.e. Integrated Circuits (ICs), resistors, capacitor, etc) to be applied to the hardware, and actions necessary to correct any deficiencies.

7. Controlling specifications: The EEE Parts Management and Implementation Plan shall define parts that are to be controlled by specifications and the minimum specification contents. As a minimum the contents shall include:
a. Complete identification of the part.
b. Physical, environmental, and performance specifications.
c. Reliability requirements, including inspections and tests for qualification, acceptance, and lot sampling.
d. Special explicit requirements such as screening and burn-in, X-ray, ionizing radiation, single event effects, and positive particle protection (e.g., coating, Particle Impact Noise Detection (PIND)).
e. Special handling, packaging, and storage requirements.
f. Documentation, data retention, and submittal requirements.

8. As Designed (Where Used) Parts List: The EEE Parts Management and Implementation Plan shall define how to prepare, submit and maintain an as-designed (e.g., where-used) EEE parts list. The list contents shall include, as a minimum:
a. Generic part type and name,
b. Common designation,
c. Controlling specification number,
d. Identification of authorized sources,
e. Quantity used,
f. Package type,
g. Qualification and Non-Standard status, and
h. Next higher assembly.

9. Part Qualification: The EEE Parts Management and Implementation Plan shall define how EEE parts will be qualified, when parts shall be requalified, and the qualification status of the parts will be documented.

10. Design Configuration Acceptability and Control: The EEE Parts Management and Implementation Plan shall address how the selected parts for a design are reviewed for application and environment suitability, how the parts quality and reliability will meet the operational performance requirements, and if the parts are being used within the specific device ratings. The selection process, technical acceptability of devices, application documentation and review results shall be available to NASA to support hardware design reviews, certification, acceptance reviews, problem resolutions, and ground and flight operations. Key elements are as-designed-parts lists, application stress analyses (including radiation effects), and nonstandard parts acceptability assessments.

11. Parts Procurement: The EEE Parts Management and Implementation Plan shall address how the Contractor will select, qualify, control, and monitor parts manufacturers. The plan shall address the Contractor's source inspections, receiving inspection (including destructive physical analysis), and stocking and handling procedures prior to and during assembly. These procedures shall address how the Contractor will avoid the procurement and any subsequent installation of parts or 'lots' of parts subject to conditions identified in Government-Industry Data Exchange Program (GIDEP) and NASA ALERT's. This section of the plan shall ensure that the selection and use of the parts will not have an 'obsolescence' issue to the greatest extent possible.

12. Commercial Off-The-Shelf/Off the Shelf (COTS/OTS)) hardware: The EEE Parts Management and Implementation Plan shall address the use of COTS sub-assemblies, and shall define screening, non-standard parts request, and risk assessment requirements. The analysis of COTS/OTS sub-assemblies shall include as a minimum:
a. A review of the as-designed and as-built EEE parts list (or equivalent) as applicable, and supporting documentation (e.g., procurement specifications, upgrade specifications, waivers, deviations, etc.).
b. A review of fabrication processes, history, GIDEP, and ALERTS.
c. Identification of EEE parts that are obsolete or which may be nearing obsolescence.
d. An application/derating analysis at the EEE part level shall be developed.
f. A test or assessment of the OTS hardware and/or associated EEE parts for susceptibility to the space radiation, micro-gravity and vacuum environment.
g. A review process considering and identifying any available prior history of successful operations, previous space flight history, failures, and causes of failures for EEE parts in the proposed hardware.
h. Identification of any known life limiting factors that may affect the intended useful life of the hardware in the application, such as use of aluminum electrolytic capacitors.
i. Rationale and plan for the certification of OTS hardware.
j. Any other available data that may be pertinent to the review process.
The EEE Parts Management and Implementation Plan shall also address the use of COTS sub-assemblies for which insufficient parts information is available. In these cases, the plan shall identify how parts used in COTS sub-assemblies may be qualified (i.e. by environmental and accelerated life testing at the COTS sub-assembly level).

13. Parts Problem Reporting and Corrective Action: The EEE Parts Management and Implementation Plan shall address a formal and controlled closed-loop system for the reporting, analysis, correction/prevention, and data feedback of SRU end item failures.

14. Ionizing Radiation Effects:
The EEE Parts Management and Implementation Plan shall require a Contractor Ionizing Radiation Control Plan. This plan must define the processes and methodology used to insure that all EEE parts will successfully operate in the CEV radiation environments as described in SLS-SPEC-159: SLS Program Design Specification for Natural Environments. The Ionizing Radiation Control Plan shall define the required content of all radiation test plans, test procedures, and test reports & analyses.

15. Data Retention Requirements: The EEE Parts Management and Implementation Plan shall define all EEE parts data retention requirements. Data retention requirements shall as a minimum be required for:
a. Non-Standard Parts Requests
b. EEE Part Specifications
c. Qualification Reports
d. Audit and Survey Reports
e. Destructive Physical Analysis (DPA)
f. EEE Parts Stress Analysis and Application Reviews
g. Ionizing Radiation test plans, procedures and reports
h. EEE Parts lists
i. Data used to evaluate COTS/OTS Hardware

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-028
3. **DATA TYPE**: 3
4. **DATE REVISED**: Nov. 2013
5. **PAGE**: 1
6. **TITLE**: As-Built EEE Parts List
7. **DESCRIPTION/USE**:
The As Built EEE Parts List provides a summary of EEE Parts usage.
8. **DISTRIBUTION**: As determined by the Contracting Officer.
9. **INITIAL SUBMISSION**: Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix
11. **REMARKS**:
12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.8.6.
13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
As Built EEE Parts List shall list the EEE parts included in completed qualification and flight hardware units and assemblies.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The report or database identifies EEE parts used in CEV Spacecraft flight equipment. The contents of the report or database shall include:

Identification of parts by generic part name and type
Component name (or part number)
Common designation
Specification control drawing
Manufacturers cage code or name
Manufacturer’s part number
Lot Date Code or Unique Lot Identifier
Applicable NSPAR and Qualification record list
Radiation classification
Quantity used per application
Next higher assembly part number

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-029
3. **DATA TYPE**: 1/4*
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Interface Control Documents

7. **DESCRIPTION/USE**:
To provide documentation in the form of drawings and/or written records to identify for each side of an interface those necessary design definitions between one or more systems, modules, subsystems, computer software configuration items (CSCI's), or computer software components (CSC's), manual operations, contractors and/or Government agencies to provide control of and ensure an agreeable and compatible interface. The Interface Control Document (ICD) provides the design solutions to the interface requirements found in the associated CEV-T-031 CEV <level> Requirements Specifications; these companion documents serve to communicate and control interface design decisions.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

The Contents section of this DRD calls out the need to identify Functional and Procedural interfaces. Functional interfaces pertain to interactions between two entities across an interface. Procedural interfaces are functional interfaces that also include sequence dependencies. A good example of this is an arm-fire interface between two entities. The entities share two functional interfaces, namely arm and fire. However, they also share a procedural interface, namely the arm function must be invoked before the fire function.

External ICDs = Type 1.

Module and Subsystem ICDs = Type 4 (includes ICDs with GFE per J-11)

Avionics & Software IDDs = Type 4

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.2, 2.3, 6.1.2, 6.2.2, 6.4.2, 6.5.2, 10.3.5.3
Related DRD(s): CEV-O-008, CEV-T-031

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Interface Control Documents (ICD's) identify design definitions for each side of an interface that shall ensure design control and compatibility. An ICD may describe any number of software interfaces.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)

MPCV 70026, Orion Multi-Purpose Crew Vehicle (MPCV) Program to Space Launch System (SLS) Program Interface Requirements Document
MPCV 70028, Multi-Purpose Crew Vehicle (MPCV) to Ground Systems Development and Operations (GSDO) Interface Requirements Document
MPCV 70029, Multi-Purpose Crew Vehicle (MPCV) Program: Orion to Mission Systems (MS) Interface Requirements Document
MPCV 70118-01, Multi-Purpose Crew Vehicle to Communications and Tracking Network Interface Requirements Document, Volume 1

Meets/Exceeds Documents per J3:
IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207; 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data.

13.3 **CONTENTS**:
The Interface Control Document (ICD) shall document the physical, functional, and procedural interface design as applicable. The ICD shall provide the descriptive text and diagrams to fully describe the interface implementation. An ICD shall be produced for each software element (flight, ground, simulation and data services) to document the design of each interface identified in the associated <level> specification document. The ICD shall address all of the engineering disciplines associated with the interface design. The ICD shall identify all applicable workmanship and applicable standards being utilized as part of the interface design. The ICD shall provide traceability from the associated <level> specification document to document design compliance with the requirements.

The ICD shall address the following class of interfaces:
For hardware:
(a) Physical - Interfaces involving physical mating and spatial relationships between interconnecting parts of interfacing end items, including clearance envelopes established to avoid interferences and to permit access. Other examples include power before connector mate and order of connector mate.
(b) Functional - Interfaces involving the interaction or influence of conditions imposed by one subsystem or component upon another or by external sources such as fluids, thermal, electrical, environmental, data, and loads.
(c) Procedural - Interfaces involving critical sequence of events occurring in assembly, disassembly, alignment, service operations, and computer programs.

For software, in accordance with NPR 7150.2 NASA Software Engineering Requirements, and using IEEE/EIA 12207.1-1997 as Meets/Exceeds, each software IDD shall include:
(a) Physical - Interfaces involving CSCI’s or CSC’s that interact through:
1) software to hardware interfaces, including but not limited to hardware register interfaces and memory interfaces.
2) network interfaces or external communications bus interfaces between software CSCI’s or CSC’s executing on separate computer processor modules within separate hardware components.
3) backplane interfaces or internal communications bus interfaces between software CSCI’s or CSC’s executing on separate computer processor modules within the same hardware component.
4) memory based interfaces between software CSCI’s or CSC’s executing on the computer processor module of any hardware subsystem.
(b) Functional - Interfaces involving the interaction (data exchange, function invocation, or signal generation) or influence of conditions imposed by one CSCI or CSC upon another.

(c) Procedural - Interfaces involving critical sequence of events performed through collaboration between software CSCI's or CSC's (as applicable). (e.g., an "arm" signal must always be provided prior to the "fire" signal for any pyrotechnic event.)
(d) Priority assigned to the interface by the interfacing entity(ies).
(e) Type of functional/procedural interface (e.g., function invocation, send real-time data, send data for information management, generate event or signal for control) to be implemented.
(f) Specification of individual data elements (command and data dictionary identifer / mnemonic, class attributes, record/structure constituents or passed parameters), data type, range of values (e.g., the numeric range for integer or real types and the integer mapping for enumerated values), units of measure, size (in bits), and bit-level descriptions of data elements that the interfacing entity(ies) will provide, store, send, access, receive.
(g) Specification of protocols the interfacing entity(ies) will use for the interface(e.g., the unique identifer of a specific hardware register, network bus, backplane bus or memory interface).
(h) Other specifications, such as physical compatibility of the interfacing entity(ies) (synchronous or asynchronous, frequency of exchange, FIFO or LIFO, buffered queue or non-buffered sample, etc.).
(i) Traceability from each interface design to the associated software interface requirement(s)in the software Interface Requirements Document (IRD).
(j) Interface compatibility, e.g., little endian vs. big endian.
(k) Error Handling, such as synchronous error handling (error handling associated with indications explicitly passed over the interface) and asynchronous error handling (error handling associated with failure to communicate over the interface) as applicable.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to the external ICDs shall be submitted to NASA for approval. Complete re-issue of these document are required with changes clearly identified.

CEV-T-030 IS RESERVED

DRD CEV-T-030 WAS DELETED WITH MODIFICATION 90

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-031
3. **DATA TYPE**: 1/4*
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: CEV <Level> Requirements Specification

7. **DESCRIPTION/USE**:
The CEV <Level> Requirements Specification DRD documents the allocation of the following:
- CEV System requirements to the Spacecraft and Contractor-provided Ground Support Equipment System Requirements Specifications
- CEV Spacecraft requirements to the module level
- CEV module requirements to the subsystem level
- CEV subsystem requirements to the component level

The CEV <level> requirements specifications will also include the associated interface requirements between each module, each subsystem, and Computer Software Configuration Items (CSCIs) or Computer Software Components (CSCs). Also to specify requirements imposed upon or by manual operations, or other system components to achieve one or more interfaces among the modules, subsystems, and CSCIs (and/or CSCs). To be used in conjunction with the Software Requirements Specification as a basis for design and qualification testing of software systems and CSCIs.

The interface requirements for flight software will be incorporated in the relevant CEV-T-048 Software Requirements Specifications.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
All system, module, subsystem, and component-level requirement documents have MPCV-72000, MPCV Systems Requirements Document , as their parent document. A common format shall be used across the system, module, subsystem, and component-level requirements documents. CEV configuration items will be determined during CEV Project phases and will be documented in the Contractor’s Configuration Management Plan.

In naming each document, <Level> should be replaced with the appropriate name (e.g., CEV Spacecraft System Requirements Specification, CEV Crew Module Requirements Specification, etc.).

All CEV System, module, level requirements documents are type 1 documents. Development of module level specification documents is at the discretion of the contractor and include the contents as described in Section 13.3. The contractor can choose to include module level requirements in the Spacecraft Specification Document.

All CEV subsystem, component, MGSE, EGSE and CEV GSE End Item level requirements documents are type 4 documents.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.2, 2.7.2, 2.7.4, 6.1, 6.2, 6.4, 10.6.4.
Related DRD(s): CEV-O-008, CEV-D-002, CEV-D-005

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:

The CEV <Level> Requirements Specification DRD establishes the format and contents of the following system-level requirements specifications:
- Spacecraft Systems Requirements Specification
- Contractor-provided Ground Support Equipment Systems Requirements Specification and the subsequent module, subsystem MGSE, EGSE, component and GSE End Item level requirements specifications.

13.2 **APPLICABLE DOCUMENTS**:

Applicable Documents per J3:
MPCV-72000: Multi-Purpose Crew Vehicle (MPCV) Systems Requirements Document
CxP 72506 CEV Orion Standard for the Design and Fabricaiton of Ground Support Equipment

13.3 **CONTENTS**:

The system requirements specifications shall allocate the CEV System functional, performance and operational requirements and constraints to define the design and architecture of the total System, including software, between the Spacecraft and Ground Systems. Two (2) documents shall be produced comprising the next level of decomposition from the CEV System level requirements. The requirements shall be allocated between Spacecraft and Ground Support Equipment.

The module requirements specifications shall decompose the CEV spacecraft system functional, performance, and operational requirements to the module level. A module is defined as a self-contained unit of a spacecraft that performs a specific task or class of tasks in support of the major function of the craft. For example, a spacecraft may be broken up into a crew module, a service module, etc.

The subsystem requirements specifications shall decompose the CEV module functional, performance, constraints and design requirements to define the design and architecture of the total subsystem, including software.

The component requirements specifications shall contain the decomposition of the requirements from the subsystem level through the lowest level of the decomposition. This specification will document the allocated functional, performance, constraints and design requirements for the CEV subsystem to the component level. For the purposes of this DRD, 'component' will be used to describe each level of the decomposition below the subsystem level as defined by the Contractor. The decomposition of the subsystem is continued until a procurement or build-to specification has been developed. A component is defined as an aggregate of hardware and/or software that can be characterized by one specification, is designed by a single activity to be functionally tested, and is verified as a unit.

The MGSE & EGSE functional grouping requirements specifications shall decompose the CEV GSE system functional, performance, constraints and design requirements to define the design and architecture of the total MGSE & EGSE functional groupings.

The end item requirements specifications shall contain the decomposition of the requirements from the MGSE & EGSE requirements through the lowest level of the decomposition, including associated software per the Software Requirements Specification (DRD CEV-T-048) for MGSE and EGSE.

The spacecraft and ground system interface requirements shall be in incorporated in the associated <level> specification and shall define all physical, functional and procedural interface requirements to ensure system, hardware, and software compatibility. The interface requirements shall include the following:

For Hardware:

a. Physical – Interface requirements involving physical mating and spatial relationships between interconnecting parts of interfacing end items, including clearance envelopes established to avoid interferences and to permit access.
b. Functional - Interfaces involving the interaction or influence of conditions imposed by one subsystem or component upon another or by external sources such as fluids, thermal, electrical, environmental, data, and loads.
c. Procedural - Interfaces involving critical sequence of events occurring in assembly, disassembly, alignment, service operations, and computer programs.

Each document shall contain a section titled 'Verification'. For each requirement in the documents, there shall be one or more verification methods identified. The document shall contain a definition of each verification method that identifies the general verification approach, and is consistent with identification of the verification methods used in the Master Verification Plan, CEV-T-015. The document shall also contain a verification traceability matrix that establishes the relationship between each requirement and the verification methods that will be used to accomplish the indicated verification actions.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. As required by ICE, the Contractor shall also include this data in a requirements management tool for easy data entry.

13.5 **MAINTENANCE**: Contractor-proposed changes to System and Module specification documents shall be submitted to NASA for approval. Complete re-issue of these documents are required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-032
3. **DATA TYPE**: 3
4. **DATE REVISED**: 12/5/2005
5. **PAGE**: 1
6. **TITLE**: CEV Specification and Drawing Trees

7. **DESCRIPTION/USE**:
A specification tree is a hierarchical breakdown (i.e., parent, child, etc.) of the specification documents interrelationships, as applicable, to the contract configuration items beginning with the highest system/product assembly level to be delievered with subsequent breakdown of lower-tiered subordinate requirements documents.

A drawing tree is a hierarchical breakdown of the engineering drawings that define the system/product to be delivered beginning with the highest assembly level with subsequent breakdown of lowered-tiered drawings. Collectively they define the complete engineering configuration of the system/product to be deliverd.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.2.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
CEV Specification and Drawing Trees depict the hardware and software configuration items in top down, or hierarchical breakdown form.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The specification and drawing trees shall consist of an indentured or generation breakdown listing of all specification documents or drawings applicable to a configuration item.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-033
3. **DATA TYPE**: 4
4. **DATE REVISED**: May 2009
5. **PAGE**: 1
6. **TITLE**: Architecture Design Document

7. **DESCRIPTION/USE**:
To describe the CEV physical architecture for purposes of guiding horizontal integration, requirements engineering, functional analyses, trade studies and system analyses activities across the CEV Project.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
Information provided in other DRD's is anticipated to be used in the preparation of data items in response to this DRD. This information may be included by reference in this data item. The Architecture Design Document (ADD) provides the functional and physical description of CEV.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.3.
Referenced from SOW Paragraph(s): 2.1.3, 6.2

13. **DATA PREPARATION INFORMATION**:

13.1 **<u>SCOPE</u>**:
In the early development phase, through completion of preliminary design work, the systems engineering activity focuses on identification of the technical requirements for the system that define what the modules, subsystems, and components must do and how well they must do it. During the detailed design phase the systems engineering activity emphasis switches to identification of requirements for the acceptance of the physical product elements by the Constellation Program and logistics requirements.

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

13.3 **<u>CONTENTS</u>**:
The Architecture Design Document shall contain:

a. Introduction. This section shall establish the context for the remainder of the document. In particular, it defines the scope of this document, and the relationship of this document to other key CEV documents; change authortiy, convention and notation and overall document organization

b. Applicable and Reference Documents. This section shall outline the reference and applicable documents. This section shall list the number, title, revision, and date of all documents referenced in this document. This section shall also identify the source for all documents not available through normal NASA stocking activities.

c. CEV Missions Overview. This section shall briefly state the purpose of the CEV System and summarizes the CEV architecture evolution in relation to the Design Reference Missions. These missions will serve as the basis for describing the CEV Architecture throughout the document. The architecture descriptions in the rest of the document are outlined according to each of the CEV DRMs.

d. CEV Functional Architecture. This section shall provide the general functional architecture desciption. This section shall provide a summary of CEV internal and external functional interfaces and a summary of the functional architecture for each DRM.

e. CEV Physical Architecture Description. This section shall describe the CEV Physical Architecture and shall provide a summary of CEV internal and external physical interfaces and a summary of the physical architecture for each DRM. The physical architecture descriptions shall be broken down into the CEV modules and subsystems. The level of detail provided in this document varies depending on the maturity of the baseline for each CEV module. Critical design decisions that were based upon trades and/or analysis shall be addressed. This section shall also address any block configuration deltas, mass properties, Master Equipment List (MEL), and power allocations. Design conventions needed to understand the design shall be presented or referenced.

NOTE: This section shall be divided into subsections that decribe the CEV System Module Architecture Design and the modules associated subsystems. Each subsection shall cover the following areas:

1. Identify the major components of the subsystems.

2. Show the static (such as 'consists of') relationship(s) of the components. Multiple relationships may be presented, depending on the selected design methodology.

3. State the purpose of each module/subsystem and identify the key driving requirements (if applicable).

4. Identify each module/subsystem development status/type, if known (such as new development, existing component to be reused as is, existing design to be reused as is, existing design or component to be reengineered, component to be developed for reuse, component planned for Build N, etc.) For existing design or components, the description shall provide identifying information, such as name, version, documentation references, location, etc.

5. Include diagrams and descriptions showing the dynamic relationship of the components, that is, how they will interact during System operation, including, as applicable, flow of execution control, data flow, dynamically controlled sequencing, state transition diagrams, timing diagrams, priorities among components, handling of interrupts, timing/sequencing relationships, exception handling, concurrent execution, dynamic allocation/deallocation, dynamic creation/deletion of objects, processes, tasks, and other aspects of dynamic behavior.

6.Include interface design characteristics between subsystems. One or more interface diagrams shall be provided, as appropriate, to depict the interfaces. Characteristics may include:

a) Type of interface
b) Data elements

c) Communication methods
d) Physical compatibiltiy

f. Software Architecture Description. This section shall describe the functional design of Spacecraft Software Architecture. To describe the organization of a CEV as composed of computer software configuration items (CSCI'S), CSCI groupings, and manual operations. To describe how the functional design and the SWCIs, and interfaces between them comprise an architecture consistent with a modular open systems approach. Critical design decisions that were based upon trades and/or analysis shall be addressed.

NOTE: This section shall be divided into subsections that decribe the componenents of the CEV Spacecraft Software Architecture. Each subsection shall cover the following areas:

1. Identify the major software components of the Software Architecture subsystems
2. Show the static (such as 'consists of') relationship(s) of the components. Multiple relationships may be presented, depending on the selected design methodology.
3. State the purpose of each component and identify the Key driving system requirements (if applicable)
4. For each computer system or other aggregate of computer hardware resources identified for use in the System, describe its computer hardware resources (such as processors, memory, input/output devices, auxiliary storage, and communications/ network equipment). Each description shall, as applicable, identify the configuration items that will use the resource, describe the allocation of resource utilization with associated margin to each CSCI that will use the resource
5. Include diagrams and descriptions showing the relationship of the components, including, as applicable, flow of execution control, data flow, dynamically controlled sequencing, state transition diagrams, timing diagrams, priorities among components, handling of interrupts, timing/sequencing relationships, exception handling, concurrent execution, dynamic allocation/deallocation, dynamic creation/deletion of objects, processes, tasks, and other aspects of dynamic behavior.
6. Include interface design characteristics between software componenets. One or more interface diagrams shall be provided, as appropriate, to depict the interfaces. Characteristics may include:
   a) Type of interface (such as real-time data transfer, storage-and-retrieval of data, etc.) to be implemented.
   b) Characteristics of individual data elements that the interfacing entity(ies) will provide, store, send, access, receive, etc. (e.g., identifiers, data type, size, format, range, accuracy, etc.).
   c) Characteristics of data element assemblies (records, messages, files, arrays, displays, reports, etc.) that the interfacing entity(ies) will provide, store, send, access, receive, etc. (e.g., identifiers, data elements, medium, visual and auditory characteristics, etc.).
   d) Characteristics of communication methods that the interfacing entity(ies) will use for the Interface (e.g., identifiers, links/bands, formatting, transfer rates, etc.).
   e) Characteristics of protocols that the interfacing entity(ies) will use for the interface (e.g., identifiers, priority/layer, error control, packeting, synchronization, etc.).

g. Requirements traceability. This paragraph shall contain (if information is contained in Requirements Traceability Matrix, or elsewhere, it may be referenced):

1. Traceability from each system identified in this Architecture Definition Document to the system requirements allocated to it.
2. Traceability from each system requirement to the System components to which it is allocated.
3. Traceability from design decision data to the requirements to support validation of the requirements

h. Notes. This section shall contain any general information that aids in understanding this document (e.g., background information, glossary, rationale). This section shall contain an alphabetical listing of all acronyms, abbreviations, and their meanings as used in this document and a list of any terms and definitions needed to understand this document.

i. Appendices. Appendices may be used to provide information published separately for convenience in document maintenance (e.g., charts, classified data). As applicable, each appendix shall be referenced in the main body of the document where the data would normally have been provided. Appendices may be bound as separate documents for ease in handling. Appendices shall be lettered alphabetically (A, B, etc.).

The appendices may contain any general information that aids in understanding this document (e.g., background information, glossary, rationale). This section shall contain an alphabetical listing of all acronyms, abbreviations, and their meanings as used in this document and a list of any terms and definitions needed to understand this document.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Requirements (including decision support and requirements validation data) must be maintained within the requirements database.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be made available for NASA review. Complete re-issue of the document is required.

KEEP CEV-T-034 AS RESERVED

KEEP CEV-T-035 AS RESERVED

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-036
3. **DATA TYPE**: 3/4*
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE:** Margins Management Plan/Report

7. **DESCRIPTION/USE**:
The Margins Management Plan is the unified system level approach to margin/contingency control. It defines the system design resources, their budgets, subsystem allocations, and current properties. The Margins Management Report includes margin properties reports for all managed design margins.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
The Margins Management Plan shall be Data Type 3; Margins Management Reports shall be Data Type 4.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.4.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Margins Management Plan is a statement of the contractor's margin management philosophy. The Margins Management Plan and Margins Management Reports provide the CEV Project with detailed identification of all resource margins and embedded margins necessary to ensure mission success and system robustness.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
This DRD consists of two products: The Margins Management Plan and Margins Management Reports. (Note: Software Metrics are included in CEV-T-049.)

The CEV Margins Management Plan shall include:

a. Identification of system level margins by SDR (e.g. mass, power, etc.).
b. Identification of subsystem level margins by PDR.
c. Plan for system level margins management, including depletion.
d. Plan for subsystem margins management, including depletion.
e. Quantification of system level margins (preliminary by SDR, final by PDR).
f. Quantification of subsystem level margins (final by PDR).

The CEV Margins Management Reports shall include:

a. Margins status, including current margin values and margin targets based on depletion plan.
b. Rationale for unplanned depletion.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA. Complete re-issue of the CEV Margins Management Plan is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-037
3. **DATA TYPE**: 3
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Qualification Test Plans and Procedures

7. **DESCRIPTION/USE**:
To provide the test procedures for demonstrating that the design and performance requirements can be demonstrated for all CEV project requirements, including the range of projected environments and operating conditions anticipated over the service life.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
Qualification hardware shall have the same configuration and experience the same manufacturing processes as the flight production hardware.
1) Test Plans and Procedures

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 6.1.5., 6.2.5, 6.4.5, 10.3.1
Related DRD(s): CEV-T-038

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Qualification Test Plans and Procedures contain the test procedures for the formal tests conducted to demonstrate that the design and manufacturing processes produce Spacecraft systems and components that conform to all CEV Project performance requirements including the range of projected environments and operating conditions anticipated over the service life. These tests demonstrate that the design and performance requirements for a Spacecraft system and component can be demonstrated under specified conditions, including stress, thermal, EEE parts, stress/de-rating, structural, off-gassing, flammability, toxicological, and others specific to the product.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The Qualification Test Plans and Procedures shall contain the following:
1. Description of the test item
2. Environmental requirements
3. Test requirements
4. Test definition
5. Test items
6. Test preparation requirements, including
    a) Test readiness review
    b) Safety and environment
    c) Personnel and training
    d) Facilities, equipment, and fixtures
    e) Security
    f) Material

g) Test documentation
h) Test recording

7. Equipment set-up
8. Test operations procedures made available 2 weeks prior to TRR (pre-test meeting).

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor shall maintain this document in accordance with company guidelines for technical documents. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-038
3. **DATA TYPE**: 3
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Qualification Test Report

7. **DESCRIPTION/USE**:
To provide the documentation that demonstrates that the product conforms to all CEV project performance requirements, including the range of projected environments and operating conditions anticipated over the service life.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
Qualification hardware shall have the same configuration and experience the same manufacturing processes as the flight production hardware.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 6.1.5, 6.2.5., 6.4.5, 10.3.1
Related DRD(s): CEV-T-037

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Qualification Test Report contains the test documentation results for the formal tests conducted to demonstrate that the design and manufacturing processes produce Spacecraft systems and components that conform to all CEV project performance requirements, including the range of projected environments and operating conditions anticipated over the service life. These reports demonstrate that the design and performance requirements for the Spacecraft system and components have been demonstrated under specified conditions, including stress, thermal, EEE parts, stress/de-rating, structural, off-gassing, flammability, toxicological, and others specific to the product.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
A Qualification Test Report shall contain the following:
1. Description of the test item
2. Description of the test performed
3. Description of the test equipment and facility
4. Test witnesses
5. Test set-up/configuration information
6. As-Run Test Procedures
7. Tests results
8. Test conclusions

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor shall maintain this document in accordance with company guidelines for technical documents. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-039
3. **DATA TYPE**: 3
4. **DATE REVISED**: Nov. 2013
5. **PAGE**: 1
6. **TITLE:** Acceptance Test Plans and Procedures

7. **DESCRIPTION/USE**:
To provide the test plans and procedures for demonstrating that a component, CSCI, module, or system is capable of meeting performance requirements prescribed in purchase specifications or other documents specifying what constitutes the adequate performance capability for the item in question.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
Acceptance testing shall be completed on all flight components, modules, and spacecraft.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 10.3.1
Referenced from SOW Paragraph: 2.6, 6.1.5, 6.2.5, 6.4.5
Related DRD(s):, CEV-T-040

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Acceptance Test Plans and Procedures contain the test procedures for demonstrating that a component, CSCI, module, or system is capable of meeting performance requirements prescribed in purchase specifications or other documents specifying what constitutes the adequate performance capability for the item in question.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The Acceptance Test Procedures shall contain the following:
1. Description of the test item
2. Test definition
3. Test preparation requirements, including
    a) Test readiness review
    b) Safety and environment
    c) Personnel and training
    d) Facilities, equipment, and fixtures
    e) Security
    f) Material
    g) Test documentation
    h) Test recording
4. Equipment set-up
5. Visual inspections required
6. Operational test requirements
7. Environmental test requirements
8. Final functional operating test

9. Test operations procedures delivered two weeks prior to TRR (pre-test meeting)

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-040
3. **DATA TYPE**: 2/4
4. **DATE REVISED**: Sept. 2012
5. **PAGE**: 1
6. **TITLE:** Acceptance Data Package (ADP)

7. **DESCRIPTION/USE**:
To provide the documentation needed by NASA to establish the acceptability of integrated systems/hardware/software for their intended use.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix
An ADP shall be prepared for each end item from component to system level. The ADP shall be in an electronic format and reside within a controlled common environment (i.e. Projectlink, etc.) which NASA can review prior to DD250/DD1149 execution. The content of the ADP for initial submission shall be as specified by the categories defined in MPCV 70146, MPCV ADP Requirements.

10. **SUBMISSION FREQUENCY**:
Deliverable Flight and Ground Software items which are of the same configuration, unless otherwise directed, shall only complete a delta ADP from the previous configuration submittal. The delta ADP shall be in an electronic format and reside within a controlled common environment (i.e. Projectlink, etc.) which NASA can review prior to DD250/DD1149 execution. The content of the ADP for submission shall be as specified by the categories defined in MPCV 70146.
Acceptance data shall be prepared and electronically delivered for each subsequent re-delivery and meet the criteria established in MPCV 70146, except as otherwise defined herein.

For EM1 and EM2, the ADPs shall be Type 2.
For AA-2, the ADP shall be Type 4.

11. **REMARKS**:
To support hardware or software deliveries to the MPCV Program, specific data, which identifies and represents the status of the item being delivered, must be provided to the receiving organization. The accumulation of this data, originally delivered for acceptance and subsequently maintained throughout the life of the item, is known as the Acceptance Data Package (ADP).

The ADP provides a complete and verified status, including the as-built configuration, of hardware or software, contains information pertinent to acceptance, identifies information unique to the item, and enables the continuation of required activities by the using organization. The ADP is prepared as part of the hardware or software acceptance/delivery criteria and will be maintained throughout the hardware or software life cycle after government acceptance. The ADP must be maintained throughout integrated testing, ground processing, launch site processing, on-orbit or in-flight operation, post landing, and maintenance/modification/refurbishment activities until the hardware or software is decommissioned.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 10.3.1, 10.3.2, 10.3.3, 10.3.5.3.
Referenced from SOW Paragraph(s): 2.6, 2.7.2.(e), 6.1.5, 6.5.4
Related DRD(s): CEV-T-014, CEV-T-039

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:

An ADP shall contain the information necessary for NASA, or its delegate, to determine the acceptability of delivered hardware, software, and integrated systems for their intended use. The acceptability of the delivered item is based on whether the acceptance data provides sufficient evidence that acceptance requirements have been satisfied for the corresponding hardware or software delivery. The term "delivery" applies to the initial delivery of an item at the time of acceptance, as well as any subsequent delivery resulting from modifications, maintenance, refurbishment, or any other activity that produces new data for the delivered item. The ADP shall be in an electronic format and reside within a controlled contractor repository (i.e. Projectlink, etc.) for customer review and approval. Upon ADP approval and DD250/DD1149 execution the ADP shall be controlled and secured by the contractor and made available for customer transition.

The ADP requirements established by this DRD shall apply to hardware flight equivalent hardware, GSE and software as defined in MPCV 70146.

13.2 **APPLICABLE DOCUMENTS**:

MPCV 70146 MPCV Program Acceptance Data Package (ADP) Requirements.

13.3 **CONTENTS**:

This DRD establishes the requirements for the minimum acceptance data which is required for Production hardware, software, and integrated systems delivered to NASA for the MPCV Program. These requirements are documented in MPCV 70146, MPCV Program Acceptance Data Package (ADP) Requirements.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Single searchable PDF requirement not applicable.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-041
3. **DATA TYPE**: 2
4. **DATE REVISED**: May 2009
5. **PAGE**: 1
6. **TITLE**: CEV Instrumentation Plan

7. **DESCRIPTION/USE**:
This DRD develops and records the plans and processes for all instrumentation development and implementation activities.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.6.1.
Related DRD(s): CEV-T-047

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The instrumentation plan provides insight into, and a tool for monitoring, the processes to be followed for CEV spacecraft instrumentation development and implementation activities. This DRD will include the provisions for the calibration of the instrumentation transducers and sensors to assure end-to-end error and tolerances are within required performance. All technical information related to the instrumentation requirements allocation, trade studies, system analysis, design, test, verfication, certification and sustaining engineering shall be documented in DRD-T-047, Avionics Design and Data Book Volume II - Command and Data Handling/Instrumentation Subsystem Data.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The CEV Instrumentation Plan shall include the following processes and plans:
a. A process that identifies and allocates instrumentation and sensor requirements across the CEV System including subsystem engineering and operational needs. The process shall include the roles and responsibilities for sensors interface design and the approval of the subsystem sensor requirements definition, procurement and testing, and the definition and provisioning for the calibration of the instrumentation transducers and sensors to assure end-to-end error and tolerances are within required performance.
b. A development process that addresses: long lead parts procurement, potential obsolescence issues, determination of required trade studies, prototyping approach and development test, modeling, and analysis aimed at reducing technical risks.
c. A plan that addresses the necessary facilities and equipment for developing and certifying the CEV instrumentation across the vehicle system and within each subsystem.
d. A ground data reduction process including a description of the

hardware/software required to support this capability.
e. A metrics plan to measure key aspects of these processes.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Microsoft® Word-compatible.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required, with changes clearly identified.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-042
3. **DATA TYPE**: 2
4. **DATE REVISED**: 12/5/2005
5. **PAGE**: 1

6. **TITLE:** Mass Properties Control Plan

7. **DESCRIPTION/USE**:
The Mass Properties Control Plan defines the processes for the collection, processing, reporting and control of CEV mass properties information. NASA will utilize the contractor's Mass Properties Control Plan to ensure that the contractor's mass properties management and control process is acceptable for the accomplishment of CEV Project objectives.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.4, 6.1.6.1, 6.2.6.1, 6.4.6.1.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Mass Properties Control Plan defines the contractor's mass properties organizational structure and the associated processes for the acquisition, reduction, control and reporting of mass properties data throughout the CEV life cycle. The Mass Properties Control Plan also covers the definition of target mass, reserve mass and growth allocations as well as the reconciliation of mass estimates with measured data from as-built hardware.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The Mass Properties Control Plan shall include the following:

a) Definition of the contractors mass properties organizational structure

b) Definition of the contractor's data preparation process and data flow from discipline organizations through management

c) Definition of the contractor's process in establishing mass allocations, reporting requirements and verification requirements including subcontractor and vendor hardware

d) Definition of the contractor's process for mass properties trend analysis, variance tracking and risk assessment

e) Definition of the gross, inert, dry and sequential mass properties control process including:

1. Mass property report format including functional breakdown
2. Data acquisition and reduction methodology for the entire CEV life cycle
3. Change procedures
4. Data uncertainties with respect to the source and maturity of the mass property data

5. Data accuracy anticipated at major program milestones

f) Contractor mass target and reserve approach

g) Identification of mass properties limits

h) Mass growth plan including growth allocations and the process for growth depletion with respect to the maturation of the basic CEV System mass

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of this document is required with changes clearly identified.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-043
3. **DATA TYPE**: 4
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Mass Properties Reports
7. **DESCRIPTION/USE**:
Mass Properties Reports provide a status on the contractor’s CEV System mass properties including allocated and non-allocated growth. NASA will employ the Mass Properties Report to track contractor variance from CEV System mass properties targets as well as to support requirements development, technical analyses and trade studies for the CEV spacecraft and mated Exploration System element configurations.
8. **DISTRIBUTION**: As determined by the Contracting Officer.
9. **INITIAL SUBMISSION**: Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix
11. **REMARKS**:
12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.4.
13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
Periodic mass properties reports provide insight into the status of the CEV System mass properties throughout all program phases. The basis (estimated, calculated or measured) of each component mass shall be included as part of the recorded component data. Totals of the estimated, calculated and measured mass properties data shall be recorded to provide an indication of the mass properties confidence.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The Mass Properties Reports shall include the following:

a) Dry Mass Properties

1. Mass summary (last, current, contract end item, maturity level in percent)
2. Comprehensive reasons for changes since the previous mass properties status report
3. List of pending and potential changes
4. Mass properties summary including mass moments and products of inertia (subsystem, element, sequential)
5. Mass history plot
6. Status of current and projected mass versus control mass
7. CEV mass properties coordinate system description including offsets from other Exploration coordinate systems
8. Detailed mass properties reflecting the current database in sufficient detail to reflect major items and subsystems
9. Summary performance margins
10. References, if applicable
11. Critical mass properties status
12. Government Furnished Equipment (GFE)

b) Sequential Mass Properties as a function of time and mission event, as appropriate
1. Gross liftoff mass, summarized by dry, inert and expendables
2. Nominal ascent
3. On-orbit
4. Nominal re-entry

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Mass properties reports provided in Microsoft® Word-compatible format with spreadsheet data supplied in Microsoft® Excel®-compatible format. NASA access to native contractor mass properties database or formatted database export file upon request.

13.5 **MAINTENANCE**: Changes to this document shall be incorporated by complete re-issue of the report.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-044
3. **DATA TYPE**: 2
4. **DATE REVISED**: Nov. 2013
5. **PAGE**: 1
6. **TITLE**: CEV MMOD Analysis Report

7. **DESCRIPTION/USE**:
Micrometeoroid and Orbital Debris (MMOD) analysis involves the assessment of risk to the spacecraft and crew resulting from damage or penetration from micrometeoroid and orbital debris impacts during various mission phases. MMOD Analyses will provide feedback verification that the CEV flight system design meets protection requirements specified by the CEV Project.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
This is a requirement to assess MMOD damage to CEV TPS and/or other vehicle hardware that leads to loss of vehicle or crew on-orbit or during reentry using Bumper code or equivalent MMOD risk assessment software.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.8.2.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
This document will be used to ensure that all CEV flight system designs meet MMOD protection requirements.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:

SLS-SPEC-159 Cross-Program Design Specification for Natural Environment (DSNE)(and associated Children documents as specified in Attachment J-3, Applicable, Meets/Exceeds, and Informational Documents List)

NASA TP-2003-210788: Meteroid/Debris Shielding, 2003, Section 2 for describing the MMOD risk assessment process using Bumper code

13.3 **CONTENTS**:
MMOD analysis reports shall include:
a. Baseline assessments of the MMOD risk (overall and by mission phase) to the CEV for loss of mission and loss of crew based on the design MMOD environments derived from SLS-SPC-159, Cross Program Design Specification for Natural Environments (DSNE) (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List). The baseline assessments will be updated as the CEV design evolves.
b. Focused MMOD impact assessments for safety-critical components and subsystems such as the thermal protection system, radiators and other fluid systems, pressure vessels and windows, and safety-critical mechanisms.

c. Supplemental MMOD analyses to define the sensitivities of the baseline results to orbital altitude, spacecraft attitude, duration of exposure, and uncertainties or projected growth in the MMOD environment.
d. Evaluation of the baseline results to support CEV design optimization with respect to competing design priorities and constraints.
e. Evaluation of supplemental or alternate MMOD shielding approaches, as appropriate.
f. Description of all CEV MMOD analysis models and tools including calibration results against accepted standards. This description includes all risk assessment assumptions and inputs, MMOD protection configurations used in the risk assessments, failure criteria as appropriate for loss of vehicle/crew and loss of mission from the MMOD environment, ballistic limit equations and available impact test data supporting the equations.
g. Document all vehicle design, system and operational considerations implemented to meet MMOD protection requirements during CEV System risk allocation.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Microsoft® Word/Excel® or Adobe® Acrobat® PDF for textual and graphics information, ASCII delimited for data, and XML.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-045
3. **DATA TYPE**: 3
4. **DATE REVISED**: Nov. 2013
5. **PAGE**: 1
6. **TITLE**: CEV Space Radiation Analysis and Certification Report

7. **DESCRIPTION/USE**:
Radiation Analyses will be used to describe the internal crew radiation exposure resulting from exposure of the CEV to both nominal space radiation environments and solar particle events. This analysis will be used by NASA to ensure that the CEV provides for crew exposures which are both below established design limits and which are further maintained As Low As Reasonably Achievable (ALARA). For ionizing radiation effects on electronic hardware, refer to DRD CEV-T-027, Electrical, Electronic, and Electromechanical Parts Eanagement and Implementation Plan.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**: Active radiation instrumentation for the vehicle and passive dosimeters for CEV missions are provided by the government.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.8.3.
Related DRD: CEV-T-027

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The contractor shall provide NASA with radiation subject matter expertise to verify and validate the mass and materials of the CAD model, help with the preparation of CAD models for radiation analyses for as flown and contingency configurations, and perform preliminary radiation analyses. These models will be used by NASA for further radiation analyses that describe the projected crew radiation exposure based on the vehicle design. These analyses will also provide information about the internal CEV radiation environment which is relevant to electronic subsystem hardware.

13.2 **APPLICABLE DOCUMENTS**:

Applicable Documents per J3:
SLS-SPEC-159: SLS Program Design Specification for Natural Environments

MPCV-70024, Section 3.2.7: MPCV Human System Integration Requirements (HSIR), Section 3.2.7

National Council on Radiation Protection and Measurements Report No. 132: Radiation Protection Guidance for Activities in Low-Earth Orbit

OSHA Standards 29 CFR: Supplementary Standards 1960.18

13.3 **CONTENTS**:
The Space Radiation Analysis and Certification Report shall use the space radiation environments described in the SLS-SPEC-159: SLS Program Design

Specification for Natural Environments and determine the doses and particle spectra internal to the CEV habitable area during enhanced space weather conditions (significant solar particle events), and nominal solar maximum and solar minimum conditions.

The Space Radiation Analysis and Certification Report shall detail the following:
- Radiation analysis performed including structural models, materials selection, stowage planning (including worst case scenarios where the plan is not followed), and design decisions.
- Transport models
- Human models

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Microsoft® Word/Excel® or Adobe® Acrobat® PDF for textual and graphics information, or ASCII delimited for data.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-046
3. **DATA TYPE**: 3
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: CEV Data and Command Dictionary

7. **DESCRIPTION/USE**:
Used to define, manage, and record all data elements that interface with the core avionics software and hardware, the subsystem specific software, and the ground systems. Specific data elements include: end-to-end channelization information, calibration information, sensor range, telemetry formats, and command information required to define the entire software system/architecture. This DRD must be sortable for use by multiple end-user functions, and includes all data used by the flight crew, ground operations, and flight operators.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.6.1.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The CEV Data and Command Dictionary applies to all flight, ground, simulation, and test software and hardware on the CEV Project.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
MPCV 70022-4 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 4: Information Representation Specification (and associated Children documents as specified in Attachment J-3, Applicable, Meets/Exceeds, and Informational Documents List)

13.3 **CONTENTS**:
The CEV Data and Command Dictionary shall be a sortable database that includes:
a. Channelization data (e.g., bus mapping, vehicle wiring mapping, end-to-end hardware channelization (from sensor/transducer, through signal conditioning, and multiplexing, to final destination of measurement) , etc.).
b. I/O variables.
c. Rate group data.
d. Raw and calibrated calibration 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, etc.).
j. Mapping to the CEV Nomenclature document.

k. Sensor reference information (e.g.. measurement type, signal type, subsystem, installation drawing number, part number).

13.4 **FORMAT**: XTCE file.

13.5 **MAINTENANCE**: Contractor-proposed changes to this DRD shall be submitted to NASA for approval.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-047
3. **DATA TYPE**: 3
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE:** Avionics Design and Data Book
7. **DESCRIPTION/USE**:
This DRD covers design information for the CEV Avionics subsystems, including the Command and Data Handling, Instrumentation, Communication and Tracking, and Displays and Controls subsytems. Software design documentation is provided in a separate DRD. This documentation will provide insight into the contractor's design and analysis data, as well as detailed reference information to support Engineering and Operations throughout the life of the CEV.
8. **DISTRIBUTION**: As determined by the Contracting Officer
9. **INITIAL SUBMISSION**: Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix
11. **REMARKS**:
12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.6.1, 2.6.2, 2.6.3, 2.6.4.
Referenced from SOW Paragraph(s): 6.1.3.2, 6.2.3.2, 6.1.3.3, 6.2.3.3, 6.1.3.4
Related DRD(s): CEV-T-033, CEV-T-041
13. **DATA PREPARATION INFORMATION**:

13.1 **<u>SCOPE</u>**:
Design and analysis data related to the Avionics subsystem from the initial trade studies, requirements analysis, architecture, math modeling, functional and performance analyses, detailed design, design analysis, and operations and maintenance strategies. Document also covers interfaces with other CEV subsystems, software interfaces, external interfaces, and interfaces with ground/users. Separate volumes shall be provided for each avionics subsystem, as specified below.

13.2 **<u>APPLICABLE DOCUMENTS</u>**:
MPCV 70022-1 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 1: Interoperability Specification (and associated Children documents as specified in Attachment J-3, Applicable, Meets/Exceeds, and Informational Documents List)

MPCV 70022-2 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 2: Spectrum and Channel Plan

MPCV 70022-4 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 4: Information Representation Specification (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational

Documents List)

MPCV 70022-5 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 5: Data Exchange Protocol Specification

MPCV 70022-8 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 8 Common Command and Control Functional requirements (and associated Children documents as specified in Attachment J-3, Applicable, Meets/Exceeds, and Informational Documents List)

CxP 70170 Constellation Program Information Technology (IT) Functional Security Requirements

13.3 **CONTENTS**:

The Avionics DRD shall contain seven volumes as follows:
Volume I: Avionics System-Level Data
Volume II: Command and Data Handling/Instrumentation Subsystem Data
Volume III: Communications and Tracking Subsystem Data
Volume IV: Displays and Controls Subsystem Data
Volume V: Avionics Subsystem - Constellation C3I Interoperability Report
Volume VI: Avionics Subsystem - Constellation Security Report
Volume VII: Software Architecture Design Data

Volumes I - IV shall include, as applicable to the subsystem, the information listed below:

1) Assumptions and groundrules
2) Subsystem Definition including architecture diagrams and GFE vs. contractor-supplied assumptions
3) Subsystem Requirements Analyses
   a) Functional decomposition
   b) Functional, performance and interface requirements
   c) Derived requirements on other systems/subsystems with analysis that yields the requirements
   d) Trade study results
   e) Analysis to show the subsystem meets the requirements
4) Detailed Design Description
   a) Hardware element descriptions and principles of operation including description of system modes
   b) Math models
   c) Mass and volume properties
   d) Power and Thermal profiles
   e) Schematics layouts, drawings, and 3-D solid geometric representations of components
   f) Interface Requirements and description (internal and external hardware interfaces including mechanical, electrical and thermal interfaces, software interfaces, and human interfaces; includes necessary Interface Control Documents)
   g) Bandwidth/throughput/memory/link margin analysis for hardline, RF, and optical data systems and processors as applicable to subsystem
   h) Telemetry/instrumentation
   i) Consumables list
   j) Reconfiguration process
5) Operational Analyses
   a) Operational scenarios and modes including the subsystem's limitations on any aspect of vehicle flight
   b) Performance and Margin analyses
   c) Operating Environments (natural and induced)

   d) Failure modes and redundancy operations including vehicle failure modes accommodated by subsystem and failure modes reacting to vehicle failures
   e) Fault Detection, Isolation and Recovery
   f) Diagnostic strategies including plans for in-flight maintenance
   g) Initialization procedures and parameters
   h) Day of launch parameters and late-load requirements
   i) Abort analysis
   j) Launch scrub turnaround plan
   k) Labeling strategy (consistent with overall CEV labeling strategy)
   l) Independent design and performance analyses including worst case timing analysis, fault tolerance and hazard identification/mitigation.

6) Maintainability and testing data
   a) Test requirements including information on Special Test Equipment design, operations and maintenance, if applicable.
   b) Maintainability strategies including sparing provisions, growth and scarring provisions, shelf-life, and long-term storage provisions
   c) Deliverable end item or equipment identification (part number)
   d) Predicted reliability assessment
   e) Component reusability/refurbishment analysis

7) References and indication of any changes from the previous submission

8) Additional Communications and Tracking Subsystem Analyses Data (Volume III)
   a) In addition to the information specified above, Volume III shall include the following analyses reports, with each report provided in a separate section. Each report shall contain the following:
      (1) Brief description of the analysis discipline and its overall function.
      (2) Summary performance matrix listing each quantitative parameter requirement the discipline is to satisfy against a concise statement of the analytically predicted performance of the parameter, whether or not the parameter requirement is met, and a reference to the location in the text where the supporting analysis is described.
      (3) Supporting analyses which shall discuss all boundary conditions, inputs (including test data), and assumptions used; analytical approaches (models, equations, algorithms) used; results; and conclusions.
      (4) In cases where computer math models or programs are utilized, a description of the program along with the source code are to be delivered.
   b) Required Analysis Reports:
      (1) Radio Frequency/Optical Link Margin Data book – Documents link margin for each RF link.
      (2) RF/Optical Coverage Analysis Report – Report of RF link availability considering vehicle trajectory, antenna patterns, structural blockage, planet blockage, and link margin.
      (3) Radiation Patterns – Documents planned performance at PDR and test measurements as available.
      (4) Emitter/Receiver pointing analysis – Analysis of antenna/laser pointing accuracy and stability considering all sources of pointing errors.
      (5) RF/Optical Radiation analysis – Analysis to show RF/Optical system compliance relating to RF/Optical operations and constraints with the launch site, vehicles and facilities.
      (6) Tracking analysis – Analysis to show that RF/Optical tracking systems meet system requirements.
      (7) RF/Optical Interference Analysis – Provide analysis or measured data showing that no other vehicle subsystems or components prevent the reception, transmission, or operation of RF

communication subsystems and components. Similarly, provide analysis or measured data showing that no RF communication subsystem or components interfere with the proper operation of other vehicle subsystems or components.

(1) 8 RF link compatibility analyses – Documents the RF compatibility between CEV communication links and between CEV communication links and other interfacing elements.

9) Power Flux Density analysis – Analysis that shows that all modes of operation meet Interdepartmental Radio Advisory Committee flux density

Volume V shall include:

1) Description of how the CEV contractor plans to implement:
   a) MPCV 70022-1 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 1: Interoperability Specification (and associated Children documents as specified in Attachment J-3, Applicable, Meets/Exceeds, and Informational Documents List)
   b) MPCV 70022-2 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 2: Spectrum and Channel Plan
   c) MPCV 70022-4 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 4: Information Representation Specification (and associated Children documents as specified in Attachment J-3, Applicable, Meets/Exceeds, and Informational Documents List)
   d) MPCV 70022-5 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 5: Data Exchange Protocol Specification(and associated Children documents as specified in Attachment J-3, Applicable, Meets/Exceeds, and Informational Documents List).
   e) MPCV 70022-8 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 8 Common Command and Control Functional Requirements (and associated Children documents as specified in Attachment J-3, Applicable, Meets/Exceeds, and Informational Documents List).
2) Provides a summation and targeted details of designs for vehicle systems that support command, control, and monitoring, including:
   a) Communications protocols
   b) Information model content related to command, control, communications, and monitoring
   c) Communications framework supporting collaborative data sharing and distribution

Volume VI shall include:

1) Description of how the CEV contractor plans to implement:
   a) CxP 70070-ANX05, Book 1, Constellation Program Functional Security Requirements (and associated children)
2) Provides a summation and targeted details of designs for vehicle systems that support command, control, and monitoring, including:
   a) Communications protocols
   b) Information model content related to command, control, communications, and monitoring
   c) Communications framework supporting collaborative data sharing and distribution

Volume VII shall include:

System architectural design. This section shall be divided into the following paragraphs to describe the CEV System architectural design. If part or all of the design depends upon CEV System states or modes, this dependency shall be indicated. If design information falls into more than one paragraph, it may be presented once and referenced from the other paragraphs. Design conventions needed to understand the design shall be presented or referenced.

NOTE: For brevity, this section is written in terms of organizing a system directly into Computer Software Configuration Items (CSCIs), and manual operations, but shall be interpreted to cover organizing a system into subsystems, organizing a subsystem into CSCIs, and manual operations, or other variations as appropriate.

1) System components. This paragraph shall:

   a) Identify the components of the system (CSCIs and manual operations). Each component shall be assigned a project-unique identifier. Note: a database may be treated as a CSCI or as part of a CSCI.
   b) Show the static (such as 'consists of') relationship(s) of the components. Multiple relationships may be presented, depending on the selected design methodology.
   c) State the purpose of each component and identify the System requirements and systemwide design decisions allocated to it.
   d) Identify each component's development status/type, if known (such as new development, existing component to be reused as is, existing design to be reused as is, existing design or component to be reengineered, component to be developed for reuse, component planned for Build N, etc.) For existing design or components, the description shall provide identifying information, such as name, version, documentation references, location, etc.
   e) For each computer system or other aggregate of computer hardware resources identified for use in the System, describe its computer hardware resources (such as processors, memory, input/output devices, auxiliary storage, and communications/ network equipment). Each description shall, as applicable, identify the configuration items that will use the resource, describe the allocation of resource utilization with associated margin to each CSCI that will use the resource (for example, 20% of the resource's capacity allocated to CSCI 1, 30% to CSCI 2), describe the conditions under which utilization will be measured, and describe the characteristics of the resource.

2) Concept of execution. This paragraph shall describe the concept of execution among the system components. It shall include diagrams and descriptions showing the dynamic relationship of the components, that is, how they will interact during System operation, including, as applicable, flow of execution control, data flow, dynamically controlled sequencing, state transition diagrams, timing diagrams, priorities among components, handling of interrupts, timing/sequencing relationships, exception handling, concurrent execution, dynamic allocation/deallocation, dynamic creation/deletion of objects, processes, tasks, and other aspects of dynamic behavior.

3) Interface design. This paragraph shall be divided into the following subparagraphs to describe the interface characteristics of the system components. It shall include both interfaces among the components and their interfaces with external entities such as other systems, configuration items, and users. Note: There is no requirement for these interfaces to be completely designed at this level; this paragraph is provided to allow the recording of interface design decisions made as part of system architectural design. If part or all of this information is contained elsewhere, these sources may be referenced.

a) Interface identification and diagrams. This paragraph shall state the project-unique identifier assigned to each interface and shall identify the interfacing entities (systems, configuration items, users, etc.) by name, number, version, and documentation references, as applicable. The identification shall state which entities have fixed interface characteristics (and therefore impose interface requirements on interfacing entities) and which are being developed or modified (thus having interface requirements imposed on them). One or more interface diagrams shall be provided, as appropriate, to depict the interfaces.

b) Project-unique identifier of interface. This paragraph shall identify an interface by project-unique identifier, shall briefly identify the interfacing entities, and shall be divided into subparagraphs as needed to describe the interface characteristics of one or both of the interfacing entities. If a given interfacing entity is not covered by this ADD (for example, an external system) but its interface characteristics need to be mentioned to describe interfacing entities that are, these characteristics shall be stated as assumptions or as 'When [the entity not covered] does this, [the entity that is covered] will ....' This paragraph may reference other documents (such as data dictionaries, standards for protocols, and standards for user interfaces) in place of stating the information here. The design description shall include the following, as applicable, presented in any order suited to the information to be provided, and shall note any differences in these characteristics from the point of view of the interfacing entities (such as different expectations about the size, frequency, or other characteristics of data elements):
   (1) Priority assigned to the interface by the interfacing entity(ies).
   (2) Type of interface (such as real-time data transfer, storage-and-retrieval of data, etc.) to be implemented.
   (3) Characteristics of individual data elements that the interfacing entity(ies) will provide, store, send, access, receive, etc. (e.g., identifiers, data type, size, format, range, accuracy, etc.).
   (4) Characteristics of data element assemblies (records, messages, files, arrays, displays, reports, etc.) that the interfacing entity(ies) will provide, store, send, access, receive, etc. (e.g., identifiers, data elements, medium, visual and auditory characteristics, etc.).
   (5) Characteristics of communication methods that the interfacing entity(ies) will use for the Interface (e.g., identifiers, links/bands, formatting, transfer rates, etc.).
   (6) Characteristics of protocols that the interfacing entity(ies) will use for the interface (e.g., identifiers, priority/layer, error control, packeting, synchronization, etc.).
   (7) Other characteristics, such as physical compatibility of the interfacing entity(ies) (dimensions, tolerances, loads, voltages, plug compatibility, etc.).

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-048
3. **DATA TYPE**: 1/3/4
4. **DATE REVISED**: Nov. 2013
5. **PAGE**: 1
6. **TITLE**: Software Requirements Specification

7. **DESCRIPTION/USE**:
A document which defines and records the software requirements, including interface requirements, to be met by a computer software configuration item (CSCI). This document specifies the requirements for a CSCI and the methods to be used to ensure that each requirement has been met. This document forms the basis for design and qualification testing of a CSCI. In addition, this document will include the display format dictionaries in the display software SRS as specified in section 13.3 below.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
Requirements pertaining to the CSCI's external interfaces may be presented in the Software Requirements Specification (SRS) or in one or more Interface Requirements Specifications (IRS's) referenced from the SRS.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 6.5.2.
Referenced from SOW Paragraph(s): 2.5, 2.6.15, 6.1.3.15, 6.2.3.15, 6.4.3.15
Related DRD(s): CEV-O-008, CEV-T-035

13. **DATA PREPARATION INFORMATION**:

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

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
CxP 72242, CEV Display Format Standards Document
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)

Meets/Exceeds Documents per J3:
IEEE/EIA 12207.0-1996: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes
IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207; 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data

13.3 **CONTENTS**:
In accordance with NPR 7150.2 NASA Software Engineering Requirements, and using IEEE/EIA 12207.1-1997 as guidance, 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 utilization requirements.
    (c). Computer communications requirements.
12. Software quality characteristics.
13. Design and implementation constraints.
14. Personnel-related requirements.
15. Training-related requirements.
16. Logistics-related requirements.
17. Packaging requirements.
18. Precedence and criticality of requirements.
19. Operations requirements, including flight-to-flight reconfiguration.

c. Qualification provisions.

d. Requirements traceability and verification method data.

e. Requirements partitioning for phased delivery.

f. Testing requirements that drive software design decisions; e.g., special system level timing requirements/checkpoint restart.

In addition to the above requirements, the display software SRS shall contain an appendix that serves as the display format dictionary to document the results of the display format prototyping activity. At the discretion of the contractor, each format may be documented in a separate appendix. The Display Format Dictionary Appendix shall document the results of the display prototyping effort which includes the following information at a minimum:

- Scope
- Introduction
- The following information for each display format:
  - General discussion on the purpose of the display format and its associated operational concept (i.e. applicable mission phase or scenario).
  - Graphical representation of each format (may include multiple images to clearly reflect mission/phase tailoring or other moding behavior).
  - Detailed description of each graphical object
  - Description of the dynamic behavior of each dynamic graphical object and/or command on the format including states, limits, modes, decluttering, etc., as applicable.
  - Required input and output data parameters and data rates, including source/destination for each input/output parameter.

In addition, for software, using IEEE/EIA 12207.1-1997 as Meets/Exceeds, interface requirements shall include:

a. Requirements imposed on one or more systems, subsystems, configuration items, manual operations or other system components to achieve one or more software interfaces among these entities.
    1. Interface identification and diagrams. One or more diagram shall be provided to depict the interfaces between the CSCIs or

CSCs and between each CSCI or CSC that interfaces directly to hardware. (e.g., a UML Domain Chart Diagram with dependencies depicted between each domain and or a context diagram depicting the interfaces between unique software and or hardware elements).

2. Project-unique identifier of interface. A project unique identifier shall be assigned to each interface with the identifier constructed by concatenating the following strings separated by an underscore character: "ORN", "FSW" for a flight software interface used for software verification, "GSW" for a ground software interface, "SSW" for a simulation software interface or "DSW" for a data services software interface, the UML KEY letter string for the source CSCI, CSC or hardware interface, and the UML KEY letter string for the destination CSCI, CSC or hardware interface (e.g., ORN_FSW_GNC_CDH for a flight software interface between the GNC software entity and the CDH software entity). The project-unique identifier shall be annotated on the interface diagram(s). Note, by definition, interfaces between one software element (flight, ground, simulation or data services) and another are hardware interfaces which are represented on the software interface diagram for each element as a software to hardware interface at the final point where the software interfaces with the hardware interface that provides communications between the flight, ground, simulation or data services systems.
3. One pair of requirements shall be documented for each unique form of interaction that occurs over each interface. One requirement of each pair shall state what the source of the interface "provides" to the destination of the interface, and one requirement of each pair shall state what the destination of the interface "receives" from the source of the interface (e.g., if software entity A provides data to software entity B and software entity A invokes a function of software entity B, then two pairs of interface requirements shall be written; one pair describing the data exchange, and one pair describing the function invocation). For the special case of a broadcast type of interface where there is a single "provider" and multiple "receivers", a pair of requirements shall be used to document each interface for which the requirements, design or implementation of the interface differs between the provider and one receiver and the provider and any other receiver (e.g., one pair of requirements is written for the single provider and the list of all receivers only if the interfaces between the provider and all receivers are identical in requirements, design and implementation, for all other conditions a pair of requirements is written for each combination of provider and receiver). Requirements associated with synchronous error handling (indications explicitly passed over the interface) and asynchronous error handling (indications associated with failure to communicate over the interface) shall be documented for each interface as applicable.
4. Precedence and criticality of requirements. The interface requirements shall document the precedence of the interface requirements (as applicable). The criticality of the interface requirements shall be determined and documented using the same approach applied to software requirements.

b. Qualification provisions. The qualification provisions for interface requirements shall be determined and documented using the same approach applied to software requirements.

Requirements traceability shall be documented between the software interface requirements and the associated software, subsystem or system level requirement(s).

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required with changes clearly identified.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-049
3. **DATA TYPE**: 4
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Software Metrics Report

7. **DESCRIPTION/USE**:
To provide visibility to contractor and government project management of actual and potential problems and progress toward meeting the cost, technical and schedule requirements. This report is to be provided quarterly.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 6.5.2.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Software Metrics Report provides data for the assessment of software cost, technical, and schedule progress.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)

Meets/Exceeds Documents per J3:
IEEE/EIA 12207.0-1996: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes
IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207; 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data

13.3 **CONTENTS**:
In accordance with NPR 7150.2 NASA Software Engineering Requirements, the Software Metrics Report shall contain as a minimum the following information tracked on a CSCI basis:
a. Software resources – planned vs. actual.
b. Software development schedule tasks (e.g., milestones) (planned vs. actual).
c. Requirements stability – number of software requirements, number of requirements changes, and number of TBD’s.
d. Software size in agreed upon measurement units (e.g. source lines of code (SLOC)) – planned vs. actual.
e. Computer resource utilization in percentage of capacity (e.g. memory, processor, I/O throughput) with agreed upon thresholds.
f. Number of test cases successfully developed, dry run, and used for formal test – planned vs. actual.

g. Number of Computer Software Units (CSUs) in design/coding phase and under Configuration Management (CM), completed Unit Test and review, and Integrated into Computer Software Configuration Item (CSCI).
h. Number of requirements included in a completed build/release (planned vs. actual).
i. Number of software problem reports and review item discrepancies – open, closed and withdrawn.
j. Number of Peer Reviews/Software Inspections – planned vs. actual.
k. Number and classification of findings found during Peer Reviews/Software Inspections.
l. Number of Software Audits – planned vs. actual.
To the extent information regarding (a) through (l) above is not provided, the contractor shall provide documented justification in the Software Metrics Report. Other information may be provided at the contractor's discretion to assist in evaluating the cost, technical, and schedule performance; e.g., innovative processes and cost reduction initiatives.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-050
3. **DATA TYPE**: 4
4. **DATE REVISED**: Nov. 2013
5. **PAGE**: 1
6. **TITLE**: Software Design Description

7. **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.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 6.5.2

13. **DATA PREPARATION INFORMATION**:

13.1 **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.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)

Meets/Exceeds Documents per J3:
IEEE/EIA 12207.0-1996: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes
IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207; 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data

13.3 **CONTENTS**:
In accordance with NPR 7150.2 NASA Software Engineering Requirements, and using IEEE/EIA 12207.1-1997 as Meets/Exceeds, 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.

13.4 **FORMAT**: Software Modeling Tool generated report format containing the above content in a easily readable format (PDF or Word).

13.5 **MAINTENANCE**: Software Designs shall be maintained to reflect the as-designed configuration.

KEEP DRD CEV-T-051 AS RESERVED

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-052
3. **DATA TYPE**: 2
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Software Test Plan

7. **DESCRIPTION/USE**:
To develop, record, and assess plans for conducting computer software component level testing, software integration testing, software qualification testing, and system qualification testing of a software system.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 6.5.4.
Related DRD(s): CEV-T-015

13. **DATA PREPARATION INFORMATION**:

13.1 **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.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)

Meets/Exceeds Documents per J3:
IEEE/EIA 12207.0-1996: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes
IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207; 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data

13.3 **CONTENTS**:
In accordance with NPR 7150.2 NASA Software Engineering Requirements, and using IEEE/EIA 12207.1-1997 as Meets/Exceeds, 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.Include identification of selected software verification procedures and criteria across the life cycle (e.g., peer review procedures, inspection procedures, re-inspection criteria, testing procedures). Identification of selected software 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).
h. Planned tests, including items and their identifiers.
i. Test schedules.
j. Requirements traceability (or verification matrix), showing bi-directional traceability to requirements and design.
k. Qualification testing environment, site, personnel, and participating organizations. (e.g., software testing environment, regression testing environment).
l. Identification of testing requirements that drive software design decisions, e.g., special system level timing requirements/checkpoint restart.
m. Identification of where the actual software verification records and anlysis of the results will be documented (e.g., test records, peer review records, inspection records), and where software verification corrective action will be documented.
n. Re-verification analysis and re-test shall be required when any of the following occur: Design process changes have been made which affect function or reliability. Inspection, test, mission change, or other data indicate that a more severe environment or operating condition exists than that to which the software was originially verified. Changes are made in specification used in operating the software.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required with changes clearly identified.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-053
3. **DATA TYPE**: 2/3
4. **DATE REVISED**: Nov. 2013
5. **PAGE**: 1
6. **TITLE**: Software Test Description
7. **DESCRIPTION/USE**:
To 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.
8. **DISTRIBUTION**: As determined by the Contracting Officer.
9. **INITIAL SUBMISSION**: Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix
11. **REMARKS**:

Note: Flight Software STDs are treated at the CSCI level, and SIM and EGSE STDs are treated at the Software Systems level.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 6.5.4.

Related DRD(s): CEV-T-054

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Software Test Description describes the test preparations, test cases, and test procedures to be used to perform qualification testing of a CSCI or a software system or subsystem.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)

Meets/Exceeds Docuemnts per J3:
IEEE/EIA 12207.0-1996: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes
IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207; 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data

13.3 **CONTENTS**:
In accordance with NPR 7150.2 NASA Software Engineering Requirements, and using IEEE/EIA 12207.1-1997 as Meets/Exceeds, the Software Test Description shall include:
a. Test preparations, including hardware and software.
b. Test procedures, 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) Test pass/fail criteria.

c. Requirements traceability.

d. Identification of test configuration.

e. A Verification matrix that clearly documents the verification method or methods employed for each software level requirement with linkage to the associated software test description shall be provided to NASA as a standalone report associated with each software verification event and with any subsequent redelivery of the STD.

Note: As-Run Test Descriptions will be delivered as an appendix to this DRD.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required with changes clearly identified.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-054
3. **DATA TYPE**: 2/3
4. **DATE REVISED**: Nov. 2013
5. **PAGE**: 1
6. **TITLE**: Software Test Report

7. **DESCRIPTION/USE**:
To record the qualification testing performed on a CSCI, a software system or subsystem, or other software- related item.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

Note: Flight Software STRs are treated at the CSCI level, and SIM and EGSE STRs are treated at the Software System level.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 6.5.4.
Related DRD(s): CEV-T-053

13. **DATA PREPARATION INFORMATION**:

13.1 **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.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)

Meets/Exceeds Documents per J3:
IEEE/EIA 12207.0-1996: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes
IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207; 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data

13.3 **CONTENTS**:
In accordance with NPR 7150.2 NASA Software Engineering Requirements, and using IEEE/EIA 12207.1-1997 as Meets/Exceeds, 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.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required with changes clearly identified.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-055
3. **DATA TYPE**: 2
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Software Maintenance Plan

7. **DESCRIPTION/USE**:
To provide government insight into the method, approach, responsibility, and processes to be used by the contractor for maintenance of software and its associated documentation.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 6.5.4.

13. **DATA PREPARATION INFORMATION**:

13.1 **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.
Note: The content of the Software Maintenance Plan may be covered by other software plans (e.g. Software Development Plan (T-005), Software Configuration Management Plan (T-006), Software Test Plan (T-052)). A virtual map to the required software maintenance content described in other software plans then serves as this DRD.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)

Meets/Exceeds Documents per J3:
IEEE/EIA 12207.0-1996: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes
IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207; 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data

13.3 **CONTENTS**:
In accordance with NPR 7150.2 NASA Software Engineering Requirements, and using IEEE/EIA 12207.1-1997 as Meets/Exceeds, 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.
    5) Migration.

6) Software Retirement.
7) 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 facilities required for software verification and implementation.
4) Updates to documentation for modified 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/verification facility 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).

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required with changes clearly identified.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-056
3. **DATA TYPE**: 3
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Software User Manual

7. **DESCRIPTION/USE**:
To define user instructions for a CSCI, a software system or subsystem.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 6.5.2.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Software User Manual defines user instructions for a CSCI, a software system or subsystem.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)

Meets/Exceeds Documents per J3:
IEEE/EIA 12207.0-1996: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes
IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207; 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data

13.3 **CONTENTS**:
In accordance with NPR 7150.2 NASA Software Engineering Requirements, and using IEEE/EIA 12207.1-1997 as Meets/Exceeds, the Software User Manual shall include:
a. Software summary including: application, inventory, environment, organization and overview of operation, contingencies and alternate states and modes of operation, security and privacy, and assistance and problem reporting.
b. Access to the software: first-time user of the software, initiating a session, and stopping and suspending work.
c. Processing reference guide: capabilities, conventions, processing procedures, related processing, data backup, recovery from errors, malfunctions, emergencies, and messages.
d. Assumptions, limitations, safety related items/concerns or constraints.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required with changes clearly identified.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-057
3. **DATA TYPE**: 3/5*
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Software Version Description Document

7. **DESCRIPTION/USE**:
To identify and describe a software version consisting of one or more CSCIs (including any open source software). The description is used to release, track, and control software versions.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

NOTE: SVDs delivered in conjunction with each formal software CSCI release as identified in J-9 (CEV-T-048) of Class A/B/C SW = Type 3. All other SVDs delivered with software CSCI releases = Type 5.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 6.5.4.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Software Version Description Document identifies and describes a software version consisting of one or more CSCIs (including any open source software). The description is used to release, track, and control software versions.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)

Meets/Exceeds Documents per J3:
IEEE/EIA 12207.0-1996: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes
IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207; 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data

13.3 **CONTENTS**:
In accordance with NPR 7150.2 NASA Software Engineering Requirements, and using IEEE/EIA 12207.1-1997 as Meets/Exceeds, the Software Version Description Document 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).

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-058
3. **DATA TYPE**: 1
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE:** Radio Frequency/Optical ICDs

7. **DESCRIPTION/USE**:
RF/Optical Interface Control documents define the end to end communications interfaces between CEV and other Exploration Systems (Communication and Tracking Networks (CTN) under Space Communications and Navigation (SCAN)). NASA will use these ICDs to ensure that all interfaces are compatible and interoperable with other Exploration Systems and communications infrastructure.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
These documents shall be consistent with the MPCV Program's integrated plans such as MPCV-70022, Volumes 1, 2, , 4, 5, and 8, MPCV Command, Control, Communication, and Information (C3I) Interoperability Specification (and associated Children documents as specified in Attachment J-3, Applicable, Meets/Exceeds, and Informational Documents List).

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.6.3.
Referenced from SOW Paragraphs: 6.1.3.3, 6.2.3.3

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
RF/Optical ICDs shall be developed for all communications links (Space to Space and Space to Ground). NASA will lead the development of the RF/Optical ICDs with participation from other Exploration Systems and SCAN. Contractor shall participate in the development of the RF/Optical ICDs. The Contactor shall generate, maintain and configuration manage the ICD. After the ICD is baselined, the Contractor shall generate change requests for any changes and submit for NASA approval.

At the contractor's discretion, the ICD's can be delivered in different volumes – For example, a volume for CEV-CTN interface, a volume for CEV-LSAM interface, etc.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:

MPCV 70022-1 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 1: Interoperability Specification (and associated Children documents as specified in Attachment J-3, Applicable, Meets/Exceeds, and Informational Documents List)

MPCV 70022-2 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 2: Spectrum and Channel Plan

MPCV 70022-4 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 4: Information Representation Specification (and associated Children documents as specified in Attachment J-3, Applicable, Meets/Exceeds, and Informational Documents List)

MPCV 70022-5 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 5: Data Exchange Protocol Specification

MPCV 70022-8 MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 8: Common Command and Control Functional Requirements (and associated Children documents as specified in Attachment J-3, Applicable, Meets/Exceeds, and Informational Documents List)

MPCV 7011801, Volume 1: MPCV to Communications and Tracking Networks Interface Requirements Document, Volume 1.

MPCV 70028, Multi-Purpose Crew Vehicle (MPCV) to Ground Systems Development and Operations (GSDO) Interface Requirements Document

MPCV 70029, Multi-Purpose Crew Vehicle (MPCV) Program: Orion to Mission Systems (MS) Interface Requirements Document

ICD-GPS-200: Navstar GPS Space Segment/Navigation User Interfaces

Meets/Exceeds Documents per J3:
450-SNUG: Space Network Users' Guide

13.3 **CONTENTS**:
The RF/Opticals ICD shall start at Layer 2 (Data Link Layer) for transmission end and end at Layer 2 (Data Link Layer) on receiving end.
RF link compatibility analyses – Documents the RF compatibility and detailed communication interfaces between CEV communication links and between CEV communication links and other interfacing elements
The RF/Opticals ICD shall detail the characteristics of the RF communication channel between the CEV, ground stations, Communication and Tracking Network, and other Exploration systems including:
- Frequencies of operation
- Modulation & Channel Coding
- Transmitter powers, receiver noise temperatures and antenna polarization and performance
- Data formats, frame synchronization, forward error correction coding
- Data link layer consisting of framing and link establishment, and negotiation protocols.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required, with changes clearly identified.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-059
3. **DATA TYPE**: 3
4. **DATE REVISED**: May 2009
5. **PAGE**: 1
6. **TITLE**: Electrical Power System (EPS) Design and Data Book

7. **DESCRIPTION/USE**:
Documents the power system design, including the input assumptions, the analytical methods used, the results of the analyses and the comparison to applicable quantitative requirements. The comprehensive equipment documentation will provide detailed reference information to support Engineering and Operations throughout the life of the CEV.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.6.5..
Referenced from SOW Paragraphs: 6.1.3.5, 6.2.3.5, 6.4.3.5

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Electrical Power System Design and Data Book documents the results of design, development, and other pertinent studies relating to the electrical power system, including all power generation, storage, and distribution/control equipment, circuit protection, interior and exterior vehicle lighting, and interfaces for ground, mated vehicles, payloads, and portable equipment. End-to-end functional schematics, engineering drawings, and associated lists shall be utilized to the maximum extent possible in performing and providing analysis reports.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
Volume 1 – Electrical Power System Circuit Protection and Isolation Plan
Plan and provisions for establishing, and maintaining electrical circuit protection for the CEV and CEV interfaces (including human safety) with ground maintenance/test facilities, launch facilities, in-flight vehicles, recovery, and re-furbishment facilities. Crewed, EVA, and uncrewed operations for both 'ground' and 'in-flight' activities such as monitoring, testing, diagnostic, safing, fault recovery, and maintenance shall be addressed.

Volume 2 – Electrical Power System Requirements and Design Analysis Reports
The deliverable shall include:
1) Assumptions, groundrules
2) Subsystem Definition
3) Subsystem Requirements Analyses
   a. Functional decomposition
   b. Functional, performance, and interface requirements
   c. Derived requirements on other systems with analysis that yields

the requirements

d. Trade studies results

e. Analysis to show the subsystem meets the requirements. In cases where computer math models or programs are utilized, a description of the program along with the source code shall be made available to NASA. The following analyses shall also be documented:

1. Electrical Power System Circuit Protection and Fault Analyses - Documents the circuit protection analysis results to determine correct circuit protection size and trip characteristics. Documents the proper circuit protection sizing that is verified by comparing source fault current with wiring and circuit protection specifications. Documents the fault analysis in which worst case faults are considered from the standpoint of safety or mission compromise to determine if power and circuit redundancy is adequate and to assure that there are adequate circuit protection margins to preclude upstream fault propagation. Documents the analysis of both line-to-ground and line-to-line faults.

2. Electrical Power System Grounding Analysis - Documents the electrical grounding design. Documents the analysis results of the electrical grounding design and consistency with the performance specifications of the various interfacing elements during all phases of ground testing and mission flights.

3. Electrical Power System Voltage Drop Analysis - Documents the analysis results using circuit resistance values based on wire size, wire length, temperature conditions, circuit element resistances, and varying load conditions. Documents voltage drops on all major circuits, loads, and interfaces at varying load conditions.

4. Electrical Power System Transient Analyses - Documents the analysis results using normal and worst case subsystem and system interface conditions (voltage and bus transient and ripple), evaluates the design for proper performance and compatibility, and assures adequate margins between the source and the loads. Also documents the evaluation of power on/off switching transient generation for adverse (out-of-spec.) impacts to the interfacing bus.

Volume 3 – Electrical Power System Architectural Notebook
Documents the EPS architectural connectivity for all vehicle configurations.

1) This volume shall include connectivity schematics of:

a. Power generation, power storage, and distribution/control equipment to each other and to each electrical consuming equipment, including interior and exterior lighting

b. Internal and external interfaces for ground support, portable equipment, payloads, mated vehicles, and human interfaces

c. Activation/deactivation architecture, dead-facing termination, as well as any temporary or contingency EPS jumpers (includes hardware utilization description)

d. Thermal and command/data connectivity to the EPS devices.

e. CEV Electrical Power Consuming Equipment List with associated power mode and integration of power channel connectivity data to wiring database.

Volume 4 – Electrical Power System Equipment Description and Performance Data
Comprehensive equipment documentation of the EPS hardware to provide detailed reference information for supporting Engineering and Operations.

1) Detailed Design Description of each EPS device shall include:

a. Hardware description with functional block diagrams

b. Internal and external hardware interfaces including mechanical, optical, electrical, thermal interfaces, software interfaces, and human interfaces

c. Mass and volume properties
d. Equipment location
e. Hardware math model (where applicable)
f. Consumables (if applicable)
g. Data bandwidths (data rates); Telemetry; Instrumentation description

2) Operational Description of each EPS ORU shall include:

a. Operational modes including default and commanded states
b. Power and thermal profile for each operational mode
c. Performance and margin capability
d. Natural and induced operating and non-operating environments (examples: min/max pressure and temperature)
e. Basic summary of operational activation/deactivation procedures and limitations
f. Initialization procedures and parameters
g. Day of launch parameters and late-load requirements
h. Launch scrub turnaround procedures
i. Failure modes and redundancy operations including vehicle failure modes accommodated by subsystem and failure modes reacting to vehicle failures (includes abort safing procedures)
j. Fault Detection, Isolation and Recovery
k. Diagnostics strategies including plans for In-flight maintenance
l. Labeling strategy (consistent with overall CEV labeling strategy)

3) Maintainability and testing data shall include:

a. Test requirements including information on Special Test Equipment design, operations and maintenance.
b. Maintainability strategies including sparing provisions, growth and scarring provisions, shelf-life, and long-term storage provisions
c. Deliverable end item or equipment identification (part number)
d. Predicted reliability assessment
e. Component reusability/refurbishment analysis

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-060
3. **DATA TYPE**: 2
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Electrical Power Quality Specification Requirements Annex Documents

7. **DESCRIPTION/USE**:
Establishes the unique electrical power quality and compatibility requirements for the power source interfaces and for the integrated/portable electrical load interfaces for the CEV. The electrical power quality specification requirements annexes define CEV specific power characteristics and the minimum performance and test requirements for loads to be compatible with these characteristics.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
This document must be consistent with the MPCV Program's integrated plans.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.6.5.
Referenced from SOW Paragraphs: 6.1.3.5, 6.2.3.5, 6.4.3.5

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The electrical power quality and compatibility specification requirements establish the unique power quality interface requirements for the CEV and the CEV power interfaces to ground test facilities, portable loads, and other mated vehicles.

13.2 **APPLICABLE DOCUMENTS**:
Meets/Exceeds Documents per J3:
CxP 70050-01 Volume 1: Electrical Power Quality Performance for 28 Vdc
CxP 70050-02 Volume 2: User Electrical Power Quality Performance for 28 Vdc
CxP 70050-03 Volume 3: Electrical Power Quality Performance for 120Vdc
CxP 70050-04 Volume 4: User Electrical Power Quality Performance for 120Vdc

13.3 **CONTENTS**:
For each major type of distributed power, four electrical power quality and compatibility specification requirement volumes shall be generated as tailored versions of the CxP 70050-01 Volume 1: Electrical Power Quality Performance for 28 Vdc, CxP 70050-02 Volume 2: User Electrical Power Quality Performance for 28 Vdc, CxP 70050-03 Volume 3: Electrical Power Quality Performance for 120Vdc, and CxP 70050-04 Volume 4: User Electrical Power Quality Performance for 120Vdc. The first volume shall define the power source interface(s) and compatibility requirements for 28Vdc, and the second volume shall define the integrated/portable load (electrical consuming equipment) interface(s) and compatibility requirements for 28Vdc. The third volume shall define the power source

interface(s) and compatibility requirements for 120Vdc, and the fourth volume shall define the integrated/portable load (electrical consuming equipment) interface(s) and compatibility requirements for 120Vdc. These volumes can be tailored to CEV specific design parameters where needed.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-061
3. **DATA TYPE**: 3
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE:** Mechanical Systems Design and Data Book

7. **DESCRIPTION/USE**:
Documentation of design information for the CEV Mechanical systems. This documentation will provide insight into the contractor's design, as well as detailed reference information to support Engineering and Operations throughout the life of the CEV.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.6.6.
Referenced from SOW Paragraphs: 6.1.3.6, 6.2.3.6, 6.4.3.6

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Mechanical Systems Design and Data Book documents the results of design, development, and other pertinent studies relating to each mechanical system.

13.2 **APPLICABLE DOCUMENTS**:
Meets/Exceeds Documents per J3:
NASA-STD-5017: Design and Development Requirements for Mechanisms, Sections 1-4

13.3 **CONTENTS**:
The deliverable shall include, as applicable, the subsystem information listed below for each mechanism:
1) Assumptions and groundrules
2) Subsystem Definition
3) Subsystem Requirements Analyses
   a. Functional decomposition
   b. Functional, performance and interface requirements
   c. Derived requirements on other systems with analysis that yields the requirements
   d. Trade study results
4) Detailed Design Description
   a. Hardware element descriptions
   b. Hardware math models
   c. Mass and volume properties
   d. Power and thermal profiles
   e. Schematic layouts, drawings and 3-D solid geometric representations of components
   f. Data and analyses necessary to support compliance to NASA-STD-5017, Design and Development Requirements for Mechanical Systems, Sections 1-4 requirements, such as thermal tolerance analyses, force margin analyses, and test data. Supporting analyses shall discuss all

boundary conditions, inputs, and assumptions used; analytical approaches (models, equations, algorithms) used; results; and conclusions.

g. Mechanical component stress analysis reports showing margins of safety under all design load conditions

h. A list of mandatory inspection points, to be performed during manufacturing, assembly, and testing of the mechanism.

i. Interfaces (internal and external hardware interfaces including mechanical, electrical and thermal interfaces, software interfaces, and human interfaces; includes necessary Interface Control Documents)

j. Consumables list

k. Data bandwidths (data rates); Telemetry; Instrumentation

5) Operational Analyses

a. Operational scenarios and modes including the subsystem's limitations on any aspect of vehicle flight

b. Performance and Margin analyses

c. Operating environments (natural and induced)

d. Failure modes and redundancy operations including vehicle failure modes accommodated by subsystem and failure modes reacting to vehicle failures

e. Fault Detection, Isolation and Recovery

f. Diagnostic strategies

g. Abort analysis

h. Launch scrub turnaround plan

i. A failure-tolerance diagram or matrix for each mechanism describing the failure tolerance in place to meet the CEV failure-tolerance requirements

6) Maintainability and testing data

a. Test requirements including information on Special Test Equipment design, operations and maintenance.

b. Maintainability strategies including sparing provisions, growth and scarring provisions, shelf-life, and long-term storage provisions

c. Deliverable end item or equipment identification (part number)

d. Predicted reliability assessment

e. Component reusability/refurbishment analysis

f. A record of all test failures, anomalies, and accidents involving qualification or potential flight hardware that are not documented in PRACA reports.

g. The results of all verification testing, analyses, and inspections not documented in other test or certification reports, including a narrative explanation of how the testing, analysis and inspection results obtained satisfy the verification requirements

7) References and Indication of any changes from the previous submission

13.4 **FORMAT**: Contractor may divide into volumes/books as necessary. Documents shall be electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-062
3. **DATA TYPE**: 2
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE:** Stress Analysis Report

7. **DESCRIPTION/USE**:
The stress analysis report documents the strength and life integrity of the structure and provides documentation for the structural certification of the hardware. The stress analysis report will establish the strength and life capability of the hardware, provide a method to evaluate proposed changes to the design loads and environment, and will provide data to resolve manufacturing, salvage, and field maintenance problems.

Supporting stress models (FEM's) will also be provided with the corresponding SAR (Content previously located in CEV-T-068).

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix
Note: Certain system-level analyses may be deferred till after CDR unless the results drive the design of components or modules. The specific items that will be deferred till after CDR will be pre-coordinated with NASA.

11. **REMARKS**:
The calculations performed in this report must be checked and verified by the responsible engineering organization.

A complete file of unsubmitted 'back-up' or 'notebook' analysis, including electronic files and spreadsheets, should be maintained by the responsible stress analysts within the originating organization for review by NASA engineering. These unsubmitted supporting analyses should be saved until the hardware has completed its design life.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.6.6, 2.6.9, 2.6.13. Referenced from SOW Paragraph(s): 6.1.3.6, 6.2.3.6, 6.4.3.6, 6.1.3.9, 6.3.6.9, 6.4.3.9, 6.1.3.13, 6.2.3.13, 6.4.3.13

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The stress analysis report shall document the strength and life integrity analysis of every structural component in the CEV System.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The stress analysis report must contain the following elements:
a. A general description of the system being analyzed.
b. A discussion of the methods and assumptions used in the analysis.
c. A margin of safety summary table that lists the lowest margin of safety for each part in the system and a cross-referenced page number where the margin calculation is performed.
d. Material property references and allowables summary.

e. Summary of load conditions and references.

The stress analysis must be able to be read and understood without having to secure drawings. A sketch of the structure being analyzed should be provided that will describe

1. What the part is and what it looks like
2. Where the part is located in the assembly or installation
3. Where the external loads are applied
4. Where the reaction loads are located
5. Drawing numbers for all parts unless already identified in the analysis
6. Dimensions and tolerances if applicable

13.4 **FORMAT**. Provide electronic version of Stress Analysis Report consisting of repository of individual part/component/subassembly SAR's and the supporting files in their native format. The necessary roadmap will be provided so that the information is coherent and traceable to NASA.

13.5 **MAINTENANCE**: NASA approval is required for any of the following modifications to the stress analysis report after its final issue:

* When a significant design change has been made to the structure, a new report shall be reissued. A copy of the old analysis will be retained for unmodified structure still in service.

* When analyses are modified to reflect new methods and/or data, the revised report shall be cross-referenced to the old analysis and the changes shall be clearly explained.

* When an old analysis is revised locally by a new analysis, the old pages will be removed and destroyed and the new pages inserted into the report, with a revision identifier.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-063
3. **DATA TYPE**: 3
4. **DATE REVISED**: 12/5/2005
5. **PAGE**: 1
6. **TITLE**: Passive Thermal Control Design and Data Book (PTCDDB)

7. **DESCRIPTION/USE**:
The TDDB is the repository of data for the CEV Passive Thermal Control System. This documentation will provide insight into the contractor's design, as well as detailed reference information to support Engineering and Operations throughout the life of the CEV.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.6.7.
Referenced from SOW Paragraphs: 6.1.3.7, 6.2.3.7, 6.4.3.7

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Passive Thermal Control Design and Data Book provides a summation and targeted details of the contractor's data, analysis and selections developed for the designs for vehicle systems that provide and manage the Passive Thermal Control System.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The PTCDDB shall contain detailed information regarding the passive thermal control design at the CEV component level as well as integrated passive thermal control at the spacecraft level.

The deliverable shall include, as applicable, the subsystem information listed below:

1) Assumptions and groundrules
2) Subsystem Definition including GFE vs. contractor-supplied assumptions
3) Subsystem Requirements Analyses
   a. Functional decomposition
   b. Functional, performance and interface requirements
   c. Derived requirements on other systems with analysis that yields the requirements
   d. Trade study results
   e. Analysis to show the subsystem meets the requirements
4) Detailed Design Description
   a. Detailed Hardware element descriptions (For heater system, this shall include information such as heater size, thermostat set points, redundancy, thermostat/temp sensor locations, sensor error, etc
   b. In cases where computer math models or programs are utilized, a description of the program along with the source code are to be delivered.
   c. Mass and volume properties

d. Constituent materials
e. Thermo-physical and thermo-optical properties
f. Interface conductance
g. Implementation of phase change materials
h. Thermo-electrics
i. Thermal profiles in all operational modes
j. Component Power Dissipation in all applicable operational modes.
k. Schematic layouts, drawings and 3-D solid geometric representations of components
l. Interfaces (internal and external hardware interfaces including mechanical and thermal interfaces and any necessary Interface Control Docuements)
m. Consumables list
n. Instrumentation description
o. Data bandwidths (data rates); Telemetry

5) Operational Analyses
a. Operational scenarios, modes, and constraints including the subsystem's limitations on any aspect of vehicle flight
b. Performance and temperature margin analyses (including both predicted and demonstrated thermal margins)
c. Operational environments (natural and induced)
d. Failure modes and redundancy
e. Diagnostics strategies
f. Abort analysis
g. Launch scrub turnaround plan

6) Maintainability and testing data
a. Test requirements including information on Special Test Equipment design, operations and maintenance.
b. Maintainability strategies including sparing provisions, shelf-life, and long-term storage provisions
c. Deliverable end item or equipment identification (part number)
d. Predicted reliability assessment
e. Component reusability/refurbishment analysis

7) References and Indication of any changes from the previous submission

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Microsoft® Word/Excel® based and ASCII, delimited for data; SINDA/FLUINT ASCII file, Thermal Desktop®/RadCAD®, and XML.

13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-064
3. **DATA TYPE**: 3
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Passive Thermal Control Mathematical Models and Documentation

7. **DESCRIPTION/USE**:
Thermal mathematical models (thermal radiation math models and thermal network models) used for design, development, and integrated analysis of the CEV. The accompanying reports document model assumptions, algorithms used, and model use.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.6.7.
Reerenced from SOW Paragraphs: 6.1.3.7, 6.2.3.7, 6.4.3.7

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Thermal Math Models and Documentation DRD provides the analytical models used for the design, development, and certification of the CEV Passive Thermal Control System. The models include, but are not limited to:

a. Thermal radiation math models (component and integrated)
b. Thermal network models (component and integrated)
c. Thermal environment models
d. Parametric analysis models
e. Thermal-structural models
f. Applicable thermophysical materials and thermo-optical properties
g. Scripts and command files, as required, for model execution, pre- and post-processing.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
Thermal radiation math models and thermal network models containing finite element, finite difference, or other analytical descriptions of CEV components, systems, and sub-systems. Documentation shall include node/element maps, thermophysical materials and thermo-optical property assumptions and assignments (beginning-of-life and degraded), and articulation schemes, constraints, and data for articulating systems. Thermal environment analyses shall include pertinent orbital element definition data, and natural environmental constants. This DRD includes models for the passive thermal control system and models to be used for integration with other Exploration elements..

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Microsoft® Word/Excel® based and ASCII, delimited for data; SINDA/FLUINT ASCII file, Thermal Desktop®/RadCAD®, and XML. Temperature data shall be in an electronic format to efficiently facilitate combined thermo-elastic stress analysis.

13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-065
3. **DATA TYPE**: 3
4. **DATE REVISED**: 12/15/2006
5. **PAGE**: 1
6. **TITLE**: Thermal Protection System Design and Data Book (TPSDDB)

7. **DESCRIPTION/USE**:
The TPSTDDB is the repository of data for the CEV thermal protection system. It documents all data pertinent to the thermal design. This documentation will provide insight into the contractor's design, as well as detailed reference information to support Engineering and Operations throughout the life of the CEV.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 6.1.3.8.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Thermal Protection System Design and Data Book provides a summation and targeted details of the contractor's data, analysis and selections developed for the designs for vehicle thermal protection during ascent and entry phases.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The TPSTDDB shall contain detailed information regarding the thermal protection subsystem design at the CEV component level (penetrations, doors, seals, barriers, etc.) as well as integrated thermal protection system design at the spacecraft level in order to support TPS certification.

The deliverable shall include, as applicable, the subsystem information listed below:
1) Assumptions and groundrules
2) Subsystem Definition including GFE vs. contractor-supplied assumptions
3) Subsystem Requirements Analyses
    a. Functional decomposition
    b. Functional, performance and interface requirements
    c. Derived requirements on other systems with analysis that yields the requirements
    d. Trade study results
    e. Thermal protection system stress analysis including pertinent material properties and analysis case descriptions.
    f. Thermal protection system thermal analysis including methodologies and the experimental data that are used to demonstrate the adequacy of the thermal modeling techniques
    g. Identification of worst case conditions for all regions of the vehicle.

4) Detailed Design Description
   a. TPS Materials identitification (including diagrams indicating material, thickness, expected thermal performance, resulting structural temperatures, and structural temperature gradients)
   b. In cases where computer math models or programs are utilized, a description of the program along with the source code are to be delivered.
   c. Mass and volume properties
   d. Thermal profiles
   e. Schematic layouts, drawings and 3-D solid geometric representations of components
   f. Interfaces (internal and external hardware interfaces including mechanical and thermal interfaces)
   g. Data bandwidths (data rates); Telemetry
   h. Instrumentation
5) Operational Analyses
   a. Operational scenarios and modes including the subsystem's limitations on any aspect of vehicle flight
   b. Performance and Margin analyses (including predicted and demonstrated thermal margins)
   c. Operational environments (natural and induced)
   d. Failure modes and redundancy data
   e. Diagnostic strategies
   f. Abort analysis
   g. Launch scrub turnaround plan
6) Maintainability and testing data
   a. Test requirements including information on Special Test Equipment design, operations and maintenance.
   b. Maintainability strategies including sparing provisions, shelf-life, and long-term storage provisions
   c. Deliverable end item or equipment identification (part number)
   d. Predicted reliability assessment
   e. Component reusability/refurbishment analysis
7) References and Indication of any changes from the previous submission

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Microsoft® Word/Excel® based and ASCII, delimited for data; SINDA/FLUINT ASCII file, Thermal Desktop®/RadCAD®, and XML.

13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-066
3. **DATA TYPE**: 3
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE:** Thermal Protection System Mathematical Models and Documentation

7. **DESCRIPTION/USE**:
Thermal mathematical models used for design, development, and integrated analysis of the CEV Thermal Protection System. The accompanying reports document model assumptions, algorithms used, and model use.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 6.1.3.8.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Thermal Protection System (TPS) Thermal Math Models and Documentation DRD provides the analytical models used for the design, development, and certification of the CEV Thermal Protection System. The models include, but are not limited to:

a. Thermal radiation math models (component, penetrations, seals, barriers, and integrated)
b. Thermal network models (component, penetrations, seals, barriers, and integrated)
c. Aerothermal and thermal environment models
c. Ablation models
d. Parametric analysis models
e. Thermal-structural models
f. Thermal Protection System (TPS) stress analysis models
g. Applicable thermophysical materials and thermo-optical properties
h. Scripts and command files, as required, for model execution, pre- and post-processing.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
Thermal radiation math models and thermal network models containing finite element, finite difference, or other analytical descriptions of CEV Thermal Protection System components including penetrations, seals, barriers, and integrated TPS representations. Documentation shall include node/element maps, thermo-optical and thermophysical property data and assignments (beginning-of-life and degraded). Thermal environment analyses shall include pertinent orbital element definition data, and natural environmental constants. Aerothermal environments shall include heating flux distributions and profiles for all regions of the vehicle including penetrations, seals, and barriers. TPS stress models shall include pertinent material properties and analysis case descriptions. This DRD includes models for the Thermal Protection

System, and models to be used for integration with other Exploration elements.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Microsoft® Word/Excel® based and ASCII, delimited for data; SINDA/FLUINT ASCII file, Thermal Desktop®/RadCAD®, and XML. Temperature data will be in an electronic format to efficiently facilitate combined thermo-elastic stress analysis.

13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

KEEP DRD CEV-T-067 AS RESERVED

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-068
3. **DATA TYPE**: 3
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Structures Mathematical Models and Documentation

7. **DESCRIPTION/USE**:
Delivery of structural static and dynamic math models and associated supporting documentation. The models are used by NASA to understand the vehicle's design and for later problem-solving analyses assuring that system performance and safety requirements will be met.

The dynamics model is critical to support coupled loads analyses that combine this element with other exploration elements at higher and lower levels of the integrated vehicle design and during different verification phases.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
Note: Stress models are provided as a part of CEV-T-062.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.6.9.
Referenced from SOW Paragraphs: 6.1.3.9, 3.2.6.9, 3.4.6.9

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
This document covers any mathematical models developed by the Contractor for static and dynamic loads of the CEV System, module, subsystem, and component structures.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
Structural math models used for structual loads and dynamics response, and aero-elastic analyses shall be documented, updated with comment log at the beginning of the model, and delivered as part of the acceptance data package. The log shall make note of relevant assumptions, boundary conditions, node/element numbering, and revisions to the model. Additional model descriptions, included in the comments log, may indicate pertinent modeling parameters, model display, material properties used, and type of model. Verification of models shall be included in the documentation. A list and scope of the structural math models shall be proposed by the contractor and approved by NASA.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. For models, either NASTRAN.bdf or PATRAN.db format is preferred. With prior NASA consent, other industry standard native-format or neutral-format model files may be accepted.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-069
3. **DATA TYPE**: 2
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Fracture Control Plan

7. **DESCRIPTION/USE**:
The Fracture Control Plan shall define the elements of the fracture control program and the associated management and control responsibilities.

8. **DISTRIBUTION**: As determined by the Contracting Officer, and at a minimum shall include the Responsible Fracture Control Authority (RFCA).

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 6.2.6
Related DRD(s): CEV-T-070, CEV-T-020, CEV-T-023

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Fracture Control Plan will provide hardware-specific information detailing how applicable fracture control requirements will be implemented to prevent catastrophic failure of hardware associated with the propagation of cracks or crack-like defects.

13.2 **APPLICABLE DOCUMENTS**:
Meets/Exceeds Docuemnts per J3:
NASA-STD-(I)-5019: Fracture Control Requirements For Spaceflight Hardware

13.3 **CONTENTS**:
The fracture control plan shall provide hardware-specific details explaining how fracture control requirements and procedures will be implemented. The plan shall describe the various fracture control approaches that will be applied to all relevant hardware and shall address cracks and crack-like defects that may be present during fabrication, testing, handling, transportation, and operational life. The plan shall contain a listing of all Fracture Critical hardware and parts in accordance with NASA-STD-(I)-5019. The plan shall address how fracture critical parts that are susceptible to damage such as impact, corrosion, material degradation, and wear, etc. will be identified. The plan shall identify organizational elements and their responsibilities for activities required to implement the Fracture Control Plan, including reviews of design and structural integrity analyses, configuration control, and generation of required documentation such as DRD CEV-T-070, Fracture Control Summary Report.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Microsoft® Word/Excel® based, XML, and ASCII, delimited for data.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-070
3. **DATA TYPE**: 2
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Fracture Control Summary Report

7. **DESCRIPTION/USE**:
The Fracture Control Summary report is used to demonstrate compliance with fracture control requirements.

8. **DISTRIBUTION**: As determined by the Contracting Officer, and at a minimum shall include the Responsible Fracture Control Authority (RFCA).

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 6.2.6
Related DRD(s): CEV-T-069, CEV-T-023

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Fracture Control Summary Report will provide detailed hardware-specific fracture control analyses and test reports, demonstrating compliance with all applicable fracture control requirements.

13.2 **APPLICABLE DOCUMENTS**:
Meets/Exceeds Documents per J3:
NASA-STD-(I)-5019: Fracture Control Requirements For Spaceflight Hardware

13.3 **CONTENTS**:
The report shall comprise an accounting of all assessed hardware and the basis for determining fracture control acceptability for each.

Supporting detailed documentation such as drawings, calculations, analyses, data printouts, inspection plans, records, specifications, certifications, reports, and procedures should be submitted as a part of the FCSR, but shall be made available for review if requested.
As a minimum, the following information shall be provided in the FCSR:

a. Identification of fracture-critical parts and low-risk fracture parts, showing the material and heat treatment used and the basis for part acceptability (i.e., damage tolerant analysis, test, acceptable durability, insignificant fatigue loading), including the referencing of documents which contain and describe the supporting data required to demonstrate fracture control requirements of the Agency, responsible Center, and Program:
   (1) Fracture-critical parts that are limited life shall be specifically identified.
   (2) A statement to the effect that all other parts were examined and determined to be non-fracture critical shall be included.

b. A statement as to whether or not the hardware contains pressure vessels or fracture-critical rotating equipment.

c. Identification of the NDE and/or tests applied for fracture control purposes to each fracture-critical part.

d. Identification of fail-safe parts and a brief statement of the basis for classification. Re-flown fail-safe hardware shall have verification that any required “between mission” inspections have been performed.

e. A statement that inspections or tests specified for fracture control were applied.

f. A statement that the flight hardware configuration has been controlled and verified for all fracture-critical parts.

g. A statement that materials usage has been verified for fracture-critical parts.

h. Copies of MUAs for fracture-critical or low-risk parts and a summary of the discrepancy reviews, or equivalent reviews, of anomalies that could affect the performance of fracture-critical parts.

i. If applicable, a summary discussion of alternative approaches or specialized assessment methodology applied, but not specifically covered by guidelines.

j. If applicable, identification of any special considerations involving fracture mechanics properties or data, inspections, analysis, or other parameters not covered by the requirements set here.

k. If during the program, no parts or procedures are identified that require information as listed above, a statement to that effect with reference to supporting documentation shall be submitted as the FCSR.

The Contractor shall keep documents supporting the Fracture Control Summary Report for the life of the hardware.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Microsoft® Word/Excel® based, XML, and ASCII, delimited for data.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-071
3. **DATA TYPE**: 3
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Propulsion Systems Design and Data Book

7. **DESCRIPTION/USE**:
This documentation is required For each unique prop systems (LAS, SM, CM), which includes compilation of requirements, design, analysis, test reports and operational information including: abort & abort re-orientation, separation,trajectory insertion, orbital maneuvering, and translation and rotation reaction control. This documentation will provide insight into the contractor's designs, as well as detailed reference information to support Engineering and Operations throughout the life of the CEV.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
The following document(s) may be used as infomational:
- CPIA 469: Principles of Solid Propellant Development.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.6.10.
Referenced from SOW Paragraphs: 6.1.3.10, 6.2.3.10, 6.4.3.10
Related DRD(s): CEV-T-081

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
This set of documents contains the results of design, development, and other pertinent studies relating to the various propulsion systems. Separate volumes shall be developed and maintained for each unique propulsion system on the CEV.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Docuemtns per J3:
AIAA-S-080: AIAA Standard for Space Systems - Metallic Pressure Vessels, Pressurized Structures, and Pressure Components
AIAA-S-081: AIAA Standard for Space Systems - Composite Overwrapped Pressure Vessels

Meets/Exceeds Documents per J3:
CPIA 655: Guidelines for Combustion Stability Specifications and Verification Procedures for Liquid Propellant Rocket Engines

13.3 **CONTENTS**:
Each volume shall include propulsion subsystem information including, but not limited to:
1. Subsystem Requirements Analysis
(a) Assumptions and groundrules
(b) Functional decomposition
(c) Functional, performance, life and interface requirements
(d) Integrated system level trade studies and subsystem models including

model assumptions, model technique, input and output data and resulting wet/dry mass, power, and volume allocations

(e) Performance of CEV during operation of propulsion sub-systems

2. Detailed Design Description

(a) Fluid, electrical, and instrumentation schematics and layouts

(b) Propulsion performance calculations including fluid, ballistics, propellant mean bulk temperature, manufacturing & processing variations, thermal and pressure variation effects. These data need to provided over the full range of operational enviroments for the given system.

(c) Propulsion Pressure System description: document the design, analysis, fabrication, test, inspection, operation and maintenance of all vessels, lines/ducts/fittings and components (including external components required for operation of the systems such as initiators & associated cables for solid motors), as well as the integrated subsystem and its assemblies. Included shall be a complete description, material properties, drawings, schematics, finite element analysis results (static and dynamic loads), factor of safety margins, debris generation & impact assessment/mitigation plan, design verification plan and damage control plan as applicable

(d) Thruster/Engine/Motor design descriptions and combustion stability assessments addressing cycle life and accumulated hot fire duration, thermal soak-back with environmental effects, restart capability, bubble ingestion, propellant saturation effects, propellant formulations; mechanical properties of propellants, liner, & insulation; ballistics properties of propellants (including but not limited to temperature & pressure sensitivities, burn rates, applicable solid propellant coefficients & exponents, etc.); definition of types of non-metallic materials & their formulas for various applications (including but not limited to throat inserts, insulation, liner); grain geometries; manufacturing & processing plans for solid motors, valve cycle life, and engine/thruster duty cycles limitations as well as required operational duty cycle spectrums with associated accumulated durations, fulfilment of mission derived detailed performance and operational capabilities (including, but not limited to vibration, shock, temperature, aging, humidity, salt fog, steady-state and pulse mode Isp and impulse bit capability over all possible operational conditions) with adequate margins for the full range of expected and possible operating conditions and life capabilities, and combustion stability, all with correlations to test results and corrections for the flight design application

(e) Component/line sizing including system pressure flow loss calculations, nozzle / bore / exit area ratio calculations including analyses of internal ballistics & fluid flow, pressurant blow down models and filtration capacity/sizing analysis, with correlations to test results and corrections for the flight design application

(f) Propellant acquisition and tank discharge analyses under all expected operating and mission environments, with correlations to test results and corrections for the flight design application

(g) Fluid and solid system transient analyses including activation, ignition interval (time to steady state thrust), firing, and safing for nominal and contingency modes, with correlations to test results and corrections for the flight design application

(h) Thermal conditioning and maintenance analysis including propellant storage quality, feed system and motor/engine/thruster/igniter thermal conditioning, and boil off losses for the allowable hot and cold environmental conditions as applicable, with correlations to test results and corrections for the flight design application

(i) Component design information including vendor component drawings and cross-sections, material usage list, stress analysis and thermal analysis (including safety factors, derating factors, safety margins and rationale), any test reports (including addressing adequate margin for required life capabilities), mill reports, NDE reports, or burst article or qualification test reports that may be available, as well as

development, qualification, and production schedules and associated information
(j) Propellant compatibility assessment and associated data including exposure duration, propellant vapor migration, corrosion, embrittlement, decomposition and leaching effects, hardening, aging effects, humidity effects, deterioration of solid propellant to liquid phase, with correlations to test results and corrections for the flight design application
(k) Instrumentation list for flight system and support equipment include sensor, range, units accuracy, drift, and sample rate. Provide details, models, flight algorithms and associated uncertainties for calculated quantities such as fluid quantity gauging, with correlations to test results and corrections for the flight design application
(l) Overpressure protection design and analysis addressing worst case failure conditions and thermal environments, define MDP/MEOP for the system with associated rationale and analyses, with correlations to test results and corrections for the flight design application
(m) Interface definition (internal and external hardware and subsystem interfaces including physical, mechanical, electrical and thermal interfaces, software interfaces)
(n) Propulsion system requirements vs. capabilities summary with supporting rationale and explanations
(o) Reliability assessment process overview and assumptions as well as reliability analysis and process for verifying reliability
(p) Shelf life and long term storage assessment and rationale
(q) Useful life assessment and rationale, and disposal approach as applicable
(r) Simulation tool description, source algorithms/code and validation report, including benchmarks of test results against model prediction
(s) cross system operational impacts design, analyses, & performance assessments including but not limited to translation of structural frequencies, effects of solid motor plume impingement, etc.

3. Verification Activities not already included in the Master Verification DRD(s)
(a) Subassembly, assembly, and system verification article(s) detailed design description(s), addressing all engineering deliverables (drawings, models, schematics, hardware configuration and selection, interface requirements and designs, associated analyses and results, manufacturing, assembly, processing plans (including non-metallic components such as propellants), installation, and checkout planning, schedules and requirements, test instrumentation, etc.), differences from the flight configuration and operational conditions and associated rationale(s)
(b) Flight propulsion system(s) checkout sequencing and associated checkout requirements, setup conditions, constraints and details, and pass/fail criteria as well as associated verification results
(c) Interface verification approaches and verification results
(d) Fracture control reports for all propulsion system fracture critical hardware, in accordance with the Fracture Control Plan DRD
(e) Cross system operational impacts verification approaches & results

4. Test Plans and Reports not already included in the Master Verification DRD(s)
(a) Development test plans and test reports at the component, assembly and system levels
(b) Propulsion System Hot Fire and Thermal Conditioning Test Plan(s) and Test Report(s) including the test scope, required schedule milestones, test objectives and rationale, test article architecture, instrumentation requirements, data acquisition requirements, facility requirements, fluid requirements, participant roles and responsibilities, a test matrix identifying test article configurations, test parameters, test durations, number of tests, success criteria, data format requirements, and a

discussion of how the test data will be interpreted to satisfy the test objectives. Raw test data shall be made available to NASA. Reports shall document the results of the tests and an assessment of integrated system performance, differences from the flight configuration and operational conditions and associated rationale(s) and and corrections for the flight design application.
(c) Acceptance test data not already included in the Acceptance Data Package capturing all flight system acceptance results down to the component level.

5. Operational Analyses
(a) Operational scenarios and modes including the subsystem’s limitations on any aspect of vehicle flight
(b) Performance and Margin analyses
(c) Operating Environments (natural and induced)
(d) Failure modes and redundancy operations including vehicle failure modes accommodated by subsystem and failure modes reacting to vehicle failures
(e) Failure detection, isolation and recovery design details including diagnostic methods and controls with supporting data, correlations to test results and corrections for the flight design application and rationale
(f) Component reusability/refurbishment/recertification analysis and maintainability strategy (if applicable)
(g) Diagnostic strategies including plans for in-flight maintenance
(h) Initialization procedures and parameters
(i) Day of launch parameters and late-load requirements
(j) Abort analysis
(k) Launch scrub turnaround plan

6) Maintainability and testing data
(a) Test requirements including information on Special Test Equipment design, operations and maintenance.
(b) Maintainability strategies including sparing provisions, growth and scarring provisions, shelf-life, and long-term storage provisions
(c) Deliverable end item or equipment identification (part number)
(d) Predicted reliability assessment
(e) Component reusability/refurbishment analysis
(f) A record of all test failures, anomalies, and accidents involving qualification or potential flight hardware that are not documented in PRACA reports.
(g) The results of all verification testing, analyses, and inspections not documented in other test or certification reports, including a narrative explanation of how the testing, analysis and inspection results obtained satisfy the verification requirements

Content of each submittal must be sufficient to satisfy the objectives of the milestone review for which it is submitted.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

KEEP DRD CEV-T-072 AS RESERVED

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-073
3. **DATA TYPE**: 3
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE:** Environmental Control and Life Support and Suit Design and Data Book

7. **DESCRIPTION/USE**:
Documentation for design information for vehicle Environmental Control and Life Support systems (ECLSS) including vehicle Active Thermal Control Systems (ATCS) and Suit/Umbilical interface. NASA will use this information as a source for insight into the contractor’s design of the vehicle ECLSS and ATCS and suit/umbilical interface.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.6.11, 2.6.12. Referenced from SOW Paragraph: 6.1.3.11, 6.1.3.12,

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Environmental Control and Life Support Systems Design and Data Book provides a summation and targeted details of the contractor’s data, analysis and selections developed for the designs for vehicle systems that provide and manage the following:
1. Active thermal control (cabin temperature/humidity, heat acquisition, transport and rejection, equipment and vehicle systems active thermal control, thermally-controlled storage)
2. Breathable atmosphere
3. Cabin pressure
4. Contaminant control (in the air, in fluids and on surfaces)
5. Emergency oxygen
6. Fire/smoke detection and suppression
7. Environmental monitoring (including active radiation monitoring, atmospheric and combustion products monitoring, atmosphere thermal properties monitoring and cabin pressure monitoring)
8. Water (potable and non-potable)
9. Waste and trash collection, storage, processing and disposal
10. Food supply interfaces, processing, preparation and storage
11. Suit and umbilical interfaces

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
JSC 20584: Spacecraft Maximum Allowable Concentrations for Airborne Contaminants

13.3 **CONTENTS**:

1. The deliverable shall include, as applicable, the information listed below:
(a) Assumptions and groundrules
(b) Subsystem Definition including GFE vs. contractor-supplied assumptions
(c) Subsystem Requirements Analyses
    1. Functional decomposition
    2. Functional, performance and interface requirements
    3. Derived requirements on other systems with analysis that yields the requirements
    4. Trade study results
    5. Analysis to show the subsystem meets the requirements

(d) Detailed Design Description
    1. Hardware element descriptions
    2. Hardware math models
    3. Mass and volume properties
    4. Power and thermal profiles
    5. Schematic layouts, drawings and 3-D solid geometric representations of components
    6. Interfaces (internal and external hardware interfaces including mechanical, electrical and thermal interfaces, software interfaces, and human interfaces; includes necessary Interface Control Documents)
    7. Consumables list
    8. Data bandwidths (data rates); Telemetry; Instrumentation
(e) Operational Analyses
    1. Operational scenarios and modes including the subsystem's limitations on any aspect of vehicle flight
    2. Performance and Margin analyses
    3. Operating Environments (natural and induced)
    4. Failure modes and redundancy operations including vehicle failure modes accommodated by subsystem and failure modes reacting to vehicle failures
    5. Fault Detection, Isolation and Recovery
    6. Diagnostic strategies including plans for in-flight maintenance
    7. Initialization procedures and parameters
    8. Day of launch parameters and late-load requirements
    9. Abort analysis
    10. Launch scrub turnaround plan
(f) Maintainability and testing data
    1. Test requirements including information on Special Test Equipment design, operations and maintenance
    2. Maintainability strategies including sparing provisions, growth and scarring provisions, shelf-life, and long-term storage provisions
    3. Deliverable end item or equipment identification (part number)
    4. Predicted reliability assessment
    5. Component reusability/refurbishment analysis
(g) References and Indication of any changes from the previous submission
2. By PDR, the Contractor shall provide to NASA definition of the process to be used for cleanliness of components for use in oxygen, fuel and pneumatic systems. The process must meet or exceed the requirements identified in the following documents:
(a) MSFC-SPEC-164B, Specification for Cleanliness of Components for Use in Oxygen, Fuel and Pneumatic Systems (and associated Children documents as specified in Attachment J-3, Applicable, Meets/Exceeds, and Informational Documents List)
(b) MSFC-PROC-404, Gases, Drying and Preservation, Cleanliness Level and Inspection
(c) MSFC-PROC-1831, The Analysis of Nonvolatile Residue Content
(d) MSFC-PROC-1832, Sampling and Analysis of nonvolatile Residue Content on Critical Surfaces
3. The following special analyses, design and plan development shall be

performed and documented by the Contractor and delivered to NASA by PDR and updated, if needed, by CDR:

(a) Active thermal control design approach, analyses and models

(b) An analysis of CO2 and humidity removal rates vs. airflow rate description of the ppO2 control logic

(c) Trace contaminant control system and CO oxidation system sizing analysis and design

(d) Odor and contaminant removal rate and sizing analysis and design

(e) Environmental control strategy for Earth entry and post landing phases; including off-nominal landing contingencies and environments

(f) Potable water quality control plan and associated analysis

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Microsoft® Word/Excel® based and ASCII, delimited for data; SINDA/FLUINT ASCII file, Thermal Desktop®/RadCAD®, and XML.

13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-074
3. **DATA TYPE**: 3
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE:** Crew Health, Survival Habitation Accommodations/Stowage and EVA Systems Design and Data Book

7. **DESCRIPTION/USE**:
Documentation for design information for vehicle habitation accommodations systems, IVA stowage systems, vehicle crew health systems interfaces, and countermeasure systems interfaces, crew survival equipment, and EVA (as applicable) support systems. NASA will use this information as a source for insight into the contractor's design of the vehicle habitation accommodations systems, IVA stowage systems, vehicle crew health systems interfaces, and countermeasure systems interfaces interfaces crew survival equipment, and EVA (as applicable) support systems. This comprehensive documentation will provide detailed reference information to support Engineering and Operations throughout the life of the CEV.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
NASA will provide crew clothing, portable crew personal items (e.g., relaxation and entertainment systems, mementos), portable medical kits and equipment and medical supplies, portable countermeasures systems. The CEV Contractor shall provide the interfaces (e.g., stowage, operations usage volume, attach points, power/data/thermal interfaces, and other resources required) for these items.
The Contractor shall support the Crew Cabin/Cockpit Layout Requirements Team in the area of habitation accommodations crew cabin layout requirements. The contractor shall only support EVA related systems development as applicable per direction from NASA.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.6.11, 2.6.12.
Referenced from SOW Paragraphs: 6.1.3.11, 6.1.3.12,

13. **DATA PREPARATION INFORMATION**:

13.1 **<u>SCOPE</u>**:
The Crew Health, Survival, Habitation Accommodations/Stowage and EVA Systems Design and Data Book provides a summation and targeted details of the contractor's data, analysis and selections developed for the designs for vehicle systems that provide and manage the following:

1. Crew 'seats' (i.e., launch and entry crew restraint systems)
2. Internal restraints and mobility aids
3. Hygiene systems
4. Privacy accommodations
5. Sleep systems
6. Ambient storage systems
7. Maintenance and repair systems
8. In-situ training systems
9. Housekeeping systems

10. Noise (acoustics) control systems
11. Vehicle on-orbit inventory systems
12. Clothing interfaces
13. Crew personal items (e.g., relaxation and entertainment systems) interfaces
14. Medical systems interfaces (including crew health system interfaces and countermeasure systems interfaces)
15. Crew Survival Equipment support systems.
16. Any specialized (i.e., nonstandard, non-government furnished) tools associated with these systems
17. External restraints and mobility aids (only as applicable).

13.2 **APPLICABLE DOCUMENTS**:

Applicable Documents per J3:
JSC 20584: Spacecraft Maximum Allowable Concentrations for Airborne Contaminants

13.3 **CONTENTS**:

The deliverable shall include, as applicable, the subsystem information listed below:

1) Assumptions and groundrules

2) Subsystem Definition including GFE vs. contractor-supplied assumptions

3) Subsystem Requirements Analyses
   a. Functional decomposition
   b. Functional, performance and interface requirements
   c. Derived requirements on other systems with analysis that yields the requirements
   d. Trade studies results
   e. Analysis to show the subsystem meets the requirements

4) Detailed Design Description
   a. Hardware element descriptions
   b. Hardware math models
   c. Mass and volume properties
   d. Power and thermal profiles
   e. Schematic layouts, drawings and 3-D solid geometric representations of components
   f. Interfaces requirements and description (internal and external hardware interfaces including mechanical, electrical and thermal interfaces, software interfaces, and human interfaces; includes necessary Interface Control Docuements)
   g. Consumables list and usage/replenishment rates
   h. Data bandwidths (data rates); Telemetry; Instrumentation

5) Operational Analyses
   a. Operational scenarios and modes including the subsystem’s limitations on any aspect of vehicle flight
   b. Performance and Margin analyses
   c. Operating Environments (natural and induced)
   d. Failure modes and redundancy operations including vehicle failure modes accommodated by subsystem and failure modes reacting to vehicle failures
   e. Fault Detection, Isolation and Recovery
   f. Diagnostics strategies, including plans for in-flight maintenance
   g. Initialization procedures and parameters
   h. Day of launch parameters and late-load requirements
   i. Abort analysis

j. Launch scrub turnaround plan
k. Labeling strategy (consistent with overall CEV labeling strategy)
l. Independent design and performance analyses including worst case timing analysis, fault tolerance and hazard identification/mitigation

6) Maintainability and testing data
   a. Test requirements including information on Special Test Equipment design, operations and maintenance.
   b. Maintainability strategies including sparing provisions, growth and scarring provisions, shelf-life, and long-term storage provisions
   c. Deliverable end item or equipment identification (part number)
   d. Predicted reliability assessment
   e. Component reusability/refurbishment analysis

7) References and Indication of any changes from the previous submission

The following special analyses and plan development shall be performed and documented by the Contractor and provided to NASA by PDR and updated, if needed, by CDR:

A. Flight Crew Equipment Management Plan
B. Analysis of hygiene systems interfaces with ECLSS
C. Stowage/inventory strategy including an analysis of stowage configurations for all mission phases
D. Crew compartment internal configurations for all mission phases (including placement of all internal restraints and mobility aids)
E. Crew launch and entry restraint systems ('seats' or equivalent) operations analysis
F. Critical Care Transport Plan for ill or injured crewmember from point of occurrence to landing; including advanced medical care life support assumptions

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Microsoft® Word/Excel® based, XML, and ASCII, delimited for data.

13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-075
3. **DATA TYPE**: 3
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE**: Pyrotechnic Subsystem Design and Data Book

7. **DESCRIPTION/USE**:
The Pyrotechnic Subsystem Design and Data Book shall provide documentation of the development, design, testing, integration, verification and operation of the pyrotechnic subsystem for the CEV. NASA will use this information as a source for insight into the Contractor’s design of the CEV pyrotechnic subsystem, especially with respect to reliability and safety. In addition, this documentation will provide detailed reference information to support Engineering and Operations throughout the life of the CEV.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
The Contractor shall plan pyrotechnic systems to be designed, fabricated, verified, and operated in accordance with CxP 70199, Constellation Program Pyrotechnic Specification.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.6.13.
Referenced from SOW Paragraphs 6.1.3.13, 6.2.3.13, 6.4.3.13

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Pyrotechnics subsystem includes all explosively-operated devices, explosive initiators/detonators, pressure cartridges, firing units/controllers, and energy transmission lines (excluding vehicle wiring) as described in CxP 70199, Constellation Program Pyrotechnic Specification.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
CxP 70199: Constellation Program Pyrotechnic Specification

13.3 **CONTENTS**:
The Pyrotechnic Subsystem Design and Data Book shall provide documentation of the development, design, testing, integration, verification and operation of the pyrotechnic subsystem.

It shall include the following data as applicable:
1) Assumptions and groundrules
2) Subsystem Definition including GFE vs. contractor-supplied assumptions
3) Subsystem Requirements Analyses
   a. Functional decomposition
   b. Functional, performance and interface requirements
   c. Derived requirements on other systems with analysis that yields the requirements
   d. Trade study result

e. Analysis to show the subsystem meets the requirements

4) Detailed Design Description

a. Hardware element descriptions including sourcing approach for initiators

b. Mass and volume properties

c. Power and thermal profiles

d. Schematic layouts, drawings and 3-D solid geometric representations of components

e. Interface requirements and description (internal and external hardware interfaces including mechanical, electrical and thermal interfaces, software interfaces, and human interfaces, including safing provisions for ground processing, servicing and pre-flight operations; includes necessary Interface Control Documents)

f. Consumables list

g. Data Bandwidth

h. Telemetry/instrumentation

5) Operational Analyses

a. Operational scenarios and modes including the subsystem's limitations on any aspect of vehicle flight

b. Subsystem operational plan and description including command and control (arming/firing) approach, nominal and off-nominal operational scenarios, servicing and safing procedures, and Day of Launch/Day of Landing activities

c. Performance and Margin analyses

d. Operating Environments (natural and induced)

e. Failure modes and redundancy operations including vehicle failure modes accommodated by subsystem and failure modes reacting to vehicle failures

f. Fault Detection, Isolation and Recovery

g. Diagnostic strategies including plans for in-flight maintenance

h. Initialization procedures and parameters

i. Abort analysis

j. Launch scrub turnaround plan

6) Maintainability and testing data

a. Test requirements and ground test reports and results.

b. Maintainability strategies including sparing provisions, shelf-life, and long-term storage provisions

c. Deliverable end item or equipment identification (part number)

d. Predicted reliability assessment/analysis

7) References and Indication of any changes from the previous submission

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Microsoft® Office-compatible for data and reports, PDF for drawings/schematics, and XML.

13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-076
3. **DATA TYPE**: 3
4. **DATE REVISED**: 12/5/2005
5. **PAGE**: 1
6. **TITLE:** Recovery Systems Design and Data Book
7. **DESCRIPTION/USE**:
This DRD documents the recovery system design, rationale, selections, development, testing, manufacturing records, and certification data. The comprehensive documentation will provide detailed reference information to support Engineering and Operations throughout the life of the CEV.
8. **DISTRIBUTION**: As determined by the Contracting Officer.
9. **INITIAL SUBMISSION**: Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix
11. **REMARKS**:
12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 6.1.3.14.
13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Recovery Systems Design and Databook documents the design and development of the recovery system.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The subsystem information listed below will be provided for each component, where applicable:
1) Assumptions and groundrules
2) Subsystem Definition
3) Subsystem Requirements Analyses
   a. Functional decomposition
   b. Functional, performance and interface requirements
   c. Derived requirements on other systems with analysis that yields the requirements
   d. Trade study results
   e. Analysis to show the subsystem meets the requirements
   f. Component-level structural stress analysis process and assumptions, including safety factors, derating factors, safety margins and rationale
4) Detailed Design Description
   a. Hardware element descriptions including supporting data needed to completely understand the operation of the recovery system (including packing density selection and rationale);
   b. Packing and rigging procedure development process (overview of content, use of inspection points, who performs the inspections, etc.), rationale, and copy of procedures
   c. Hardware math models
   d. Mass and volume properties and moments of inertia
   e. Power and thermal profiles
   f. Schematic layouts, drawings and 3-D solid geometric representations of components, including recovery sequence of events,

hardware assemblies, and components

g. Interfaces (internal and external hardware interfaces including mechanical (e.g. parachute attachment points, sling routing, sling loading (including magnitude, direction of the loading and load sharing between the slings), sling tiedown locations, insulation, surface roughness and curvature where soft goods come into contact with vehicle, and compartments (e.g.restraints, smooth walls, no sharp edges, venting)), electrical and thermal interfaces, software interfaces, and human interfaces; includes necessary Interface Control Documents)

h. Materials selections and rationale

i. Consumables list

j. Data bandwidths (data rates); Telemetry; Instrumentation

5) Operational Data and Analyses

a. Operational scenarios and modes including the subsystem's limitations on any aspect of vehicle flight

b. Performance and Margin analyses

c. Operating environments (natural and induced) and appropriate analyses

d. Failure modes and redundancy philosophy/rationale including vehicle failure modes accommodated by subsystem and failure modes reacting to vehicle failures

e. Fault Detection, Isolation and Recovery

f. Predicted reliability analysis and process for achieving demonstrated reliability

g. Reliability assessment process overview and assumptions

h. Initialization procedures and parameters

i. Nominal and abort scenario sequence of events and timelines

j. Launch scrub turnaround plan

6) Maintenance and testing data

a. Component reusability/refurbishment analysis

b. Shelf life and long term storage assessment and rationale

c. Diagnostics and maintainability strategies

d. Useful life assessment and rationale

e. Repair philosophy, process, and rationale

f. Test and flight hardware storage and rationale

g. Description/results of ground testing/analysis for both soft materials and metallic components, including narrative explanation of how the testing, analysis and inspection was performed and how the results obtained satisfy the verification requirements, if not provided in another DRD

h. Development and qualification test concept and rationale

i. Hardware inventory

7) Special documentation on drop tests for the recovery system

a. Drop test plans and test philosophy

b. Drop test procedures and matrix including test configuration and test objectives, test concept (drop zone, storage of drop-related hardware, shipping, etc), techniques, analysis, and test planning and reporting

c. Drop test readiness review data, including test hardware configuration for the test, status/disposition of previous test's or any open anomalies, damage maps, use history, any configuration changes that were implemented during the preparations, results of tests that have been conducted in support of anomaly resolution or design changes, stress analysis and safety margins for all components, test objectives and success critieria, test trajectory, sequence and timeline, performance predictions, predicted loads and performance, rigging details, procedures or flight rule changes/readiness, go/no critieria, contingency plans, and test/range services

d. Drop test reports, including test configuration and objectivess, specific hardware used, test trajectory, test results, test anomalies, and test conclusions

e. Photography and video documentation of tests, packing, and rigging

f. Packing and rigging procedures

g. Post-test inspection procedures

h. Post flight data and hardware inspection review package

i. Anomaly log maintained to track drop anomalies. The log should include anomaly title, description, impact of the anomaly, resolution, and status (i.e. open or closed)

8) References and Indication of any changes from the previous submission

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-077
3. **DATA TYPE**: 3
4. **DATE REVISED**: 12/5/2005
5. **PAGE**: 1
6. **TITLE:** Recovery Systems Simulation Models and Documentation

7. **DESCRIPTION/USE**:
Delivery of recovery system math models, descriptions, analyses results and associated supporting documentation, including detailed models for stress analysis. These models are used to understand the system's design and to assess critical design decisions and system performance.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 6.1.3.14.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The document provides details of the models developed for the recovery systems, including parachute assemblies, equipment for impact attenuation and floatation and the recovery system interfaces to the vehicle.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The document shall include the models used in the design, development, and assessment of the recovery system. For each model, include the model descriptions, applicable natural environment constraints and assumptions. These models include the following:
1. Trajectory development for recovery sequences
2. Selection of disreefing timing
3. Parachute inflation, staging, sling, extraction and energy modulator stripout loads
4. Performance assessment including descent rate predictions
5. Component-level stress analyses (including safety factor, design factor, working loads, pull test results, and safety margins),
6. Reliability analysis
7. Landing attenuation device related-analyses
8. Analysis of any auxiliary mechanisms, such as floatation devices, used to stabilize or orient the spacecraft after water landing. Documentation shall include assumptions, model description and model verification. The analyses shall include pertinent vehicle data.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Applications should be industry standard and gain NASA consent before delivery.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-078
3. **DATA TYPE**: 3
4. **DATE REVISED**: 12/20/2005
5. **PAGE**: 1
6. **TITLE**: GN&C Design and Data Book

7. **DESCRIPTION/USE**:
To provide documentation for vehicle Guidance, Navigation, and Control (GN&C) subsystem design information. This documentation will provide insight into the contractor's design, as well as detailed reference information to support Engineering and Operations throughout the life of the CEV.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.6.15.
Referenced from SOW Paragraphs: 6.1.3.16, 6.2.3.15, 6.4.3.15

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
Provides a summation and targeted details of the contractor's data, analysis and selections developed for the GN&C subsystem, including GN&C sensors.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The GN&C Design and Data Book is divided into four volumes. Volume 1 is the Guidance System Design and Data Book. Volume 2 is the Navigation System Design and Data Book. Volume 3 is the Control System Design and Data Book. Volume 4 is the Integrated GN&C System Design and Data Book.

1. Volumes 1 through 3 shall each contain the following generic design and data information. Additional data required for each specific volume is listed below this section.

(a) Assumptions and groundrules
(b) Subsystem Definition including architecture design and GFE vs. contractor-supplied assumptions
(c) Subsystem Requirements Analyses
    1. Functional decomposition
    2. Functional, performance and interface requirements
    3. Derived requirements on other systems with analysis that yields the requirements
    4. System Trade study results
    5. Analysis to show the subsystem meets the requirements
(d) Detailed Design Description
    1. Hardware element descriptions and principles of operation including description of system modes
    2. Hardware math models
    3. Mass and volume properties

4. Power and thermal profiles
5. Architecture diagram, schematic layouts, drawings and 3-D solid geometric representations of components
6. Interface requirements and description (internal and external hardware interfaces including mechanical, electrical and thermal interfaces, software interfaces, and human interfaces; includes necessary Interface Control Documents)
7. Consumables list
8. Data Bandwidth/memory/processor throughput utilization and margin analysis
9. Telemetry/instrumentation

(e) Operational Analyses
1. Operational scenarios and modes including the subsystem's limitations on any aspect of vehicle flight
2. Performance and Margin analyses
3. Operating Environments (natural and induced)
4. Failure modes and redundancy operations including vehicle failure modes accommodated by subsystem and failure modes reacting to vehicle failures
5. Fault Detection, Isolation and Recovery
6. Diagnostic strategies including plans for in-flight maintenance
7. Initialization procedures and parameters
8. Day of launch parameters and late-load requirements
9. Abort analysis
10. Launch scrub turnaround plan
11. Labeling strategy (consistent with overall CEV labeling strategy)

(f) Maintainability and testing data
1. Test requirements including information on Special Test Equipment design, operations and maintenance.
2. Maintainability strategies including sparing provisions, growth and scarring provisions, shelf-life, and long-term storage provisions
3. Deliverable end item or equipment identification (part number)
4. Predicted reliability assessment
5. Component reusability/refurbishment analysis
6. Developmental Test and Evaluation Guidelines (test matrix, pass/fail criteria, developmental flow diagram, developmental and evaluation tools)

2. In addition to the data listed in section A above, Volume 1 (the Guidance System Design and Data Book) shall contain the following data:

(a) General Design Guidelines
1. Stability (Gain and Phase Margins)
2. Performance (Step response, Flight Phase Discontinuities)
3. Operational Envelope (Dynamic pressure, Body Rates, Attitude Limits, Load Limits)
4. Digital Signal Processing (computation rates, end-to-end data latency for all control loops)

(b) Longitudinal Design Guidelines
(c) Lateral-Directional Design Guidelines
(d) Algorithm Design (Flight phase transition logic, equation derivations)

3. In addition to the data listed in section A above, Volume 2 (the Navigation System Design and Data Book) shall contain the following data:

(a) General Design Guidelines
1. Performance
2. Digital Signal Processing
3. Sensor Characteristics & Math Models

(b) Algorithm Design (equation derivations, Kalman Filter equations, state vector propagation, State Vector update and Covariance Matrix, Reference frames, Navigation phases and major modes)

4. In addition to the data listed in section A above, Volume 3 (the Control System Design and Data Book) shall contain the following data:
(a) General Design Guidelines
1. Stability (Gain and Phase Margins)
2. Performance (Step response, Command Tracking Response, Disturbance Rejection, Control Authority)
3. Operational Envelope (Dynamic pressure, Body Rates, Attitude Limits, Load Limits, Winds/Gust/Turbulence)
4. Digital Signal Processing (computation rates, end-to-end data latency for all control loops)
5. Sensor Characteristics (I/O fidelity, latency) & Math Models
6. Structural modes notch filter design
7. Handling qualities
(b) Longitudinal Design Guidelines
(c) Lateral-Directional Design Guidelines
(d) Algorithm Design (equation derivations, system lead/lag requirements, filters, gains, hysteresis, deadbands, mode logic)

5. Volume 4 (the Integrated GN&C System Design and Data Book) shall contain the following data:
(a) General Design Guidelines
1. Stability (Integrated G&C Gain and Phase margins)
2. Performance (End to End testing)
3. Operational Envelope
(b) Developmental Test and Evaluation Guidelines (test matrix, pass/fail criteria, developmental flow diagram, developmental and evaluation tools)

6. The following data is available in other DRD's therefore listing the DRD and section where the data can be found is sufficient.
(a) Failure Modes and Effect Analysis
(b) Software Requirements and Specifications
(c) Interface Requirements
(d) Databases
1. Vehicle Specification (vehicle geometry, mass properties)
2. Aerodynamic data
3. Environment model
4. Propulsion model [ISP, Thrust profile]
5. Small Perturbation Equations of Motion
6. Flex and propellant slosh
7. Modal results at sensor locations
(e) Parachute/Parafoil model

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

KEEP DRD CEV-T-079 as Reserved

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-080
3. **DATA TYPE**: 3
4. **DATE REVISED**: Nov 2013
5. **PAGE**: 1
6. **TITLE**: CEV Vehicle Wiring Configuration, Identification, and Definition Reports

7. **DESCRIPTION/USE**:
The *CEV Vehicle Wiring Configuration, Identification, and Definition Reports* provide information defining the electrical and optical data, command, and power connectivity in the CEV System, and enables the distribution of this information in support of CEV design, integration, testing, certification and operations. The report allows for the identification of vehicle configuration and the electronic location (projectlink/PDMLink) where discrete wiring data can be obtained to support design and failure analysis.

8. **DISTRIBUTION**: As determined by the Contracting Officer. ODS data are available to NASA via the Kedalion interface. Drawings are available to NASA via the Projectlink interface.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s):2.6.16
Referenced from SOW Paragraphs: 6.1.3.16, 6.2.3.16, 6.4.3.16.

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The CEV Vehicle Wiring Configuration, Identification, and Definition Reports shall provide key wiring information for the CEV Systems as well as the CEVs electrical and optical interfaces with other Exploration elements and external equipment.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The CEV Vehicle Wiring Configuration, Identification, and Definition Reports shall provide the following information:

a) Wiring design data supporting functional and signal path connectivity that are available for access includes: Wire list; wire number; wire awg & color; from reference designator; from Pin; from shield code; from notes code; to reference designator; to shield code; to notes code; signal name code; wire p/n code; routing category code; wire length code; criticality; C/O page number.
b) Wiring design data in support of wire/cable length; parts/materials info; special manufacturing instructions (ref the harness assembly drawing.)
c) Access to reports tying the wiring data to the CEV Data and Command Dictionary to support integration of signal paths with software channelization and command data.

d) Ability to access signal path diagrams in standard drawing formats or in PDF.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1, native data format defined by the Contractor

13.5 **MAINTENANCE**: Changes shall be incorporated by complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-081
3. **DATA TYPE**: 3
4. **DATE REVISED**: 12/20/2005
5. **PAGE**: 1
6. **TITLE**: Launch Abort System Design and Data Book

7. **DESCRIPTION/USE**:
This DRD documents the abort system design information. The comprehensive documentation will provide detailed reference information to support Engineering and Operations throughout the life of the CEV.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 6.4.2.
Related DRD(s): CEV-T-071

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Launch Abort System Design and Databook documents the design and development of the CEV launch abort system. The content of this deliverable addresses the CEV launch abort system in potential usage during launch and first stage launch vehicle ascent operations. (Note: Any launch abort system inherent to the launch vehicle upper stage [if required], based on use of the service module, shall meet and address the requirements specified in CEV DRD-T-071, Propulsion System Design and Databook.).

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
As a minimum, the deliverable shall include, the following data. All specified design data shall be provided considering nominal, off nominal, and failure operations conditions. Additionally, fluids related subsystems and components shall meet and address the requirements and applicable documents specified in DRD CEV-T-071, Propulsion System Design and Data Book, as part of this DRD deliverable.

NOTE: It is recognized that some of the information requested in this document, may also be requested by other documents required under this contract. In such cases, the contractor may, at its own discretion, not repeat the same information, but shall provide the appropriate references.

1. Assumptions and groundrules
2. Subsystem Definition including GFE vs. contractor-supplied assumptions
3. Subsystem Requirements Analyses
(a) Functional decomposition
(b) Functional, performance and interface requirements

(c) Derived requirements on other systems with analysis that yields the requirements
(d) Trade study results
(e) Analysis to show the subsystem meets the requirements
4. Detailed Design Description
(a) Hardware element descriptions including data needed to completely understand the operation of the abort system and design rationale
(b) Hardware math models and simulation tools description, source algorithms/code and validation report, including benchmarks of test results against model predictions.
(c) Mass, volume, and moments of inertia properties
(d) Material and component selections, rationale, and compatibility analysis (including vendor component drawings and cross-sections, material usage list, any test reports, mill reports, NDE reports, burst article or qualification test reports that may be available)
(e) Power and thermal profiles
(f) Schematic, layouts, drawings and 3-D solid geometric representations of components,
(g) Interfaces (internal and external hardware and functional interfaces including mechanical, electrical and thermal interfaces, software interfaces, and human interfaces; includes necessary Interface Control Documents)
(h) Consumables list
(i) Data bandwidths (data rates);Telemetry; Instrumentation
(j) Manufacturing concept for hardware (location, type of manufacturing processes, quality control, lot control, etc.)
5. Operational Analyses and Data
(a) Operational scenarios and modes including the subsystem's limitations on any aspect of vehicle flight
(b) Performance and Margin analyses (including component-level structural stress analysis process and assumptions, safety factors, derating factors, safety margins and rationale, and Margins of Safety tracking
(c) Thermal, static and dynamic (including startup transient, vibro-acoustic) load models and performance calculation models (include model assumptions, model technique, input and output data)
(d) Operating environments (natural and induced) and constraints including G-load profiles (both translational and rotational during abort/escape operation and at touch down), and peak surface temperatures, sea states, explosion debris field, including landing footprint debris field, overpressure, and fire ball, etc.
(e) Separation dynamics and aerodynamics, multi-vehicle relative motion trajectories, jet interaction induced over pressures (if appropriate), attitude control and disposal perforance, and re-contact assessment. Failure modes and redundancy operations including vehicle failure modes accommodated by subsystem and failure modes reacting to vehicle failures
(f) Failure modes
(g) Fault Detection, Isolation and Recovery
(h) Flight, ground, and test anomaly tracking and disposition process including sibling anomaly tracking process
(i) Initialization procedures and parameters
(j) Day of launch parameters and late-load requirements
(k) Abort analysis
(l) Launch scrub turnaround plan
6. Maintainability and testing data
(a) Test requirements including information on Special Test Equipment design, operations and maintenance.
(b) Development test concept and rationale, planned activites and test plan
(c) Concept for hardware integration, assembly, test and checkout
(d) Maintainability strategies including sparing provisions, shelf-life, and long-term storage provisions,
(e) Deliverable end item or equipment identification (part number)

(f) Reliability analysis and assessment, including assumptions and process for verifying reliability
(g) Component reusability/refurbishment analysis including fluid compatibility and cleanliness needs
(h) Firing test results, including test configuration and objectives, specific hardware used, test trajectory and sequence of events, comparison of pre-test predicted performance versus actual results, test anomalies, and test conclusions.
7. References and Indication of any changes from the previous submission.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

KEEP DRD CEV-T-082 AS RESERVED

KEEP DRD CEV-T-083 AS RESERVED

KEEP DRD CEV-T-084 AS RESERVED

KEEP DRD CEV-T-085 AS RESERVED

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-086
3. **DATA TYPE**: 2
4. **DATE REVISED**: September 2012
5. **PAGE**: 1
6. **TITLE:** Manufacturing and Assembly Plan
7. **DESCRIPTION/USE:** This document provides the plans for manufacturing and assembling the flight articles, associated unique tooling, fixtures, support and test equipment for producing an integrated, tested CEV.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.10. Referenced from SOW Paragraphs: 6.1.6, 6.2.6, 6.4.6

13. **DATA PREPARATION INFORMATION:**

13.1 **SCOPE:**

The Manufacturing and Assembly Plan applies to production activities performed by the Prime Contractor and major subcontractors through DD-250 of the integrated vehicle (CM/SM/SA) and DD-250 of the LAS for flight vehicles and flight test articles. This plan applies to all hardware designed, built and assembled to create and support the development of the CEV System throughout the life time of the program.

13.2 **APPLICABLE DOCUMENTS:**

13.3 **CONTENTS:**

The Manufacturing and Assembly Plan shall address hardware development of (category):

1) Test articles
2) Prototype vehicles
3) Flight vehicles
4) Ground Support Equipment (GSE)
5) Flight Support Equipment (FSE)
6) Test Support Equipment (TSE)
7) Maintenance Support Equipment (MSE)

The Manufacturing and Assembly Plan shall address the following for Test articles, Prototype vehicles, and Flight vehicles (categories 1-3):

a. Description of product deliverables
b. Master Equipment List or equivalent
c. Manufacturing, assembly and test processes including manufacturing flow(s)
d. Configuration at delivery (to include DD250 configuration(s) if applicable)
e. Packaging, Handling, Shipping, and Transportation (PHS&T) requirements
f. Unique certification and/or training requirements and/or processes (as required)

g. Unique tooling/test equipment or requirements necessary at delivery site(s).

The Manufacturing and Assembly Plan shall address the following for GSE, FSE, TSE, and MSE (categories 4-7):

a. Description of product deliverables
b. Configuration at delivery (to include DD-250 configuration(s) if applicable)
c. Packaging, Handling, Shipping, and Transportation (PHS&T) requirements
d. Unique certification and/or training requirements and/or processes (as required)
e. Unique tooling/test equipment or requirements necessary at delivery site(s).

This Manufacturing and Assembly Plan shall include the following specialty areas for Test articles, Prototype vehicles, and Flight vehicles (categories 1-3):

1) vehicle primary structure
2) secondary structure to attach subsystem components (as required) to the primary structure
3) subsystem hardware interfaces to the Spacecraft (cabling, power, fluid systems, attachment hardware).

This Manufacturing and Assembly Plan shall include the following specialty areas for GSE, FSE, TSE, and MSE (categories 4-7):

1) lifting fixtures and attachment hardware (for all required orientations/configurations), with considerations for both launch and landing sites
2) transportation/holding apparatuses (for all pieces), with considerations for both launch and landing sites
3) text fixtures (for all test verification orientations)
4) flight interface mechanical simulators for the launch vehicle

The Manufacturing and Assembly Plan shall cover manufacturing requirements performed at the following locations:

a. Prime Contractor sites
   i. Michoud Assembly Facility (MAF)
   ii. Lockheed Martin Mission Services (LMMS) – Houston
   iii. LAS Processing at KSC
   iv. Operations & Checkout (O&C) Facility - KSC

Government Furnished Equipment (GFE) is addressed by J-11 and not applicable to CEV-T-086.
The Manufacturing and Assembly Plan shall list information for the manufacturing process, including:

1) loads data (by category)
2) preferred standard hardware list
3) preferred standard manufacturing processes
4) soft vs. hard tooling
5) design for manufacturability.

13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE:** Contractor- shall maintain this document in accordance with company guidelines for technical documents.Complete re-issue of the document is required.

KEEP DRD CEV-T-087 AS RESERVED

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-088
3. **DATA TYPE**: 2/3*
4. **DATE REVISED**: 12/20/2005
5. **PAGE**: 1
6. **TITLE**: CEV Imagery Plan/Imagery Deliverables

7. **DESCRIPTION/USE**:
To define the approach and strategy for the imagery documentation (still photo, motion picture, digital imagery, or video) of the configuration of the CEV spacecraft, systems, subsystems and components during manufacture, bench testing, assembly, integration, and closeout. The imagery will be used to support on-orbit maintenance, configuration verification, post launch evaluation, anomaly analysis, sustaining engineering, and hardware reconfiguration.

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

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:
Imagery Plan will be Type 2. Imagery will be Type 3.

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.10.
Referenced from SOW Paraagraphs: 6.1.6, 6.2.6, 6.4.6
Related DRD(s): CEV-T-014

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The CEV Imagery Plan shall define the approach and strategy for documenting of the CEV spacecraft and its components during manufacturing, test, ground operations, ascent and on-orbit phases, re-entry and descent phases, and landing and recovery phases, including crew egress.

13.2 **APPLICABLE DOCUMENTS**:

13.3 **CONTENTS**:
The CEV Imagery Plan shall include:
1. The approach and strategy for imagery documentation of the CEV spacecraft and its systems, subsystems and components during manufacture, assembly, and test. The plan shall include the approach for imaging the following areas:
(a) Intravehicular Activity (IVA) Hardware
i. Orbital Replacement Units (ORUs) as-installed to show visible connectors, fittings, attachment fasteners, reference designators, thermal cooling interfaces, and filters.
ii. M/assembly interfaces of ORU and other organizational maintenance hardware.
iii. Fluid/gas lines and electrical/data harnesses prior to final mate.
iv. Fluid/gas lines and electrical/data harnesses as installed to show visible fittings, couplings, connectors, and reference designators.
v. Each area to show ORUs and other systems hardware accessibility and the final configuration of the hardware just prior to close-out panel installation.

vi. Close-out panels and covers to show attachment fasteners and nomenclature (labels, placards, etc.)
vii. Overall and close-up views of ORUs and system hardware.
viii. Manual crew interfaces - e.g., panels, hatches, valves, etc.
(b) Extravehicular Activity (EVA) Hardware
i. Performance of a photo survey of everything within the physical reach along the primary and secondary EVA translation paths on the spacecraft. This is defined as a 1.1-meter cylinder tangent to the handrail and the hull. The EVA handholds themselves are a key photo target. Also required are several views of any item that is susceptible to kick-load damage that are within physical reach of the crewman, regardless of whether it is in the 'corridor.'
ii. Exterior mechanisms in both stowed and deployed position, seen from up to three orthogonal views.
iii. General views of EVA worksites.
iv. At least one photo of every connector feed-through plate, with the cable harness installed.
v. Internal control panels and switches that relate to EVA crew safety.
vi. Any deployment/retraction mechanisms.
vii. Antenna locations.
2. The approach for ensuring the imagery documentation is accessible for reference during CEV processing and mission.
3. The approach for categorizing, maintaining, organizing, and archiving the imagery.

13.4 **FORMAT**: Contractor format is acceptable. Imagery loaded to ICE as images are processed and catagorized.

13.5 **MAINTENANCE**: Changes shall be incorporated by complete reissue.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-089
3. **DATA TYPE**: 2
4. **DATE REVISED**: Nov. 2013
5. **PAGE**: 1
6. **TITLE**: Orion Crew Interface Label Map

7. **DESCRIPTION/USE**:
The Orion Crew Interface Label Map will detail the content, design (font, label size, material, etc.), location, and orientation of all crew interface labels for the Orion project (i.e., not all vehicle labels, only crew interface labels). This data will be used by NASA to ensure that all crew interface labels on the Orion meet the MPCV Program Crew Interface Labeling Standard (MPCV 70152) when integrated into the design of the vehicle. It is not intended to be the approval process for every crew interface label drawing. One drawing can represent multiple crew interface labels. The Orion Crew Interface Label Map documents the content, orientation, location and drawing number reference for each crew interface label.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: Per Data Requirements Matrix

10. **SUBMISSION FREQUENCY**: Per Data Requirements Matrix

11. **REMARKS**:

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.8.7

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
The Orion Crew Interface Label Map provides a “map” of technical labeling information, including content, design (font, label size, material, etc.), location, and orientation, for all crew interface labels as integrated into the design of the vehicle. This includes crew interface labels at the vehicle, module, subsystem, and component level. This also includes information on ground labeling that is in the vicinity of flight crew interface labeling, only for the purpose of showing non-interference with the flight labels. The Orion Crew Interface Label Map does not include information on part-marking, on ground labels not in the vicinity of flight labels, or any other labels not used by the flight crew during nominal operations and maintenance activities.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
MPCV 70024, MPCV Human Systems Integration Requirements (HSIR) (and associated Children documents as specified in Attachment J-3, Applicable, Meets/Exceeds, and Informational Documents List).
MPCV 70152, MPCV Program Crew Interface Labeling Standard (This document is also an HSIR child document.)

13.3 **CONTENTS**:
The Orion Crew interface Label Map shall use the labeling standards defined in MPCV 70152 to provide crew interface labels for the Orion vehicle. The contents of the Crew Interface Label Map shall include, but not be limited to, 1) label content (including approved Operations Nomenclature), 2) label design details (font, label size, material,

etc.), 3) label location on the hardware, vehicle, etc., and 4) label orientation when integrated into the flight vehicle design. The Crew Interface Label Map shall include both textual descriptions of the labels used, as well as figures that show the label design, and the label location and orientation on the hardware. The Crew Interface Label Map shall also contain details on any labeling standards that are not met by the Orion design, as well as justification for the deviation. Deviations should be limited to instances where the implementation of a specific labeling standard is not feasible because of limitations created by the design (e.g. label real-estate limitations), or a unique implementation is agreed upon between NASA and the Contractor for the overall benefit of the crew interface.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Microsoft® Word/Excel® or Adobe® Acrobat® PDF for textual and graphics information, or ASCII delimited for data.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required with changes clearly identified.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM**: CEV
2. **DRD NO.**: CEV-T-090
3. **DATA TYPE**: 2
4. **DATE REVISED**: Nov. 2013
5. **PAGE**: 1
6. **TITLE**: Environments Definition Document (EDD)

7. **DESCRIPTION/USE**:
To define all environments for the spacecraft design, development, test, and flight.

8. **DISTRIBUTION**: As determined by the Contracting Officer.

9. **INITIAL SUBMISSION**: See item 10.

10. **SUBMISSION FREQUENCY**: As updated for, or during, design cycles

11. **REMARKS**:
Informational Documents per J3:
CxP-70137: Constellation Loads Control Plan

12. **INTERRELATIONSHIP**: Parent SOW Paragraph(s): 2.8.1. Referenced in SOW Paragraphs: 2.6.7, and 2.6.9

13. **DATA PREPARATION INFORMATION**:

13.1 **SCOPE**:
A unified collection of all of the environments that will be used to design, test, verify, and certify Project Orion.

13.2 **APPLICABLE DOCUMENTS**:
Applicable Documents per J3:
SLS-SPEC-159: SLS Program Design Specification for Natural Environments
SLS-SPEC-048 SLSP Integrated Vehicle Coordinate System
MPCV-72000: Multi-Purpose Crew Vehicle (MPCV) Systems Requirements Document
CxP-72385: Crew Exploration Vehicle Government Furnished Data for Orion System Design and Analysis

Meets/Exceeds Documents per J3:
NASA-STD-5002: "Loads Analyses of Spacecraft and Payloads", NASA, June 1996

13.3 **CONTENTS**:
During all phases of the mission (inclusive of all pre-flight, flight, and post-flight phases), environments shall be provided for specific components or spacecraft zones necessary to design the vehicle. The environments shall consist of, at a minimum:
1) Structural environments (such as load factors, random vibration, acoustics, and shock) for primary structures, major assemblies, zones, and components as necessary, including the LM Loads Memos,
2) Thermal environments for spacecraft zones and components as necessary, in both operating and non-operating conditions,
3) Natural environments (as defined in SLS-SPEC-159 DSNE), including a mapping of how requirements are flowed from DSNE to either a) specifications, b) analyses, or c) other requirements document.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Word-compatible document or Adobe® Acrobat® PDF.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval.

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-B-001	Financial Management Report (533)	3		I 30 Days After								U	The initial (baseline) NF533Q report shall be submitted within 30 days after authorization to proceed. In addition, NF533 reporting shall begin no later than 30 days after the incurrence of cost. Submission frequency is monthly for NF533M and Quarterly for NF533Q. An electronic 533M shall be delivered 10 working days after calendar month end. An electronic NF533Q shall be delivered 10 working days after the month proceeding the quarter being reported. Hardcopy 533M and 533Q shall be delivered two working days later.
CEV-B-002	Workforce Reporting	3		I 30 Days After								U	The initial report shall be submitted within 30 days after authorization to proceed. Submission frequency is Quarterly for the first year, and Annually thereafter. Submission shall be by the twelth working day of the month following the month end.
CEV-B-003	Cost Performance Report	3	I		F 30 Days Prior							U	Proposal submission shall be the IMS portion only, per instructions in Section L. Initial CPR submission shall be 8 days prior to IBR. Monthly electronic CPR submission, Formats 1, 3 and 5, shall be 15 working days after the calendar month end following the month being reported. Significant EVM system changes shall be submitted within 5 working days of such change.

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-B-004	Property Financial Reporting	3										U	The due date for the first Monthly Property Financial Reporting submission is the 21st day after the close of the month, beginning at the first month after contract start. Subsequent monthly reports shall be due the 21st day after the end of the month; for example, August 21 for the month ending July 31. The due date for for the first Annual Property Reporting via NASA Form (NF) 1018 is November 30. Subsequent annual reports shall always be due on November 30.
CEV-D-001	Reserved												
CEV-D-002	PA-1 Flight Test Article (FTA) <Level> Requirements	2/3*										I,F,U	System-Level Specifications: Module Level Specifications: Initial 30 days prior to Applicable PTR (PDR Level) for all tests (PA-1) (Type 2) Final 30 days prior to Applicable PTR (CDR Level) for all tests (PA-1) (Type 2) Subsystem Level Specifications: Initial 30 days prior to Applicable PTR (PDR Level) for all tests (Type 2) Final 30 days prior to Applicable PTR (CDR Level) for all tests (Type 2) Component Level Specifications: Final 30 days prior to Applicable PTR (CDR Level) for all tests (Type 3) Module Level Interfaces: Initial 30 days prior to Applicable PTR (PDR Level) for all tests

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
													(Type 2) Final 30 days prior to Applicable PTR (CDR Level) for all tests (Type 2) Subsystem Level Interfaces: Final 30 days prior to Applicable PTR (CDR Level) for all tests (Type 2)
CEV-D-002	PA-1 Flight Test Article (FTA) <Level> Requirements (cont)	2/3										I,F,U	Software Requirements Specifications: Initial 30 days prior to Applicable PTR (PDR Level) for all tests (Type 3) Final 30 days prior to Applicable PTR (CDR Level) for all tests (Type 3) Software Interface Requirements Specifications: Initial 30 days prior to Applicable PTR (PDR Level) for all tests (Type 3) Final 30 days prior to Applicable PTR (CDR Level) for all tests (Type 3) All Levels: Update as required
CEV-D-003	Reserved												
CEV-D-004	Reserved												
CEV-D-005	Reserved												

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-D-006	Reserved												
CEV-D-007	Orbital Flight Test FTA <Level> Specifications	**2**										**F, U**	Update as required
CEV-D-008	Orbital FlightTest FTA Verification Plan	**2**										**F, U**	Update as required
CEV-D-009	Orion Exploration Flight Test 1 (EFT-1) Flight Test Article (FTA) Post Test Data Results and Report	**3**										**I, F**	Initial 14 days following the EFT-1 launch Final 90 days following the EFT-1 launch
CEV-D-010	Ascent Abort-2 (AA-2) FTA <Level> Specification	**2**										**F, U**	Final 45 days prior to AA-2 PTR-1 Update 30 days prior to AA-2 PTR-2
CEV-D-011	Orion Ascent Abort-2 (AA-2) Flight Test Article (FTA) Post Test Data Results and Report	**2**										**I, F**	Initial 30 days following the AA-2 launch Final 90 days following the AA-2 launch

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-M-001	CEV Prime Project Management Plan	3	I		F 30 Days Prior to							U	Updates as required. In the event of changes due to streamlining plan efforts or significant changes in key personnel or in the reporting structure, an update shall be submitted within 5 working days of such change.
CEV-M-002	Performance Assessment Plan, Reports and Management Reviews	1/4	I	U 90 Days After	F							U*	Performance Assessment Plan delivery shall be at IBR. The first Monthly input should support a review 20 working days after the initial financial month end. Monthly Reports should be made available by the 4th Monday of the month * Plan= Type 1, Reports=Type 4
CEV-M-003	Configuration and Data Management Plan and Reports	2/4		I 90 Days After	F							U	Initial submission is ATP + 90 days; update as necessary to incorporate changes. CM & DM Plans Type-1 CM & DM Reports Type-4
CEV-M-004	Reserved												
CEV-M-005	Reserved												
CEV-M-006	Reserved												
CEV-O-001	Contractor's CEV Concept of Operations	3	I			U 45 Days Prior		U 45 Days Prior	F* 45 Days Prior				* Due 45 Days Prior to CDR

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-O-002	Flight Hardware Software Operations and Maintenance Requirements Development Plan and Requirements Document	2				I 45 Days Prior		F/I 45 Days Prior	F 6 Months After			U	Requirements Development Plan: Initial delivery 45 days prior to SDR. Final delivery 45 days prior to PDR. Requirements Document : Initial delivery 45 days prior to PDR, Final delivery 6 Months After CDR. Requirements Document update as required after Final delivery.
CEV-O-003	Launch Site Support Requirements Documentation	3						I 45 Days Prior	F 6 Months After			U	Updates as Required
CEV-O-004	CEV Operations Data Book	2				I 45 Days Prior			U 9 Months After	F 90 Days Prior	U	U	Initial submission shall consist of outline of data to be provided. Update as required after Final delivery.
CEV-O-005	Flight Operations Procedures Data	3							I 9 Months After			F	EM-1 Final required @ L-18 months for EM-1 EM-2 Final required @ L-18 months for EM-2
CEV-O-006	CEV Stowage Capabilities and Services Handbook	3							F 9 Months After			U	Update as required after Final delivery.

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-O-007	Range Safety Requirements Documents	3				I 45 Days Prior			F 45 Days Prior			U	Final due 45 Days Prior to EM-1 and EM-2 CDR and to AA-2 PTR-3 Updates if required shall be provided 45 days prior EM-1, EM-2, and AA-2 FRR
CEV-O-008	Ground Systems Requirements, Plans, Reports and Design Data	2/3*		I 45 Days After		U 45 Days Prior		U See Notes	F 90 Days After				Ground Systems Requirements, Plans, Reports and Design Data Volume I, Ground Systems End Item Requirements Document and Report Part 1 of 2 NASA Provided Facilities & Facility System Requirements & Part 2 of 2 NASA Provided Ground Support Equipment (GSE) Requirements; Volume IV: Ground Systems Sustaining Engineering Plan: Update 45 days prior to PDR. All other volumes of CEV-O-008 will not be delivered at PDR. * Plans, Requirements = Type 2 * Reports, Design Data = Type 3.
CEV-S-001	Safety and Mission Assurance (S&MA) Plan	2	I	U 15 Days After		F 15 Days Prior						U	Proposal – deliver high level plan and schedule of DR deliveries. Update as Required – Type-2
CEV-S-002	Reserved												

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-S-003	Flight System Safety Hazard Analyses	1/4				U 7 Days After SDR Board		U 60 Days After	U 60 Days After	F 30 Days Prior		I, U	Initial 50 days prior to CEV SRR (includes Ground System Safety Hazard Analyses) Mid-term Update due 45 days prior to SDR. This version to be updated and redelivered at 7 days after SDR Board. EM1/EM2: Update (Type 4) at all design (or design equivalent) milestones plus 60 days. Final (Type 1) at SAR minus 30 days. Final submission includes Safety Verification Tracking Log (SVTL). Update as required after SAR (Type 1) Deliveries required for EM1 and EM2 design milestones and EM1 and EM2 SAR. EFT1: Not Applicable AA-2: Not Applicable
CEV-S-004	Mishap Plan and Safety Statistics	2/4*		I 15 Days After		F 7 days after SDR Board							Initial Mishap Plan shall be submitted 15 days after ATP with a final version due 7 days after SDR Board. Plan: Data type 2 The contractor shall provide access to monthly reports **10 days** after the end of the calendar month documenting monthly mishaps and safety statistics starting with contract approval. *Reports: Data Type 4

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-S-005	Ground System Safety Hazard Analysis	1						I 60 Days After	U 60 Days After	F* 30 Days Prior		U**	EM1/2: *Final (Type 1) submission includes the Safety Verification Tracking Log (SVTL) **Update as required after MPCV SAR (Type 1) EFT1: Submission dates at equivalent milestones (PTR2, PTR3, and MSCSR) and updates as required after final delivery AA2: Submisson dates at equivalent milestones (PTR2, PTR3, and SAR)) and updates as required after final delivery
CEV-S-006	Reserved												
CEV-S-007	Orbital Debris Assessment	1/4						I	U		F 60 Days Prior		EFT 1 Deliveries: 1) Initial ODAR at CIR + 30 days (spacecraft only) as Type 4 2) CDR equivalent ODAR (spacecraft + Launch Vehicle) delivery twelve (12) months prior to launch as Type 4 3) Final ODAR (spacecraft + LV) at LM FRR - 3 months as Type 1 EM1 and EM2 Deliveries: 1) PDR ODAR at PDR (or equivalent milestone) as Type 4 2) CDR ODAR at CDR-45 days (or equivalent milestone) as Type 4 3) Final ODAR at FRR - 60 days as Type 1 AA2: Not Applicable
CEV-S-008	Safety and Health Plan	1	I	F									The contractor may revise the plan at any time or at the direction of the Government. Revisions are subject to Government review and approval. Distributions of approved revisions will be as described above.

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-S-009	Failure Modes Effects Analysis & Critical Items List (FMEA/CIL)	3/4				I 7 Days After SDR Board		U	F				EM1/EM2: Updates (Type 4) required for EM1 and EM2 PDR (or equivalent milestones) Final (Type 3) required for EM1 and EM2 CDR (or equivalent milestones) Update as required after Final delivery EFT1: Per NS088, the conduct of FMEA/CILs was required, but not the delivery of S-009. EFT1 FMEA/CILs provided as LM-ORN-494. AA-2: Make available the FMEAs that have been performed to support the Range Safety Data Package and the unique AA-2 design development (Type 4).

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-S-010	Probabilistic Risk Assessment Results	2/4*				I 45 Days Prior		U	U*	F 30 Days Prior		See notes	EM1/EM2: Updates (Type 4) required for EM1 and EM2 PDR (or equivalent milestones) Updates (Type 4) required for EM1 and EM2 CDR (or equivalent milestones) Final (Type 2) required for EM1 and EM2 at SAR minus 30 days. Interim "delta" deliveries (Type 4) required every six (6) months after EM1 PDR (or equivalent milestone) EFT1: Per NS088, Loss of Test Vehicle/Loss of Data PRA required, but not the delivery of S-010. Analysis provided as LM-ORN-0530. AA-2: S-010 scope reduced to LOTV for the LAV @ AA-2 milestones as Type 4

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-S-011	Reliability, Maintainability, and Supportability Integrated Report	4				I 7 Days After SDR Board		U	U		F 30 Days Prior	U*	Initial 7 days after SDR Board, providing high-level system allocations. EM1/EM2: Updates (Type 4) required for EM1 and EM2 PDR (or equivalent milestones) Updates (Type 4) required for EM1 and EM2 CDR (or equivalent milestones) Final (Type 4) required for EM1 and EM2 at SAR minus 30 days. Appendices (Type 4) required every six (6) months after EM1 PDR (or equivalent milestone) EFT1: Not required for EFT1 per NS088 AA-2: Not required
CEV-S-012	Government-Industry Data Exchange Program and NASA Advisories/ALERTS	1/3*										I	GIDEP, NASA Advisories, and Alerts shall begin with the manufacturing of flight or flight like hardware The Contractor and Subtier Implementation Procedures shall be submitted 60 days after Contract Award. GIDEP documents shall be released in compliance with GIDEP Operations Manual and Policy. Release of NASA advisories IAW NASA Policy. * Implementation Procedures = Type 1, GIDEP documents = Type 3 Implementation Procedures may be included in the Contractor S&MA Plan (CEV-S-001)
CEV-S-013	Reserved												

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-S-014	Reserved												
CEV-S-015	Critical Processes	2/4						I	F				EM1/EM2: Final at EM1 CDR (or equivalent milestone) as Type 2. Update, if required, for EM2 CDR. Type 2 applies to the general procedures and processes. Critical processes are to be identified at the applicable component and subsystem CDRs in accordance with design milestone entrance criteria. At the EM1 CDR (or equivalent milestone), the compilation of critical processes shall be provided as Type 4. The list shall be maintained and updated, if required, for the EM2 CDR (or equivalent milestone) as Type 4. EFT1: Not Applicable AA-2: Not Applicable
CEV-S-016	Mechanical Parts Management and Implementation Plan	2				I 45 Days Prior		F	U*			U	EM1/EM2: Update as required at EM1 CDR (or equivalent milestone) as Type 2. Update as required at EM2 CDR (or equivalent milestone) as required. EFT1: Compliance to S-016 required for part lots that cannot be isolated to EFT-1 AA-2: Update as required at PTR-3 or equivalent milestone *Update as required after Final delivery

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-S-017	Reserved												
CEV-S-018	Reserved												
CEV-T-001	Models, Simulations, and Integrated Support Plan	2/3/4				I 45 Days Prior		U 45 Days Prior	F 45 Days Prior			U*	Initial submission will contain Modeling & Simulation Support Plan M&S Support Plan is Type-2 Final/Baseline deliveries of simulations and models are Type-3 M&S Database is Type-4 Informal deliveires of simulations and models are Type-4 *Update support plan as required
CEV-T-002	Reserved												
CEV-T-003	CEV CAD Models	3				U 45 Days Prior		U 20 Days Prior	U 20 Days Prior	F 45 Days Prior		U	PDR: 20 days prior to SSDR an available set of Models required as Type-4 CDR: 20 days prior to SSDR a complete set of models required as Type-4 Updates required between milestones as Type-4 Final delivery 45 Days Prior to EM-1/EM-2 SAR as Type-3 Other: update as required.

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-004	CEV Drawings	3/4						I 20 Days Prior	U 20 Days Prior	F 45 Days Prior		U	PDR: 20 days prior to SSDR an available set of drawings required as Type-4 CDR: 20 days prior to SSDR a complete set of drawings required as Type-4 Updates as required between milestones as Type-4 Final delivery 45 Days Prior to SAR as Type-3 Other: update as required.
CEV-T-005	Software Development Plan	2	I			U 45 Days Prior				F 45 Days Prior		U, F	Volume 4, Recon Process Plan – Initial submission at PDR + 210 days and Final submission at CDR + 3 months. Volume 5, Software Classification and NPR 7150.2 Mapping—Initial submission at SwRR and Final submission 45 days prior to PDR. Volume 6, Software Build Plan—Initial submission 45 days prior to SDR (as part of the entire CEV-T-005). Updated submissions at SwRR, PDR + 210 days, and CDR + 3 months. Final submission (as built) at EM-1/EM-2 SAR.
CEV-T-006	Software Configuration Management Plan	2				F 45 Days Prior						U	Update As Required.
CEV-T-007	Software Development Folder	5											

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-008	CEV System Analysis Plan	2/4	I			U 45 Days Prior						U	Plan is Type-2 Analysis Cycle specific TDS list is Type-4 Analysis specific TDS list to be provided at the Kickoff for each analysis cycle. Final to be provided 10 calendar days after Analysis Cycle Kickoff.
CEV-T-009	CEV Analysis Reports	3/4										U	15 days after the completion of each analysis cycle. Analysis Reports for Design Analyses: Type-4 Analysis Reports for Verification Analyses: Type-3
CEV-T-010	Reserved												
CEV-T-011	Integrated Logistics Support Plan	2	I			U 45 Days Prior		F 45 Days Prior	U 45 Days Prior	U 12 Mnths Prior			Update 12 months prior to DD250 (SAR)
CEV-T-012	Logistics Support Analysis	4				I 45 Days Prior			F 45 Days Prior	U 12 Mnths Prior			Update 12 months prior to DD250 (SAR)
CEV-T-013	Launch Site CEV Propellants, Fluids, and Gases Forecast	4										I,U	Initial delivery on March 1, 2009. Update required when forecast changes require an update to prepare for Ground Ops and integrated testing.
CEV-T-014	Reserved												

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-015	Master Verification Plan (MVP)	2/4*				I 45 Days Prior		U 45 Days Prior	U/F 45 Days Prior			U,F	Volumes I and II Update 45 Days prior to PDR as Type 2 Final delivered 45 days prior to CDR as Type-2 Volume III Initial 45 Days prior to CDR as Type 4 Final delivered 30 days after CDR as Type 2 Volume I: Contains the processes and integrated test strategy Volume II: Contains the environmental test requirements Volume III: Contains the structural verification plan *Schedule for Type-4 data products are defined/described in Volume I: • Requirements Verification Traceability Matrix (RVTM) • Verification Information Sheets (VIS) • Component Verification Closure Matrices (CVCM) • Component Test Matrix (CTM) • Orion Master Test Plan (OMTP).
CEV-T-016	Certification Plans	2						I 45 Days Prior	F 45 Days Prior				Program certification plan: Initial 45 days prior to PDR Final 45 days prior to CDR.

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-017	Certification Data Package	2/4*								F* 45 Days Prior		F**	Certification Data Packages shall be completed at the spacecraft, module, subsystem, and component levels. Software CDPs shall be separate but included at each applicable hardware level. Certification reviews shall be held at each level. *Spacecraft, Module and Deliverable Software will be delivered as Type 2 and will include the previously reviewed lower level CDPs. **Component, Subsystems and other Software CDPs will be provided as Type 4 and incrementally reviewed with NASA.
CEV-T-018	Reserved												
CEV-T-019	Materials and Processes Selection, Implementation, and Control Plan	2				F 45 Days Prior						U	Update as required
CEV-T-020	Materials Usage Agreements (MUA)	3*/5							I 45 Days Prior	F 45 Days Prior		U	Cat I and II MUAs are Type-3 Cat III MUAs are Type-5 Cat I and Cat II MUAs shall be incremently approved in accoordance with the M&P Selection, Implementation and Control Plan (CEV-T-019). At CDR the contractor shall make available as Type-4 the approved Cat I and Cat II MUAs Other: Update as required after Final delivery *MUAs may be delivered in conjunction with the CDP/ADP

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-021	Contamination Control Plan (CCP)	2						I 45 Days Prior	F 45 Days Prior			U	Other: update as required
CEV-T-022	Materials Identification and Usage List (MIUL)	4							I* 15 Days Prior		F 45 Days Prior		* MIUL delivered 2 weeks prior to CDR
CEV-T-023	Nondestructive Evaluation Plan	2						I 45 Days Prior	F 45 Days Prior			U	Other: Update as required
CEV-T-024	Corona Design Criteria	2				I 45 Days Prior		F 45 Days Prior				U	Other: Update as required
CEV-T-025	CEV Electromagnetic Compatibility Control and Verification Document	1				I 45 Days Prior		U 45 Days Prior	F* 45 Days Prior			U	Section 1 Final SDR Section 2 Final at PDR; Updates as required. Section 3 Final at PDR; Updates as required. Section 4 Final at PDR; Updates as required. Section 5 Final at SDR; Updates as required. Section 6 Final at SDR; Updates as required. Section 7 Final at SDR for plans; * Due 45 Days Prior to CDR

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-026	Spectrum Management Documents	2				I 90 Days Prior		U See Notes	F 45 Days Prior			U	Forms NTIA-33 - Transmitter Equipment Characteristics, NTIA-34 -Receiver Equipment Characteristics, & NTIA-35 -Antenna Equipment Characteristics shall be completed by the contractor for each RF system for operational vehicle. Spectrum Management documents: Stage 1 Forms shall be delivered 90 days prior to SDR. Draft Stage 2 Forms and Updated Stage 2 delivered to support the NTIA Stage 2 submission and approval cycle for the experimental license. This experimental license needs to be in place prior to the S-Band brassboard testing. Further stages finalized for CDR. These will be delivered 45 days prior to CDR to support NTIA submission and apporval for the operational license. Update as required after Final delivery.
CEV-T-027	Electrical, Electronic, and Electromechanical Parts Management and Implementation Plan	2				F 45 Days Prior						U	Update as required after Final delivery
CEV-T-028	As-Built EEE Parts List	3								F		U	The As-Built EEE Parts List for the entire system shall be submitted at Systems Acceptance Rievew. Update as required.
CEV-T-029	Interface Control Documents	1/4 see note						I See notes	F 45 Days Prior			I,F,U	All External ICDs are Type-1 • Orion to GSDO • Orion to SLS • Orion to MS

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
		S											• Orion to CTN Initial 45 days prior to PDR Final 210 days after PDR Update as required after Final Delivery ESM related ICDs are Type-1 Initial 45 days prior to PDR Final 210 days after PDR Update as required after Final Delivery All Internal ICDs are Type-4 Module Level ICDs Initial 45 days prior to PDR Final 45 days prior to CDR Subsystem Level ICDs Include: MGSE, GFE, EGSE & Simulator: GFE sections only of Subsystem ICDs will be delivered at 45 days prior to PDR. Final 45 days prior to CDR. Software IDDs are Type-4: Initial 210 days after PDR Final 45 days prior to SwCDR All levels: Update as required after Final delivery. For AA-2: Module to Module and Module to External ICDs (Type 1) Final 45 days prior to AA-2 PTR-1 Update 30 days prior to AA-2 PTR-2

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-030	Reserved												
CEV-T-031	CEV <Level> Requirements Specification	**1/4***				**See notes**		**See notes**				**I,F,U**	Ground and Spacecraft System-level Requirements Specifications: Initial 50 days prior to CEV SRR Final 45 days prior to SDR Module-level Requirements Specifications: Final 45 days prior to SDR Subsystem-level Reqts Specs (Includes GSE): Initial 45 days prior to SDR Final 45 days prior to PDR Component-level Reqmts Specs (Includes GSE): Final concurrent with the Contractor Specification approval All levels: Update as required after Final delivery. * System-level and Module-level, = Type 1. Subsystem-level Requirements Specifications and Component-level Requirements Specifications =Type 4.

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-032	CEV Specification and Drawing Trees	3				U 45 Days Prior		F/I 45 Days Prior See notes	F 45 Days Prior See notes	U 45 Days Prior		I,U	Specification Tree: Initial 50 days prior to CEV SRR Update 45 days prior to SDR Final 45 days prior to PDR Drawing Tree: Initial 45 days prior to PDR (Type 4) Final 45 days prior to CDR and CDR SSDR (Type 4) Update 45 days prior to EM-2 Delivery (Type 3) Update as required after Final delivery. * Due 45 Days Prior to CDR SSDR
CEV-T-033	Architecture Design Document	4				F 45 Days Prior		U 28 Days Prior	U 28 Days Prior			U	Update as required after Final delivery to support PDR, CDR and Point-of-Departure kick-off activities.
CEV-T-034	Reserved												
CEV-T-035	Reserved												

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-036	Margins Management Plan/Report	3/4*				I 45 Days Prior		F 45 Days Prior				U	This DRD consists of two products: a Margin Management Plan and monthly reports. The Margin Management Plan shall be submitted: Initial 45 days prior to SDR and Final 45 days prior to PDR Margin Management Reports shall be submitted by the 4th Monday of each month and at each major review. * Plan = Type 3. Reports = Type 4
CEV-T-037	Qualification Test Plans & Procedures	3							F* 45 Days Prior			U	*Program Qualification Test Approach shall be delivered as part of the MVP (CEV-T-015) 45 days prior to CDR. Discrete Qualification Test Plans shall be delivered 60 days prior to Test/TRR.
CEV-T-038	Qualification Test Report	3										F	As-Run Test Procedures and results delivered 2 months after each test completion May be included or referenced as part of CDP (CEV-T-017)
CEV-T-039	Acceptance Test Plans & Procedures	3							F* 45 Days Prior			U	*Program Acceptance Test Approach shall be delivered as part of the MVP (CEV-T-015) 45 days prior to CDR. Discrete Acceptance Test Plan delivered 60 days prior to TRR. Acceptance Test Plans may be combined with Qualification Test Plan (CEV-T-037), as appropriate.

DRD	**Title**	**Type**	**Submission Events (See Note: 1 & 2)**										**Notes**
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-040	Acceptance Data Package	**2/4**								**F 45 Days Prior**		**F**	Acceptance Data Packages shall be completed at the J-9 Delivery Level (e.g., Spacecraft, LAS, and GSE) per the DRD description. Lower level HW/SW ADPs (e.g., component) shall be made available to NASA, via the contractor controlled repository, for NASA review and concurrence to promote an incremental review strategy per the DRD description. EM-1 and EM-2 = Type 2. Flight Test Vehicles (AA-2) = Type-4 EFT-1: Not applicable
CEV-T-041	CEV Instrumentation Plan	**2**						**I 45 Days Prior**	**F* 45 Days Prior**			**U**	Some parts of this DRD (e.g. the calibration provision, the ground data reduction process) may continue to evolve as the design matures and will need to be updated after baseline. Plan (Type 2) Master Measurement List (Type 4) * Due 28 Days Prior to CDR
CEV-T-042	Mass Properties Control Plan	**2**				**F 45 Days Prior**						**U**	Update as required
CEV-T-043	Mass Properties Reports	**4**				**I 45 Days Prior**		**U 45 Days Prior**	**U* 28 Days Prior**	**F 45 Days Prior**	**U 45 Days Prior**	**U**	In addition to the formal deliveries at major project milestones, mass properties reports will be needed on a periodic and as-requested basis to support design and integration activites. Mass properties updates will be required throughout the life of the CEV Project for each production spacecraft by mission. * Due 28 Days Prior to CDR

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-044	CEV MMOD Analysis Report	2						I 45 Days Prior	U* 28 Days Prior	F 45 Days Prior			* Due 28 Days Prior to CDR
CEV-T-045	CEV Space Radiation Analysis and Certification Report	3				I 45 Days Prior		U 45 Days Prior	U* 28 Days Prior	F** 45 Days Prior		U	Reports to be delivered at major project milestones and as needed for the design and integration of the MPCV System. * Due 28 Days Prior to CDR SSDR **Final System Level Assessment is only required for EM-2 due 45 days prior to SAR
CEV-T-046	CEV Data and Command Dictionary	3						I 45 Days Prior	U* 28 Days Prior	U 45 Days Prior	F 45 Days Prior	U	Living document maintained throughout design and operation. * Due 28 Days Prior to CDR Software SSDR
CEV-T-047	Avionics Design and Data Book	3						I 7 Days Prior	U* 20 Days Prior	F 45 Days Prior	U 45 Days Prior		Design and data books are intended to be living documents maintained throughout the design and development process. By Acceptance Review the design and data books should transition to operational data books. Databooks will include unique data items/content and may reference previously delivered data (e.g., drawings, specs, models) * Due 28 Days Prior to CDR Avionics SSDR Vol 006: Due 45 Days Prior to SwCDR Board

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-048	Software Requirements Specification	**1/3/4**					**I**	**F 210 days after PDR Board**	**See notes***			**U,F**	All levels: SRS Final after PDR + 210 days. Updates as required to display format dictionary though EM-2 Delivery. The Display format and associated Simulation Software SRSs to be provided in NASA approved increments between PDR and CDR. The 75% complete versions of these SRSs shall be provided by SwCDR, with the final versions provided at 60 days post SwCDR. Update as required after Final delivery. * Vols 013 FSW D&C, 070 Sim D&C, unnumbered SRSs for simVTB, simITL, simSSDL, BFCS, EGSE ELAB: Due 45 Days Prior to SwCDR Board Software Deliverables: Flight Software is Type 1. Ground Software and Simulation Software is Type 3. Non-Deliverable Levels = Type 4
CEV-T-049	Monthly Software Metrics Report	**4**					**I 45 Days Prior**					**U**	Other = Monthly by **the 22nd** of the reporting month after the initial submission at SwRR.

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-050	Software Design Description	4					I	I 210 days after PDR	F 45 Days Prior to SwCDR Board			U	One document delivered per CSCI. All levels: Update as required after Final delivery.
CEV-T-051	Reserved												
CEV-T-052	Software Test Plan	2					I	U 210 days after PDR Board	F 45 Days Prior to SwCDR Board			U	All levels: Update as required after Final delivery.
CEV-T-053	Software Test Description	2/3							I 45 Days Prior to SwCDR Board			U	All levels: Update as required after Final delivery. Deliver final test descriptions 2 weeks prior to relevant SW TRR; deliver As-Run test descriptions as an appendix of Software Test Report (T-054). Flight Software = Type 2 Ground Software = Type 3

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-054	Software Test Report	**2/3**								**F 45 Days Prior**		**U**	One document delivered per CSCI. Redelivered in conjunction with each formal verified software release. Flight Software = Type 2 Ground Software = Type 3 Ground Software shall be submitted at the system level.
CEV-T-055	Software Maintenance Plan	**2**						**I 210 days After PDR Board**	**I* 45 Days Prior to SwCDR Board**	**F****			*Initial at appropriate S/W TRR **Final SMP due 45 days prior to EM-2 Delivery
CEV-T-056	Software User Manual	**3**							**I 45 Days Prior to SwCDR Board**	**F 45 Days Prior**			Flight Software = SUM at Flight Software System Level. Simulation & Test Software and Electrical Ground System Equipment (EGSE) Software SUM at Facility / Test Set Level only.
CEV-T-057	Software Version Description Document	**3/5**								**F**			SVDs delivered in conjunction with each formal software CSCI release as identified in J9 (CEV-T-048) of Class A/B/C SW = Type 3. All other SVDs delivered with software CSCI releases = Type 5. Delivery can be referenced in appropriate ADP CEV-T-040 / CDP CEV-T-017.

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-058	Radio Frequency/Optical ICDs	1						I 20 Days Prior	F 20 Days Prior			U	Update as required after Final delivery.
CEV-T-059	Electrical Power System (EPS) Design and Data Book	3						I 20 Days Prior	U* 20 Days Prior	F 45 Days Prior	U 45 Days Prior		Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books. Databooks will include unique data items/content and may reference previously delivered data (e.g., drawings, specs, models) * Due 20 Days Prior to PDR EPS SSDR and CDR EPS SSDR FRR update only if required
CEV-T-060	Electrical Power Quality Specification Requirements Document	2				F 45 Days Prior						U	Update as required.
CEV-T-061	Mechanical Systems Design and Data Book	3						I 20 Days Prior	U* 20 Days Prior	F 45 Days Prior	U 45 Days Prior		Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books. Databooks will include unique data items/content and may reference previously delivered data (e.g., drawings, specs, models) * Due 20 Days Prior to PDR SSDR and CDR SSDR FRR update only if required

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-062	Stress Analysis Report	2						I 7 Days After PDR Board	U* 28 Days Prior	F 45 Days Prior	U 45 Days Prior		* Due 28 Days Prior to CDR SSDR FRR update only if required
CEV-T-063	Passive Thermal Control Design and Data Book (PTCDDB)	3						I 20 Days Prior	U* 20 Days Prior	F 45 Days Prior	U 45 Days Prior		Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books. Databooks will include unique data items/content and may reference previously delivered data (e.g., drawings, specs, models) * Due 20 Days Prior to PDR SSDR and CDR SSDR FRR update only if required
CEV-T-064	Passive Thermal Control Mathematical Models and Documentation	3/4				I 45 Days Prior		U 20 Days Prior	U* 20 Days Prior	F 45 Days Prior			Initial and Update Deliveries (Type 4) Final Delivery (Type 3) * Due 20 Days Prior to PDR SSDR and CDR SSDR FRR update only if required
CEV-T-065	Thermal Protection System Design and Data Book (TPSDDB)	3						I 20 Days Prior	U* 20 Days Prior	F 45 Days Prior	U 45 Days Prior		Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books. Databooks will include unique data items/content and may reference previously delivered data (e.g., drawings, specs, models) * Due 20 Days Prior to PDR SSDR and CDR SSDR FRR update only if required

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-066	Thermal Protection System Mathematical Models and Documentation	3				I 45 Days Prior		U 20 Days Prior	U* 20 Days Prior	F 45 Days Prior			*Due 20 Days Prior to PDR SSDR and CDR SSDR Final Delivery (Type 3) FRR update only if required
CEV-T-067	Reserved												
CEV-T-068	Structures Mathematical Models and Documentation	3				I 45 Days Prior		U 20 Days Prior	U* 20 Days Prior	F 45 Days Prior	U 45 Days Prior		*Due 20 Days Prior to PDR SSDR and CDR SSDR Final Delivery (Type 3) FRR update only if required
CEV-T-069	Fracture Control Plan	2						F 45 Days Prior				U	Other: Update as required
CEV-T-070	Fracture Control Summary Report	2							I* 28 Days Prior	F 45 Days Prior	U 45 Days Prior		* Due 28 Days Prior to CDR FRR update only if required

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-071	Propulsion Systems Design and Data Book	3						I 20 Days Prior	U* 20 Days Prior	F 45 Days Prior	U 45 Days Prior		Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books. Databooks will include unique data items/content and may reference previously delivered data (e.g., drawings, specs, models) * Due 20 Days Prior to PDR SSDR and CDR SSDR FRR update only if required
CEV-T-072	Reserved												
CEV-T-073	Environmental Control and Life Support and Suit Design and Data Book	3						I 20 Days Prior	U* 20 Days Prior	F 45 Days Prior	U 45 Days Prior		Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books. Databooks will include unique data items/content and may reference previously delivered data (e.g., drawings, specs, models) * Due 20 Days Prior to PDR SSDR and CDR SSDR FRR update only if required

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-074	Crew Health, Survival, Habitation Accommodations /Stowage and EVA Systems Design and Data Book	3						I 20 Days Prior	U* 20 Days Prior	F 45 Days Prior	U 45 Days Prior		Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books. Databooks will include unique data items/content and may reference previously delivered data (e.g., drawings, specs, models) * Due 20 Days Prior to PDR SSDR and CDR SSDR FRR update only if required
CEV-T-075	Pyrotechnic Subsystem Design and Data Book	3						I 20 Days Prior	U* 20 Days Prior	F 45 Days Prior	U 45 Days Prior		Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books. Databooks will include unique data items/content and may reference previously delivered data (e.g., drawings, specs, models) * Due 20 Days Prior to PDR SSDR and CDR SSDR FRR update only if required

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-076	Recovery Systems Design and Data Book	3						I 20 Days Prior	U* 20 Days Prior	F 45 Days Prior	U 45 Days Prior		Drop testing-related documentation to be delivered as addendum to databook during drop test program. Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books. Databooks will include unique data items/content and may reference previously delivered data (e.g., drawings, specs, models) * Due 20 Days Prior to PDR SSDR and CDR SSDR FRR update only if required
CEV-T-077	Recovery Systems Simulation Models and Documentation	3						I 20 Days Prior	U* 20 Days Prior	F 45 Days Prior	U 45 Days Prior		*Due 20 Days Prior to PDR SSDR and CDR SSDR FRR update only if required
CEV-T-078	GN&C Design and Data Book	3						I 20 Days Prior	U* 20 Days Prior	F 45 Days Prior	U 45 Days Prior		Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books. Databooks will include unique data items/content and may reference previously delivered data (e.g., drawings, specs, models) * Due 20 Days Prior to PDR SSDR and CDR SSDR FRR update only if required
CEV-T-079	Reserved												

DRD	Title	Type	Submission Events (See Note: 1 & 2)										Notes
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-080	CEV Vehicle Wiring Configuration, Identification, and Definition Reports	3/4							I* 28 Days Prior	F 45 Days Prior		U	Database maintenance will be required throughout the life of the CEV Project. Reports will be provided as needed to status wiring progress and to support design and integration activities for the CEV System. Initial and Update Deliveries (Type 4) Final Delivery (Type 3) * Due 28 Days Prior to CDR Wiring SSDR
CEV-T-081	Launch Abort System Design and Data Book	3						I 20 Days Prior	U* 20 Days Prior	F 45 Days Prior	U 45 Days Prior		Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books. Databooks will include unique data items/content and may reference previously delivered data (e.g., drawings, specs, models) * Due 20 Days Prior to PDR SSDR and CDR SSDR FRR update only if required
CEV-T-082	Reserved												
CEV-T-083	Reserved												
CEV-T-084	Reserved												
CEV-T-085	Reserved												

DRD	**Title**	**Type**	**Submission Events (See Note: 1 & 2)**										**Notes**
			Proposal	ATP	IBR	SDR	SwRR	PDR (See Note: 3)	CDR	SAR/DCR (See Note: 4)	FRR	Other	
CEV-T-086	Manufacturing and Assembly Plan	**2**						**I 45 Days Prior**	**F* 28 Days Prior**				* Due 28 Days Prior to CDR AI&P SSDR
CEV-T-087	Reserved												
CEV-T-088	CEV Imagery Plan/Imagery Deliverables	**2/3***						**F 45 Days Prior**				**U**	CEV Imagery Plan - Final 45 days prior to PDR. CEV Imagery Deliverables - Imagery loaded to ICE as images are processed and catagorized. * Plan = Type 2. Deliverables = Type 3.
CEV-T-089	Orion Crew Interface Label Map*	**2**						**I 6 Months after**	**U* 45 Days Prior**	**F 45 days prior**	**U 45 days prior**	**U***	The Orion Crew Interface Label Map is intended to be a living document maintained throughout the design and development process. Interim deliveries of the document prior to fabrication of labels may be needed for coordination with NASA. PDR and CDR deliveries are Type-4 all subsequent deliveries follow Type-2 document delivery process. Deliveries are applicable to support EM2. * Due 45 Days Prior to CDR SSDR FRR update only if required
CEV-T-090	Environments Definition Document	**2**						**I 20 Days Prior**	**F 45 Days Prior**			**U**	Update as required to support procurement schedule Initial at PDR

Notes:

1. Data deliveries prior to the Final delivery for Type-1, Type-2, and Type-3, unless directed otherwise in the Notes column, shall be treated as Type-4 data per Section 1.3 of the Data Procurement Document. The Final delivery and all subsequent deliveries shall be made in accordance to the specified data Type for the DRD.
2. Data deliveries to support the various elements of a millstone review, such as Subsystem Design Reviews (SSDRs) for PDRs and CDRs, shall be in accordance with the Program agreed to review plan.
3. The contractor shall update any previously delivered data products as necessary to reflect the EM-1 and EM-2 Program Baseline, to meet the maturity expectations for PDR, in accordance with the Program agreed to review plan.
4. Assume an integrated System Acceptance Review (SAR) and Design Certification Review (DCR) for each delivered vehicle (e.g., AA-2, EM1 and EM2). Additionally, lower level (e.g., component) certifications and acceptance reviews will occur incrementally. Acceptance Data Packages (ADPs) or Certification Data Packages (CDPs) will be delivered with the applicable deliverable items as defined in J-9.

ATTACHMENT J-3

February 21, 2014

APPLICABLE, MEETS OR EXCEEDS, AND INFORMATIONAL DOCUMENTS LIST

Note – DRD and reference columns for updated documents are not fully defined

TABLE OF CONTENTS

INTRODUCTION

This attachment includes documents classified as Applicable, Meets or Exceeds, and Informational to the MPCV Program, including the definitions of how these should be applied.

Items listed in the Applicable, Meets or Exceeds, and Informational Documents will contain some items that have been determined as export controlled documents. These documents are so marked and anyone with access to the documents must comply with the export control law. This includes both control and disclosure of any said documents. Other documents and data listed may not contain any restrictions, however before the release of any information or data the Contractor shall make a determination as to the applicability of U.S. export control laws and regulations.

1.0 APPLICABLE DOCUMENTS

In addition to the regulations and procedures identified elsewhere in this contract, the Contractor shall comply with the following regulations and procedures to the extent that they are employed in the Statement of Work (SOW) or Data Requirements Documents (DRDs). Applicable document versions that are in effect at CFI release constitute requirements for this contract. Any applicable and reference documents embedded in the applicable and meets or exceeds documents listed in this attachment shall not be applicable unless overtly specified as applicable in the SOW or DRDs.

For Applicable Documents, the use of alternate applicable documents in place of the ones specified in this list is not permitted.

ID	Document Version/Date	APPLICABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
ANSI/EIA-748		Earned Value Management Systems	CEV-B-003	
MPCV-70022-02	Rev. A 12/6/13	MPCV Program Command, Control, Communication, And Information (C3I) Interoperability Standards Book, Volume 2: Spectrum And Channel Plan	CEV-T-047, CEV-T-058, CEV-T-026	2.6.1, 2.6.3
MPCV-70022-04 Includes Applicability Matrix VOL4-REVA-APPLICABILITY-072118	Baseline 12/12/12	MPCV Program Command, Control, Communication and Information (C3I) Interoperability Standards Book, Volume 4: Information Representation Specification	CEV-T-046, CEV-T-047, CEV-T-058	2.6.1, 2.6.3
MPCV-70022-05	Baseline 12/12/12	MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Book, Volume 5: Data Exchange Protocol Specification	CEV-T-047, CEV-T-058	2.6.1, 2.6.3
MPCV-70022-08	Baseline 12/12/12	MPCV Program Command, Control, Communication, and Information (C3I) Interoperability Standards Book, Volume 8: Common Command and Control Functional Requirements	CEV-T-047, CEV-T-048	2.6.1,2.6.3
CXP-70152	Rev A 11/2/09	Constellation Program Crew Interface Labeling Standard	CEV-T-089	2.8.7
CxP 70199	Rev A 9/24/2010	Constellation Program Pyrotechnic Specification	CEV-T-075	2.6.13, 6.1.3.13, 6.2.3.13, 6.4.3.13
CxP 72095	Baseline March 1, 2007	Crew Exploration Vehicle (CEV) Thermal Protection System Design Standard	TBD	6.1.3.8
MPCV-72167	Latest MPCB Approved version	Orion Aerodynamic Database (for all phases of flight)		2.3.(c), 10.6. 4

ID	Document Version/Date	APPLICABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
MPCV-72168	Latest MPCB Approved version	Orion Aerothermodynamic Database (for all flight phases)		2.3.(c), 10.6. 4
CXP-72242	Rev A 9/8/10	Orion Display Format Standards Document		2.5 (f), 6.5.2 (g)
MPCV 72385	DAC-2 Release, VICB approved 12-11-2013	CEV Government Furnished Data for Orion System Design and Analysis Note: **(Rev DRAFT 5/8/2013 Launch Vehicle environments applied to LAS structural design; Assessment of LAS shall be performed to latest Launch Vehicle environments in the 12-11-2013 release.)**		2.3a), 2.4, 2.6.9, 2.8.1, 6.1.3.9, 6.2.3.9, 6.4.3.9
MPCV 72465	Baseline 4/25/13	Orion MPCV Program EFT-1 and Ascent Abort 2 (AA-2) Flight Objectives	D-007, D-008	10.6.4.1
CxP 72506	14 June 2011	Crew Exploration Vehicle (CEV) Orion Standard for the Design and Fabrication of Ground Support Equipment (Note: CxP 72506 reflects tailoring recommended by LM)	CEV-D-006, CEV-O-008	2.7.2.(e), 6.1.6.1, 6.2.6.1, 6.4.6.1, 10.6.6
FIPS 140-2	25 May 2001	Security Requirements for Cryptographic Module		2.6.3
FIPS-197	26 Nov. 2001	Advanced Encryption Standard		2.6.3
FTO-AFT-FTA-004	Rev F 6 Aug. 2008	Flight Test Article System Requirements Document (PA-1)	CEV-D-002	10.6.4
IS-GPS-200	Rev D Dec 2004	Navstar GPS Space Segment/Navigation User Interfaces	CEV-T-058	2.6.3
JPR 8080.5, E-6	Rev A 15 March 2005	JSC Design and Procedural Standard E-6, Corona Suppression	CEV-T-024	2.8.4

ID	Document Version/Date	APPLICABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
JPR 8080.5, M/S-11	Rev A 15 March 2005	JSC Design and Procedural Standards, Section M/S-11, Meteoroid and Orbital Debris Protection Levels for Structures	CEV-T-044	2.8.2
JSC 20584	June 1999	Spacecraft Maximum Allowable Concentrations for Airborne Contaminants	CEV-T-073, CEV-T-074	2.6.12, 6.1.3.9, 6.2.3.9, 6.4.6.9
JSC 62550	Sept. 2006	Strength, Design and Verification Criteria for Glass, Ceramics and Windows in Human Space Flight Applications		2.6.9
CxP 72407	Baseline 10/29/09	Orion Crew Exploration Vehicle Window Optical Properties Requirements		
MPCV-70022-01	Rev. A 12/6/13	Multi-Purpose Crew Vehicle (MPCV) Program Command, Control, Communication, and Information (C3I) Interoperability Standards Book, Volume 1: Interoperability Specification	CEV-T-026, CEV-T-047, CEV-T-058	2.6.1, 2.6.3
MPCV-70024	Baseline 9/7/12	Multi-Purpose Crew Vehicle (MPCV) Program Human-Systems Integration Requirements (HSIR)	CEV-T-045, CEV-T-089	2.6, 2.7.1, 2.8.7, 2.8.3, 6.1.3, 6.2.3, 6.4.3
MPCV-70026	Rev B 4/4/13	Orion Multi-Purpose Crew Vehicle (MPCV) Program-to-Space Launch System (SLS) Program Interface Requirements Document (IRD)		*2.3.(a)*
MPCV-70028	Rev B 7/17/13	Multi-Purpose Crew Vehicle (MPCV) to Ground Systems Development and Operations (GSDO) Interface Requirements Document (IRD)	CEV-T-026, CEV-T-058	*2.3.(a)*
MPCV-70029	Rev A 10/10/12	Multi-Purpose Crew Vehicle (MPCV) Program: Orion-to-Mission Systems (MS) Interface Requirements Document (IRD)	CEV-T-026, CEV-T-058	*2.3.(a)*
MPCV-70068	Baseline July 26, 2012	Orion Multi-Purpose Crew Vehicle (MPCV) Program Problem Reporting, Analysis and Corrective Action (PRACA) Requirements	CEV-S-013	
MPCV 70080	Baseline, 9/18/2013	Cross Program Electromagnetic Environmental Effects (E3) Requirements Document		
MPCV-70118-01	Baseline 9/7/12	Multi-Purpose Crew Vehicle (MPCV) Program: Systems-to-Communications and Tracking Network (CTN) Interface Requirements Document (IRD), Volume 1: Orion	CEV-T-026, CEV-T-058	2.3 (a)

ID	Document Version/Date	APPLICABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
MPCV 70135	Preliminary Baseline CR MPCV-0075 Version+ LM Comments	Orion MPCV Program: Structural Design and Verification Requirements (SDVR)		
MPCV-70146	Baseline June 7, 2012	Orion Multi-Purpose Crew Vehicle (MPCV) Program Acceptance Data Package (ADP) Requirements	CEV-T-040	2.2.1c, 2.2.2c, 6.1.4c, 6.1.4g, 6.2.1.1f, 6.4i, 6.5j, 9.2p, 9.2s
MPCV-72000	Rev A, 7/10/2013	Multi-Purpose Crew Vehicle (MPCV) System Requirements Document (SRD)	CEV-M-001, CEV-M-002, CEV-O-001, CEV-S-009, CEV-T-031, CEV-T-034	Scope, 1.1, 2.2, 2.3.(c), 3.1, 6.1.3, 6.1.6.1, 6.2.3, 6.2.6.1, 6.4.3, 6.4.6.1, 6.5.3, 2.6 (b),2.7.2 (e), 6.1.6.2,6.4.6.2
MPCV-72091	Rev A 5/6/13	Orion Multi-Purpose Crew Vehicle (MPCV) Program Integrated Risk Management Plan		
MPCV-72093	Rev A (CR0087 version)	Orion Multi-Purpose Crew Vehicle (MPCV) Program Concept of Operations (CONOPS)		
MPCV 72223	Baseline 4/17/13	Orion MPCV Mishap Preparedness and Contingency Plan		
MPCV-72524	Baseline July 2, 2012	Orion Multi-Purpose Crew Vehicle (MPCV) Operations Nomenclature Plan		
MSFC-STD-3029	Rev A 24 Feb. 2005	Guidelines for the Selection of Metallic Materials for Stress Corrosion Cracking Resistance in Sodium Chloride Environments	CEV-T-020	

ID	Document Version/Date	APPLICABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
NASA TP-2003-210788	April 2003	Meteroid/Debris Shielding, 2003, Section 2 for describing the MMOD risk assessment process using Bumper code	CEV-T-044	2.1.9.2
National Council on Radiation Protection and Measurements Report No. 132	2000	National Council on Radiation Protection and Measurements Report No. 132: Radiation Protection Guidance for Activities in Low-Earth Orbit	CEV-T-045	2.8.3
NIST FIPS PUB 180-3	**October 2008**	Secure Has Signature Standard (SHS)		1.3b
NIST SP811	March 2008 Edition, Appendix B	Guide for the Use of the International System of Units (SI) for Standardization and Conversion of the Units of Measure., Appendix B		
NPD 9501.1G	May 22, 2000	NASA Contractor Financial Management Reporting System		
NPR 1600.1 (Chapter 4, 6, and 8 only)	3 November 2004	NASA Security Program Procedural Requirements w/Change 2 (4/01/2009)		
NPR 2810.1A	16 May 2006	Security of Information Technology	H-20?	1.1.e
NPR 6000.1G	28 March 2005 – 28 March 2008	Requirements for Packaging, Handling, and Transportation of Aeronautical and Space Systems, Equipment, and Associated Components	CEV-T-011	
NPR 8580.1	26 Nov. 2001 – 26 Nov. 2006	Implementing the National Environmental Policy Act and Executive Order 12114		10.1
NPR 8621.1B	03/15/2010	NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping w/Change 5	CEV-S-004	3.3
NPR 8715.5A	September 17, 2010	Range Safety Program	CEV-O-007	2.7.4, 3.3
NPR 9501.2D	May 23, 2001	NASA Contractor Financial Management Reporting	CEV-B-001, CEV-M-002	
NSTS 08307	Rev A 6 July 1998	Space Shuttle Criteria for Preloaded Bolts		2.6.9

ID	Document Version/Date	APPLICABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
OSHA Standards 29 CFR		Supplementary Standards 1960.18	~~CEV-S-005,~~ CEV-T-045	2.8.3
SLS-SPEC-048	Rev B	Space Launch System (SLS) Program Integrated Vehicle Coordinate System		
SLS-SPEC-159	Rev A , 12-11-2013	Cross-Program Design Specification for Natural Environments (DSNE)		
S0300-BT-PRO-010	Nov. 1994	Government-Industry Data Exchange Program (GIDEP) Operations Manual	CEV-S-001, CEV-S-012	

1.1 APPLICABLE AND MEETS OR EXCEEDS DOCUMENT CHILDREN

For the following applicable or meets or exceeds documents, their embedded applicable children documents identified in the Approved Children Table are also applicable or meets or exceeds depending on the parent document's category or as otherwise indicated:

- CxP-72506, Crew Exploration Vehicle (CEV) Orion Standard for the Design and Fabrication of Ground Support Equipment
    - All documents listed in Section 2.2 of CxP-72506 are applicable to this contract.
- CxP 70199, Constellation Program Pyrotechnic Specification
- NASA-STD-6016 Standard Materials and Processes Requirements for Spacecraft
- MPCV-70022, Multi-Purpose Crew Vehicle (MPCV) Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books Volumes 1 and 4
- SLS-SPEC-159, Cross-Program Design Specification for Natural Environments (DSNE)
- MPCV-70059, Multi-Purpose Crew Vehicle (MPCV) Program Safety and Mission Assurance (S&MA) Requirements
- JPR 8080.5, JSC Design and Procedural Standards
- MPCV-70024, Multi-Purpose Crew Vehicle (MPCV) Program Human- Systems Integration Requirements (HSIR)
- MPCV-72000, Multi-Purpose Systems Requirement Document (SRD)
    - CxP 72407, Orion Crew Exploration Vehicle Window Optical Properties Requirements
- MPCV-70026, Orion Multi-Purpose Crew Vehicle (MPCV) Program-to-Space Launch System (SLS) Program Interface Requirements Document (IRD
- MPCV-70135 (Implementation Tailoring)– Structural Design and Verification Requirements
- FTO-AFT-FTA-004, Flight Test Article System Requirements Document
- CxP 72385 CEV Government Furnished Data for Orion System Design and Analysis
- Note – Typically the children section does not duplicate Section 1.0 Applicable Documents.

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
PARENT APPLICABLE DOCUMENT		**PARENT APPLICABLE DOCUMENT: CxP 72506, Crew Exploration Vehicle (CEV) Orion Standard for the Design and Fabrication of Ground Support Equipment**	CEV-D-006, CEV-O-008	2.7.2.(e), 6.1.6.1, 6.2.6.1, 6.4.6.1, 10.6.6
		CxP 72506 Approved Children—all documents listed in Section 2.2		
PARENT APPLICABLE DOCUMENT		**PARENT APPLICABLE DOCUMENT: CxP 70199 Rev A Constellation Program Pyrotechnic Specification**	CEV-T-075	2.6.13, 6.1.3.13, 6.2.3.13, 6.4.3.13
		CxP 70199 Approved Children		
AFJMAN 24-204	12 Oct 2004 Suppl1 – 1 Dec 2004	Preparing Hazardous Materials for Military Air Shipments		2.6.13
ASTM E 1742		Standard Practice For Radiographic Examination		2.6.13
ASTM E 8		Standard Test Methods of Tension Testing of Metallic Materials		2.6.13
JPR 8080.5	Rev A 15 March 2005	JSC Design and Procedural Standards E-1, G-2, G-12, P-1, P-6		2.6.13
JSC 20431	Rev A 7 Nov. 2002	NASA JSC Neutron Radiography Specification		2.6.13
JSC 65877	Rev NC	Specification for HNS Explosive		2.6.13
JSC/SKD 26100132	Rev B	Performance Specification for NSTS Use of Percussion Primers		2.6.13

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
MIL-DTL-398	Rev D: Part 1 - 12 Dec.1996; Part 2 – 17 April 1999	RDX (Cyclotrimethylenetrinitramine)		2.6.13
MIL-DTL-45444	Rev C: 17 April 1996; Amend. 1: 17 Apri; 1999	HMX (Cyclotetramethylenetetranitramine)		2.6.13
MIL-L-3055	Rev C 12 Jan. 1993 Amend. 1 – 19 March 1993	Type I Lead Azide		2.6.13
MIL-L-46225	Rev C Aug. 1968 Amend 3 – 11 May 1990	Lead Azide RD-1333		2.6.13
MIL-P-20444C	Amend. 1 – 31 Aug.2000 Notice 1 – 19 March 1986 Notice 2 – March 1997	Primer, Percussion, M42 Parts for and Loading, Assembling and Packaging		2.6.13

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
MIL-P-387	Rev C 8 Dec. 1976 Amend. 1 – 26 March 1990 Amend: 2 – 26 July 1994	Pentaerythrite Tetranitrate (PETN)		2.6.13
MIL-STD-2073-1	December 1999	Department of Defense Standard Practice for Packaging		2.6.13
MIL-STD-286	Rev C 8 Aug. 1991 CN 1 – 18 Jan 1994	Military Standard Propellants, Solid: Sampling Examination and Testing; Method 802.1		2.6.13
MIL-STD-810F	Rev F 1 Jan. 2000	DOD Test Method Standard for Environmental Engineering Considerations and Laboratory Tests	CEV-T-073	2.6.12, 6.1.3.12, 6.2.3.12
MS20003	**5 June 2003**	Indicator, Humidity, Card Three Spot, Impregnated Areas		2.6.13
SAE-AS-8879		Screw Threads-UNJ Profile, Inch Controlled Radius Root with Increased Minor Diameter		2.6.13
WS 5003	Revision F	Material Specification for HNS Explosive		2.6.13
PARENT APPLICABLE DOCUMENT		**PARENT APPLICABLE DOCUMENT: NASA-STD-6016, Standard Materials and Processes Requirements for Spacecraft**		
		NASA-STD-6016 Approved Children		
ASTM E1548		Standard Practice for Preparation of Aerospace Contamination Control Plans		

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES DRD	 SOW
NASA-STD-6001		Flammability, Odor, Off-Gassing and Compatibility Requirements & Test Procedures for Materials in Environments that Support Combustion (Superseding NHB-8060.1C)		
PARENT APPLICABLE DOCUMENT		**PARENT APPLICABLE DOCUMENT: MPCV-70022, Multi-Purpose Crew Vehicle (MPCV) Program Command, Control, Communication, and Information (C3I) Interoperability Standards Books, Volume 1**	CEV-T-026, CEV-T-047, CEV-T-058	2.6.1, 2.6.3
		MPCV-70022 V1 Approved Children		
IEEE 802.3-2008		IEEE Standard for Information Technology—Section 3, Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements. Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) access method and physical layer specifications		
RFC-1918		Address Allocation for Private Internets (Internet Engineering Task Force (IETF, http://www.ietf.org)) (Section 3 – Private Address Space)		
RFC-3171		IANA Guidelines for Ipv4 Multicast Address Assignments (Internet Engineering Task Force (IETF, http://www.ietf.org)) (Section 2, 3, 4, 5, 6, 7, 8, 9)		
RFC-1812		Requirements for IP Version 4 Routers (Internet Engineering Task Force (IETF, http://www.ietf.org)) (Section 3 – LINK LAYER Section 4 – INTERNET LAYER – PROTOCOLS Section 5 – NTERNET LAYER – FORWARDING Section 10 – OPERATIONS AND MAINTENANCE)		
CCSDS 727.0-B-3	June 2005	CCSDS File Delivery Protocol (CFDP) – Recommended Standard (http://public.ccsds.org/publications/SpaceIntServ.aspx) Protocol (Consultative Committee for Space Data Systems		

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
STD-0005, RFC-791		Internet Protocol (IP) Specification, Version 4 (Internet Engineering Task Force (IETF, http://www.ietf.org)) (Section 1 – INTRODUCTION Section 2 – OVERVIEW Section 3 – SPECIFICATION Appendix B – Data Transmission Order)		
RFC-792		Internet Control Message Protocol (Internet Engineering Task Force (IETF, http://www.ietf.org)) (Message Formats Destination Unreachable Message Time Exceeded Message Parameter Problem Message Source Quench Message Redirect Message Echo or Echo Reply Message Timestamp or Timestamp Reply Message Information Request or Information Reply Message)		
RFC-3246		An Expedited Forwarding PHB (Per-Hop Behavior) (Internet Engineering Task Force (IETF, http://www.ietf.org)) (Section 2 – Definition of EF PHB)		
RFC-2474		Definition of the Differentiated Services Field (DS Field) in the Ipv4 and Ipv6 Headers (Internet Engineering Task Force (IETF, http://www.ietf.org)) (Section 2 – Terminology Used in This Document Section 3 – Differentiated Services Field Definition Section 4 – Historical Codepoint Definitions and PHB Requirements Section 5 – Per-Hop Behavior Standardization Guidelines)		
CCSDS 732.0.B-2	**Section 3**	AOS Space Data Link Protocol (Consultative Committee for Space Data Systems, http://www.ccsds.org) – Section 3		
CCSDS 131.0-B-1		TM Synchronization and Channel Coding (Consultative Committee for Space Data Systems, http://www.ccsds.org)(Sections 6 and 7. (Section 6 covers ASM and & covers randomization/de-randomization))		

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES DRD	 SOW
CCSDS 131.1-O-2	**Orange Book Issue 2 Sept. 2007**	Low Density Parity Check Codes for Use in Near Earth and Deep Space Applications (Consultative Committee for Space Data Systems http://www.ccsds.org)		
CCSDS 133.1-B-2	**July 2009**	Encapsulation Service		
CCSDS 135.0-B-4	**July 2009**	Space Link Identifiers		
RFC-2644		Changing the Default for Directed Broadcasts in Routers (IETF, http://www.ietf.org) (Section 3 – Recommendation)		
STD-0003, RFC-1122		Requirements for Internet Hosts – Communications Layers (Internet Engineering Task Force (IETF, http://www.ietf.org)) (Section 2 – LINK LAYER Section 3 – INTERNET LAYER PROTOCOLS Section 4.1 – USER DATAGRAM PROTOCOL – UDP)		
RFC-3140		Per Hop Behavior Identification Codes (Internet Engineering Task Force (IETF, http://www.ietf.org)) (Section 2 – Encoding Section 3 – Signaling the Class Selector Codepoints		
STD-0007, RFC-0793		Transmission Control Protocol (Internet Engineering Task Force (IETF, http://www.ietf.org)) (Section 3 – FUNCTIONAL SPECIFICATION)		
RFC-1323		TCP Extensions for High Performance (Internet Engineering Task Force (IETF, http://www.ietf.org)) (Section 2 – TCP WINDOW SCALE OPTION Section 3 – RTTM: ROUND-TRIP TIME MEASUREMENT Section 4 – PAWS: PROTECT AGAINST WRAPPED SEQUENCE NUMBERS)		
STD-0006, RFC-0768		User Datagram Protocol (Internet Engineering Task Force (IETF, http://www.ietf.org)) (Format Fields Only)		

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES DRD	 SOW
STD-0064, RFC-3550		RTP: A Transport Protocol for Real-Time Applications (Internet Engineering Task Force (IETF, http://www.ietf.org)) (Section 3 – Definitions Section 4 – Byte Order, Alignment, and Time Format Section 5 – RTP Data Transfer Protocol Section 8 – SSRC Identifier Allocation and Use)		
RFC-3551		RTP Profile for Audio and Video Conferences with Minimal Control (Internet Engineering Task Force (IETF, http://www.ietf.org)) Section 4.1 Encoding Independent Rules Section 4.2 Operating Recommendations Section 4.3 Guidelines for Sample Based Audio Encoding Section 4.4 Guidelines for Frame-Based Audio Encoding Section 4.5.6 Audio Encoding – G279 Section 7.0 RTP over TCP and Similar Byte Stream Protocols. Section 8.0 Port Assignments Section 10.0 Security Assignments)		
RFC-1305	Version 3	Network Time Protocol (NTP) Version 3 (http://www.ietf.org/rfc/rfc1305.txt) (Internet Engineering Task Force (IETF, http://www.ietf.org)) (Section 3 – Network Time Protocol Section 4 – Filtering and Selection Algorithms Section 5 – Local Clocks		
ITU G.729		Coding of speech at 8 kbit/s using conjugate-structure algebraic-codeexcited linear prediction (CS-ACELP) (International Telecommunications Union, (ITU, http://www.itu.ch))		
ITU H.264		Advanced Video Coding for Generic Audiovisual Services (http://www.itu.int/rec/recommendation.asp?type=folders&lang=e&parent=T-REC-H.264). (International Telecommunications Union, (ITU, http://www.itu.ch))		
FIPS PUB 197		Advanced Encryption Standard (AES) National Institute for Standards and Technology (NIST, http://www.nist.gov))		
FIPS PUB 180-3	**October 2008**	Secure Hash Algorithms (SHA), sections on Secure Hash Algorithms (SHA) SHA-1 and SHA-256 National Institute for Standards and Technology (NIST, http://www.nist.gov)) All sections except 4.1.3, 4.2.3, 5.1.2, 5.2.2, 5.3.3, 5.3.4, 6.3, 6.4		

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
FIPS PUB 198		Keyed-Hash Message Authentication Code (HMAC) method National Institute for Standards and Technology (NIST, http://www.nist.gov))		
C/S T.001	Oct. 2008 Revision 9	Specification for Cospas-Sarsat 406 MHz Distress Beacons (Sections 2 and 3)		
ITU-R M.633		Transmission characteristics of a satellite emergency position indicating radio beacon (satellite EPIRB) system operating through a low polar-orbiting satellite system in the 406 MHz band (International Telecommunications Union, (ITU, http://www.itu.ch)) (Sections 3 and 4)		
NPD 2570.5D	**October 17, 2005**	NASA Electromagnetic (EM) Spectrum Management		
451-PN CODE-SNIP	Revision 1	Space Network PN Code Libraries		
FAA TSOC91a		Emergency Locator Transmitter (ELT) Equipment		
RFC 2597	June 1999	Assured Forwarding PHB Group		
NIST SP 800-38D	Nov. 2007	Recommendation for Block Cipher Modes of Operation: Galois/ Counter Mode (GCM) and GMAC		
		THE FOLLOWING DOCUMENTS ARE APPLICABLE CHILDREN OF THE C3I CHILDREN DOCUMENTS LISTED ABOVE		
RFC-1112		Host Extensions for IP Multicasting (Section 4 – HOST GROUP ADDRESSES Section 6 – SENDING MULTICAST IP DATAGRAMS Section 7 – RECEIVING MULTICAST IP DATAGRAMS)		
RFC-1213		STD-0017 Management Information Base for Network Management of TCP/IP-based internets: MIB-II (Sections 4 and 6)		
RFC-1519		Classless Inter-Domain Routing (CIDR): an Address Assignment and Aggregation Strategy (Section 4 – Changes to inter-domain routing protocols and practices Section 7 – Domain Naming Service considerations)		

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
RFC-2119		Key words for use in RFCs to Indicate Requirement Levels (Section 1 – MUST Section 2 – MUST NOT Section 3 – SHOULD Section 4 – SHOULD NOT Section 5 – MAY)		
RFC-2287		Definitions of System-Level Managed Objects for Applications (Section 2 – The SNMPv2 Network Management Framework Section 5 – The Structure of the MIB Section 6 – Definitions)		
RFC-2385		Protection of BGP Sessions via the TCP MD5 Signature Option (Section 2 – Proposal Section 3 – Syntax)		
RFC-2578		Structure of Management Information Version 2 (SMIv2) (Section 2 – Definitions Section 3 – Information Modules Section 4 – Naming Hierarchy Section 5 – Mapping of the MODULE-IDENTITY macro Section 6 – Mapping of the OBJECT-IDENTITY macro Section 7 – Mapping of the OBJECT-TYPE macro Section 8 – Mapping of the NOTIFICATION-TYPE macro)		
RFC-2580		Conformance Statements for SMIv2 (Section 2 – Definitions Section 3 – Mapping of the OBJECT-GROUP macro Section 4 – Mapping of the NOTIFICATION-GROUP macro Section 5 – Mapping of the MODULE-COMPLIANCE macro Section 6 – Mapping of the AGENT-CAPABILITIES macro)		
RFC-2790		Host Resources MIB (Section 4 – Definitions)		
RFC-2863		The Interfaces Group MIB (Section 3 – Experience with the Interfaces Group Section 6 – Interfaces Group Definitions)		
RFC-2983		Differentiated Services and Tunnels (Section 4 – Ingress Functionality Section 5 – Egress Functionality)		

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
RFC-1155		Structure and Identification of Management Information for TCP/IP-based Internets (Section 3 – Structure and Identification of Management Information Section 4 – Managed Objects Section 6 – Definitions)		
RFC-1156		Management Information Base for Network Management of TCP/IP-based internets (Section 4 – Objects Section 5 – Object Definitions Section 6 – Definitions)		
RFC-3410		Introduction and Applicability Statements for Internet-Standard Management Framework (Section 2 – The Internet Standard Management Framework Section 6 – SNMPv3 Framework Module Specifications)		
RFC-3411		An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks (Section 3 – Elements of the Architecture Section 5 – Managed Object Definitions for SNMP Management Frameworks)		
RFC-3412		Message Processing and Dispatching for the Simple Network Management Protocol (SNMP) (Section 3 – Elements of Message Processing and Dispatching Section 4 – Dispatcher Elements of Procedure Section 5 – Definitions Section 6 – The SNMPv3 Message Format Section 7 – Elements of Procedure for v3MP)		
RFC-3413		Simple Network Management Protocol (SNMP) Applications (Section 3 – Elements Of Procedure Section 4 – The Structure of the MIB Modules Section 5 – Identification of Management Targets in Notification Originators Section 6 – Notification Filtering Section 7 – Mangement Target Translation in Proxy Forwarder Applications)		

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
RFC-3414		User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3) (Section 2 – Elements of the Model Section 3 – Elements of Procedure Section 4 – Discovery Section 5 – Definitions Section 7 – HMAC-SHA-96 Authentication Protocol Section 8 – CBC-DES Symmetric Encryption Protocol)		
RFC-3415		View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP) (Section 2 – Elements of the Model Section 3 – Elements of Procedure Section 4 – Definitions)		
RFC-3416		Version 2 of the Protocol Operations for the Simple Network Management Protocol (SNMP) (Section 3 – Definitions Section 4 – Protocol Specification)		
RFC-3417		Transport Mappings for the Simple Network Management Protocol (SNMP) (Section 2 – Definitions Section 3 – SNMP over UDP over Ipv4)		
RFC-3418		Management Information Base (MIB) for the Simple Network Management Protocol (SNMP) (Section 2 – Definitions)		
RFC-919		Broadcasting Internet Datagrams (Section 6 – Gateways and Broadcasts Section 7 – Broadcast IP Addressing – Proposed Standards)		
RFC-922		Broadcasting Internet datagrams in the presence of subnets (Section 4 – Broadcast Classes Section 5 – Broadcast Methods Section 6 – Gateways and Broadcasts Section 7 – Broadcast IP Addressing – Conventions)		
RFC-950		Internet standard subnetting procedure (Section 2.1 – Interpretation of Internet Addresses Section 2.2 – Changes to Host Software to Support Subnets)		

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES DRD	 SOW
FIPS PUB 180-1	**April 17, 1995**	FIPS PUB 180-1: Secure Hash Standard, April 1995. (Section 3 – Message Padding Section 6 – Constants Used Section 7 – Computing the Message Digest)		
FIPS PUB 197		FIPS PUB 197, "Advanced Encryption Standard (AES)," November 2001. (Section 2 – Definitions Section 3 – Notation and Conventions Section 5 – Algorithm Specification)		
RFC-2104		HMAC: Keyed-Hashing for Message Authentication (Sections 2, 5)		
RFC-3629		UTF-8, a transformation format of ISO 10646 (Section 2 – Notational conventions Section 3 – UTF-8 definition Section 4 – Syntax of UTF-8 Byte Sequences Section 5 – Versions of the standards Section 6 – Byte order mark (BOM))		
ISO/IEC 10646:2003, December 2003	December 2003	Information Technology – Universal Multiple-Octet Coded Character Set (UCS) (Appendix D – UCS Transformation Format 8 (UTF-8))		
PARENT APPLICABLE DOCUMENT		**PARENT APPLICABLE DOCUMENT: MPCV-70022, MPCV C3I Interoperability Standard Books, Volume 4**		
		MPCV-70022 V4 Approved Children		
CCSDS 301.0-B-3	Issue 3, January 2002	Time Code Formats. Recommendation for Space Data System Standards, Blue Book. Issue 3. Washington, D.C.: CCSDS, January 2002. http://public.ccsds.org/publications/archive/301x0b3.pdf		
CCSDS 660.1-B-1	Issue 1 Oct 2007	XML Telemetry and Command Exchange (XTCE)		

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
IEEE 754		IEEE Floating Point Standard http://en.wikipedia.org/wiki/IEEE_754 http://babbage.cs.qc.edu/courses/cs341/IEEE-754references.html		
ISO 8601:2000	2nd edition, 2000	Data Elements and Interchange Formats, Information Exchange, Representation of Dates and Times. International Standard, ISO 8601:2000. 2nd ed. Geneva: ISO, http://www.iso.org/iso/en/prods-services/popstds/datesandtime.html http://www.cl.cam.ac.uk/~mgk25/iso-time.html		
Unicode Standard	Version 5.0, Fifth Edition, 27 Oct. 2006	The Unicode Standard, Version 5.0, Fifth Edition, The Unicode Consortium, Addison-Wesley Professional, Oct. 27, 2006. ISBN 0321480910.		
PARENT APPLICABLE DOCUMENT		**PARENT APPLICABLE DOCUMENT: SLS-SPEC-159, Cross-Program Design Specification for Natural Environments (DSNE)**	CEV-T-044, CEV-T-045	2.8.1, 2.8.2, 2.8.3
		SLS-SPEC-159 Approved Children		
DRWP (Meet or Exceed)		KSC Doppler Radar Wind Profiler Data Base		
GGM02C		Gravity Recovery and Climate Experiment (GRACE) Gravity Model 02 C		
GRAM-2010	2010	Global Reference Atmospheric Model, 2010 Version (GRAM-2010)		
JWPD		Jimosphere Wind Profile Dataset		
GRAIL		Gravity Recovery and Interior Laboratory (GRAIL) Model		
MEM R2		Meteoroid Engineering Model (MEM)		
MVWPM		Monthly Vector Wind Profile Model		
KGWM		KSC Ground Wind Models		

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
ORDEM 2000	2000	Orbital Debris Engineering Model (ORDEM 2000)		
NASA-HDBK-1001		Terrestrial Environment (Climatic) Criteria Handbook for Use in Aerospace Vehicle Development		
RRA		Range Reference Atmosphere (RRA) Model		
SAE-ARP-5412 (Meet or Exceed)		Aircraft Lightning Environment		
SAE-ARP-5414 (Meet or Exceed)		Aircraft Lightning Zoning		
PARENT MEETS OR EXCEEDS DOCUMENT		**PARENT MEETS OR EXCEEDS DOCUMENT: MPCV-70059, Multi-Purpose Crew Vehicle Program Safety Mission Assurance (S&MA) Requirements**	CEV-S-001, CEV-S-014	3.5
		MPCV-70059 Approved Children		
ANSI/ESD S20.20-1999 (Meet or exceed)	1999	ESD Associa tion S tandard for the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)	CEV-S-01 7	
ANSI/NCSL Z540-2-1997 (R2002)	R2002	US Guide to the Expression of Uncertainty in Measurement		
AS9003		Inspection and Test Quality System		
AS9100B		Quality Management Systems - Aerospace Requirements (SAE)		
IPC-2221A **(Meet or Exceed)**	January 2000	Generic Standard on Printed Board Design – Amendment 1	CEV-S-017	3.5
IPC-2222 **(Meet or Exceed)**	1 Feb 1998	Sectional Design Standard for Rigid Organic Printed Boards	CEV-S-017	3.5
IPC-2223A **(Meet or Exceed)**	1 Jun 2004	Sectional Design Standard for Flexible Printed Boards	CEV-S-017	3.5
IPC-2225 **(Meet or Exceed)**	1 May 1998	Sectional Design Standard for Organic Multichip Modules (MCM-L) and MCM-L Assemblies		

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES DRD	 SOW
IPC-6011 **(Meet or Exceed)**	1 Jul 1996	Generic Performance Specification for Printed Boards, (Performance Class 3)	CEV-S-017	
IPC-6012B **(Meet or Exceed)**	1 Aug 2004	Qualification and Performance Specification for Rigid Printed Boards	CEV-S-017	
IPC-6013A-A2 **(Meet or Exceed)**	A: Jan 2005 A2: Apr 2006	Qualification and Performance Specification for Flexible Printed Boards , Performance Class 3. –Incorporating Amendment 1: 1/2005 and Incorporating Amendment 2: 4/2006	CEV-S-017	
IPC-6015 **(Meet or Exceed)**	1 Feb 1998	Qualification and Performance Specification for Organic Multichip Module (MCM-L) Mounting and Interconnecting Structures, (Performance Class 3)	CEV-S-017	
ISO 9001	November 15, 2008	Quality Management Systems -- Requirements		
NASA-STD-8719.14A	December 12, 2008	Process for Limiting Orbital Debris	CEV-S-007	
NASA-STD-8739.1 A, Chg 001 **(Meet or Exceed)**	July 23, 2009	Workmanship Standards for Polymeric Application on Electronic Assemblies	CEV-S-017	
NASA-STD-8739.2 **(Meet or Exceed)**	August 31, 1999	Workmanship Standard for Surface Mount Technology	CEV-S-017	
NASA-STD-8739.3 **(Meet or Exceed)**		Soldered Electrical Connections	CEV-S-017	
NASA-STD-8739.4, Chg 004 **(Meet or Exceed)**	**July 23, 2009**	Crimping, Interconnecting Cables, Harnesses, and Wiring	CEV-S-017	
NASA-STD-8739.5, Chg 001 **(Meet or Exceed)**	July 25, 2008	Fiber Optic Terminations, Cable Assemblies, and Installation	CEV-S-017	
NPR 8715.3C Chapters 3 and 6	March 12, 2008	NASA General Safety Program Requirements		
NPR 8715.6A	May 14, 2009	NASA Procedural Requirements for Limiting Orbital Debris	CEV-S-007	

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
PARENT MEETS OR EXCEEDS DOCUMENT		**PARENT MEETS OR EXCEEDS DOCUMENT : JPR 8080.5, JSC Design and Procedural Standards**	E-22 : CEV-T-027 ; E-6 : CEV-T-024 ; E-7 : CEV-027 ; M/S-11 :CEV-T-044	2.6, 2.8.4, 6.1.3, 6.2.3, 6.4.3
		JPR 8080.5 Approved Children		
AIAA-S-080	1999	AIAA Standard for Space Systems – Metallic Pressure Vessels, Pressurized Structures, and Pressure Components		
ANSI/AIAA-S-081A-2006	2006	AIAA Standard for Space Systems – Composite Overwrapped Pressure Vessels		
ASME Vessel Code, Section VIII, Divisions 1, 2, and 3		ASME Boiler and Pressure Vessel Code, Section VIII : Pressure Vessels Divisions 1, 2, and 3		
CxP-70199	Revision A September 24, 2010	Constellation Program Pyrotechnic Specification		
NASA-STD-6016 (replaces JSC-49774A) (Meet or Exceed)	09-11-2006	Standard Materials and Processes Requirements for Spacecraft	CEV-T-019 Rev 5, 2/11/2014	
NAS 412 (1997) (Meet or Exceed)	1997	Foreign Object Damage/Foreign Object Debris (FOD) Prevention		
SAE-ARP-5412 (Meet or Exceed)		Aircraft Lightning Environment		
SAE-ARP-5413 (Meet or Exceed)		Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning		
SAE-ARP-5414 (Meet or Exceed)		Aircraft Lightning Zoning		
SAE-ARP-5415 (Meet or Exceed)		Users Manual for Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning		

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
SAE-ARP-5577 (Meet or Exceed)		Aircraft Lightning Direct Effects Certification		
PARENT APPLICABLE DOCUMENT		**PARENT APPLICABLE DOCUMENT: MPCV-70024, Multi-Purpose Crew Vehicle (MPCV) Human-Systems Integration Requirements (HSIR)**	Section 3.7 : CEV-T-045	2.6, 2.7.1, 2.8.7, 3.1.6, 6.2.3, 6.4.3
		MPCV-70024 Approved Children		
CxP 70152	See Revision Version in Applicable Document Section	Constellation Program Crew Interface Labeling Standard	CEV-T-089	2.8.7
JSC-20584	June 1999	Spacecraft Maximum Allowable Concentrations for Airborne Contaminants		
ANSI Z136.1	2007	American National Standards Institute (ANSI) standard, ANSI Z136.1, "American National Standard for Safe Use of Lasers" (2000)		
ANSI S3.2-2009 (for information only)	2009	American National Standard Method for Measuring the Intelligibility of Speech Over Communication Systems		
ANSUR Database (NATICK/TR-89/044)	**12 Jan 2009**	1988 U.S. Army Anthropometry Survey (ANSUR) Database (NATICK/TR-89/044) 5^{th} to 95^{th} Percentiles ONLY THE NASA-PROVIDED TRUNCATED AND GROWTH TREND DATA DERIVED FROM THE ANSUR DATABASE IS APPLICABLE		
EPA Method 524.2	**Rev 4.1 1995**	Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry		
EPA Method 625	40 CFR Part 136, Appendix A (Current Edition)	Base/Neutrals And Acids		

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
FAA-HF-STD-001 Sections 14.1 through 14.5 (for information only)		Federal Aviation Administration Human Factors Design Standard		
FED-STD-595 (Meet or Exceed)		Colors Used in Government Procurement (12/15/89)		
ISO 2631-1 (for information only)		International Standards Organization (ISO) standard 2631-1:1997 (E)		
ISO 3382 (for information only)		"Measurement of the reverberation time of rooms with reference to other acoustical parameters"		
MPCV 72524	Baseline July 2, 2012	Orion Multi-Purpose Crew Vehicle (MPCV) Operations Nomenclature Plan		
NASA-STD-3000 (Meet or Exceed)		Volume I, Man-Systems Integration Standards (MSIS), Revision B, 1995, Section 3.3.3.		
No Number		41-node man model for calculating stored body heat		
No Number (for information only)		"Usability Engineering" (1993) by Jakob Nielsen		
No Number (for information only)		"The use of pilot rating in the evaluation of aircraft handling qualities" by Cooper, G.E. and Harper, R.P. (1969) Report TN-D-5153.		
No Number		Wissler model for calculating stored body heat		
PARENT APPLICABLE DOCUMENT		**PARENT APPLICABLE DOCUMENT: MPCV-72000, Multi-Purpose Crew Vehicle (MPCV) System Requirements Document (SRD)**	CEV-M-001, CEV-M-002, CEV-O-001, CEV-S-009, CEV-T-031, CEV-T-034	Scope, 1.1, 2.2, 2.3.(c), 3.1, 6.1.3, 6.1.6.1, 6.2.3, 6.2.6.1, 6.4.3, 6.4.6.1, 6.5.3, 10.6.6
		MPCV-72000 Approved Children		

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
JPR 8080.5 (Meet or Exceed)		JSC Design and Procedural Standards'		
NASA-STD-5017 (Meet or Exceed)		Design Development for Critical Mechanical Systems		
NPR 8715.5A		Range Safety Program		
JSC 62550	September 2006	Strength, Design and Verification Criteria for Glass, Ceramics and Windows in Human Space Flight Applications		
NASA-STD-(I)-5019 (Meet or Exceed)	September 12, 2006	Fracture Control Requirements for Spaceflight Hardware	CEV-T-069000, Rev 3, 1/29/2014	
CxP 70199	Revision A 9/24/10	Constellation Program Pyrotechnic Specification		
NASA-STD-(I)-6016 (Meet or Exceed)		Standard Manned Spacecraft Requirements for Materials and Processes	CEV-T-019, Rev 5, 2/11/2014	
SAE AS 50881	Rev C Oct 2006	Wiring, Aerospace Vehicle		
ANSI S3.2-2009 (for information only)	2009	American National Standard Method for Measuring the Intelligibility of Speech Over Communication Systems		
MPCV-70038(Meet or Exceed)	Rev A, Feb 13, 2014	Orion Multi-Purpose Crew Vehicle (MPCV) Program Hazard Analyses Requirements		
MIL-STD-130M	M 02 Dec 2005	Identification Marking of U.S. Military Property		
NASA-STD-4003 (Meet or Exceed)	Baseline 08 Sep 2003	Electrical Bonding for NASA Launch Vehicles, Spacecraft, and Flight Equipment		
JSC 63557 (for information only)	Baseline, 9 April 2009	Net Habitable Volume Verification Method		

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
IS-GPS-705	ICD Rev 2 02 Dec 2005	NAVSTAR GPS Space Segment / User Segment L5 Interfaces		
IS-GPS-800	Rev D 07 Mar 2006	NAVSTAR GPS Space Segment / User Segment L1C Interfaces		
CxP 70050-03 (Meet or Exceed)	Rev A 6/13/10	Constellation Program Electrical Power System Specification, Volume 3: Electrical Power Quality Performance for 120 VDC		
CxP 70050-04 (Meet or Exceed)	Rev A 6/13/10	Constellation Program Electrical Power System Specification, Volume 4: User Electrical Power Quality Performance for 120 VDC for equipment powered by 120 VDC		
CxP 72407	Baseline October 29, 2009	Orion Crew Exploration Vehicle Window Optical Properties Requirements		
		THE FOLLOWING DOCUMENTS ARE APPROVED CHILDREN OF THE MPCV-72000 CHILD DOCUMENT CXP-72407		
ASTM D1003	10 June 2000	Procedure A 10.Jun.00 Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics		
ASTIM-F733	2003	Standard Practice for Optical Distortion and Deviation of Transparent Parts Using the Double-Exposure Method		
PARENT APPLICABLE DOCUMENT		**PARENT APPLICABLE DOCUMENT: MPCV-70026, Orion Multi-Purpose Crew Vehicle (MPCV) Program-to-Space Launch System (SLS) Program Interface Requirements Document IRD**		2.3.(a)
		MPCV-70026 Approved Children		
NASA-STD-4003	8 Sept. 2003	Electrical Bonding for NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment		
SAE-ARP-5412 (Meet or Exceed)		Aircraft Lightning Environment		

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES DRD	 SOW
SAE-ARP-5413 (Meet or Exceed)		Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning		
SAE-ARP-5414 (Meet or Exceed)		Aircraft Lightning Zoning		
SAE-ARP-5415 (Meet or Exceed)		Users Manual for Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning		
SAE-ARP-5416 (Meet or Exceed)		Aircraft Lightning Test Methods		
SAE-ARP-5577 (Meet or Exceed)		Aircraft Lightning Direct Effects Certification		
PARENT APPLICABLE DOCUMENT		**PARENT APPLICABLE DOCUMENT: MPCV-70135, Constellation Program Structural Design and Verification Requirements** (Implementation Tailoring)		
		MPCV-70135 Approved Children		
AIAA-S-080	1999	AIAA Standard for Space Systems - Metallic Pressure Vessels, Pressurized Structures, and Pressure Components	CEV-T-071	2.3.(c), 6.1.3, 6.2.3, 6.4.3
ANSI/AIAA-S-081A-2006	2006	AIAA Standard for Space Systems - Composite Overwrapped Pressure Vessels	CEV-T-071	2.3.(c), 6.1.3, 6.2.3, 6.4.3
AIAA-S-110 (for information only)		Space Systems Structures, Structural Components, and Structural Assemblies		
NASA-STD-5012		Strength and Life Assessment Requirements for Liquid Fueled Space Propulsion System Engines		
NASA-STD-5020 (Meets or Exceeds)		Requirements for Threaded Fastening Systems in Spaceflight Hardware		
NASA-STD-(I)-6016 (Meet or Exceed)	9/11/06	Standard Manned Spacecraft Requirements for Materials and Processes	CEV-T-019, Rev 5, 2/11/2014	
NASA-STD-(I)-5019 (Meet or Exceed)	9-12-2006	Fracture Control Requirements for Constellation Spaceflight Hardware	CEV-T-069000 Rev 3, 1/29/2014	
JSC-62550	Rev A	Strength, Design and Verification Criteria for Glass, Ceramics and Windows in Human Space Flight Applications		
NASA-STD6008 **(Meet or Exceed)**		NASA Fastener Integrity		

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES DRD	 SOW
NSTS 08307 (Meets or Exceeds)	Rev A 6 July 1998	Criteria for Preloaded Bolts		
ANSI/AIAA-S-080-1998		Standard for Space Systems-Metallic Pressure Vessels, Pressurized Structures, and Pressure Components		
MSFC-RQMT-3479		Fracture Control Requirements for Composite and Bonded Vehicle and Payload Structures		
NSTS 08123		Certification of Flex Hose and Bellows for Flow Induced Vibration		
PARENT APPLICABLE DOCUMENT		**PARENT APPLICABLE DOCUMENT: FTO-AFT-FTA-004, Flight Test Article System Requirements Document**		
FTO-AFT-OPS-001	Rev. A 19 Jan. 2007	Concept of Operations		
FTO-AFT-FTA-003-PA1	Rev E 17 Jun 09	Flight Test Article Geometry & Mass Properties Requirements Document PA-1		
FTO-AFT-FTA-030-AA1	Baseline 27 Mar 08	Flight Test Article Geometry and Mass Properties Requirements Document AA-1		
FTO-AFT-FTV-011-PA1 (Meet or Exceed)	Rev. C 22 Feb 2009	Orion Launch Abort Vehicle Developmental Flight Instrumentation Master Measurement List for PA-1		
FTO-AFT-FTA-024-PA1	Rev. A 27 Feb 2009	DFI to FTA Interface Control Document, PA-1		
PARENT APPLICABLE DOCUMENT		**PARENT APPLICABLE DOCUMENT: CXP-72385 CEV Government Furnished Data for Orion System Design and Analysis**		2.3 a), 2.4, 2.6.9, 2.8.1, 6.1.3.9, 6.2.3.9, 6.4.3.9
		CXP-72385 Approved Children		
PDAC Loads		PDAC Version 4 Loads		
SLS Loads	12/2/2013	SLS DAC3E Loads		

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
SLS-10-C-ALA-003	7/6/2012	SLS Ascent Line Loads		
EV30 (13-103)	DAC-2R, 6/11/2013	Delivery of SLS-10004 DAC2R External Thermal Environments as RFTU		
SLS Timelines, Official Release	11/20/2013	Space Launch System (SLS) Flight Operation Timelines - OFFICIAL RELEASE		
SLS-SPEC-044-04	Rev A, 5/13/2013	Space Launch System Program Vehicle Design Environments Specification Volume 4: Acoustic		
MPCV 72167	8.0, 8/29/2013	Orion MPCV Aerodynamic Databook (for all phases of flight)		
MPCV 72168	0.94, 11/20/2013	Orion MPCV Aerothermodynamic Databook		
SLS-HDBK-053-01	Version 1, 5/3/2013	SLSP Vehicle Aerodynamic Data Book, Volume 1: SLS1000x		
SLS-10003-TD2	11/7/2012	SLS DAC2 Block 1 6-DOF Dispersed Trajectory Results		
EV30 (13-001)	1/11/2013	Failure Trajectory Dispersed data release memo - MSFC/EV30 (13-001)		
EV30 (13-103)	6/11/2013	Delivery of SLS-10004 DAC2R External Thermal Environments as RFTU		
SLS-SPEC-044-02	Rev B (DAC-2R), 8/28/2013	Space Launch System Program Vehicle Design Environments Specification Volume 2: External Aero-Thermal		
EV30 (12-024)	12/5/2012	SLS-10-D-APA-001, Surface Pressure Data		
SLS Headless Stack	1/29/2013	SLS Headless Stack Aero Lineloads and Model		

ID	Document Version/Date	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
			DRD	SOW
SLS-RPT-080	5/14/2013	Space Launch System Program Integrated Guidance, Navigation, and Control Performance Assessment		
DAC3_references-08272013	8/27/2013	DAC3 3-DOF Reference Trajectories (Corrected), DAC3_references-08272013_SBU_ITAR.xlsx		
SLS-RPT-083	5/17/2013	Space Launch System Program Aborts and Failure Modes Trajectory Analysis		
VSPA-TM13-06	4/30/2013	mDAC-1 Design Environments for SM Fairing and LAS Jettison		
EG-CEV-13-108	11/20/2013	EM-1 Distant Retrograde Orbit (DRO) Conceptual Flight Profile (CFP)		
01/12/2013	1/12/2013	Conceptual Flight Profiles for Exploration Mission 2		
SLS-SPEC-044-06	5/10/2013	Space Launch System Program Vehicle Design Environments Volume 6: Compartment Venting		
SLS-SPEC-044-05	12/19/12	SLSP Vehicle Design Environments Volume 5 Vibroacoustics and Shock		
SLS-RPT-082,	PDR draft, 5/17/2013.	SLSP 6-DOF Dispersed Trajectory Analysis		

2.0 MEETS OR EXCEEDS DOCUMENTS

Meets or Exceeds documents are listed for two purposes.
1) To be used by the contractor as a level of standards that must be met or exceeded if alternative standards are recommended by the contractor. The Contractor may request use of alternate documents instead of the ones specified in this list. The alternate document proposed must reflect a revision version and/or date so that the version is configuration managed. Once approved, the alternate item will be added to this list and shown as the approved alternate to the original proposed document.

2) To be used or tailored per direction within a DRD description. The resulting new or tailored document deliverable will take precedence over the associated document once the new or tailored document deliverable is approved by NASA. After the new or tailored document is approved by NASA, the item will be added to this list and shown as the approved alternate to the original document. .

ID	Document Version/ Date	MEETS OR EXCEEDS DOCUMENT TITLE	REFERENCES		Alternate ID	Document Version/ Date	ALTERNATE DOCUMENT TITLE
			DRD	SOW			
450-SNUG	Rev 9 Aug. 2007 – Aug. 2012	Space Network Users' Guide	CEV-T-058	2.6.3			
533 DRD-eCCR		533 Electronic Submission Example	CEV-B-001	1.2.(a)			
AFSPCMAN 91-710, All Volumes	1 July 2006	Range Safety User Requirements Manual, All Volumes	CEV-O-007	2.6.13, 3.3, 2.7.4			
AIA/NAS NASM20995		Wire, Safety or Lock		2.6.13			
AIA NAS 410		Certification & Qualification of Nondestrictive Test Personnel	CEV-T-023				
ANSI/AIAA G043-1992	1992/2004	Guidance for Preparation of Operational Concept Documents	CEV-O-001	2.7.1			
ANSI/ASQC Z1.4		Sampling Procedures and Tables for Inspection by Attributes		2.6.13			
ANSI/ESD S20.20-2007	2007	ESD Association Standard for the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)	CEV-T-025				
ANSI/NCSL Z450-1		Calibration Laboratories and Measuring and Test Equipment - General Requirements		2.6.13			
ASME Y14.100	2004	Engineering Drawing Practices	CEV-T-004				

ID	Document Version/ Date	MEETS OR EXCEEDS DOCUMENT TITLE	REFERENCES		Alternate ID	Document Version/ Date	ALTERNATE DOCUMENT TITLE
			DRD	SOW			
ASME Y14.24		Types and Applications Of Engineering Drawings	CEV-T-004				
ASME Y14.34M		Associated Lists	CEV-T-004				
ASME Y14.35M		Engineering Drawings and Associated Documents	CEV-T-004				
ASTM E1742		Standard Practice for Radiographic Examination		2.6.13			
ASTM E8		Standard Test Methods of Tension Testing of Metallic Materials		2.6.13			
ATEC Regulation 385-1	16 Feb. 2005	Army Test and Evaluation Command (ATEC) Regulation 385-1, ATEC Safety Program	CEV-D-002				
CPIA 655		Guidelines for Combustion Stability Specifications and Verification Procedures for Liquid Propellant Rocket Engines	CEV-T-071	2.6.10			
CXP-70036	Revision D 9/27/10	Constellation Program Environmental Qualification and Acceptance Testing Requirements (CEQATR)		10.2.1			
CXP-70050-01	Rev B 9/27/10	Constellation Program Electrical Power System Specification Volume 1: Electrical Power Quality Performance for 28VDC					
CxP-70050-02	Rev B 9/27/10	Constellation Program Electrical Power System Specification, Volume 2: User Electrical Power Quality Performance for 28VDC					

ID	Document Version/ Date	MEETS OR EXCEEDS DOCUMENT TITLE	REFERENCES		Alternate ID	Document Version/ Date	ALTERNATE DOCUMENT TITLE
			DRD	SOW			
CxP 70050-03	Rev A 6/13/10	Constellation Program Electrical Power System Specification, Volume 3: Electrical Power Quality Performance for 120 VDC					
CxP 70050-04	Rev A 6/13/10	Constellation Program Electrical Power System Specification, Volume 4: User Electrical Power Quality Performance for 120 VDC for equipment powered by 120 VDC					
CxP-70065 Section 3.5 and Appendix C Only	Baseline Release 10/11/2007	Constellation Program Computing System Requirements					
Dept. of the Army Pamphlet 385-64	15 Dec. 1999	Department of the Army Phamplet 385-64, Ammunition and Explosives Safety Standards					
FIPS 200	March 2006	Minimum Security Requirements for Federal Information and Information Systems		1.1.e			

ID	Document Version/ Date	MEETS OR EXCEEDS DOCUMENT TITLE	REFERENCES		Alternate ID	Document Version/ Date	ALTERNATE DOCUMENT TITLE
			DRD	SOW			
FTO-AFT-FTA-036	Rev. B 18 Dec. 2008 (Agreements and expectations are documented in FTO-AFT-FTA-048 PA-1 Pyrotechnic Requirements Compliance Matrix Baseline, 6 Jan 2009)	Flight Test Article (FTA) Pyrotechnics Requirements for PA-1 and AA-1	CEV-D-004				
CxP 70145	Baseline Change 001, Re-Release 5/13/09 (Cancelled)	Cross-Program Contamination Control Requirements Document	CEV-T-021		CEV-T-021	Rev 4, 1/15/2014	Project Orion Contamination Control Plan
ISO 14300-1	15 May 2001	Space Systems - Programme Management - Part 1: Structuring of a Program		1.1.(a)			
JPR 1700.1	Rev 1 July 2002	JSC Safety and Health Handbook	CEV-S-008				
JPR 8080.5	Rev A 15 March 2005	JSC Design and Procedural Standards		2.6, 2.8.4, 6.1.3, 6.2.3, 6.4.3			

ID	Document Version/ Date	MEETS OR EXCEEDS DOCUMENT TITLE	REFERENCES		Alternate ID	Document Version/ Date	ALTERNATE DOCUMENT TITLE
			DRD	SOW			
JPR 8080.5, E-14	Rev A 15 March 2005	JSC Design and Procedural Standard, E-14, Electrical Wire Harness Acceptance Testing		2.8.4			
JPR 8080.5, E-22	Rev A 15 March 2005	JSC Design and Procedural Standards, Section E22, Ionizing Radiation Effects	CEV-T-027	2.8.6			
JPR 8080.5, E-24	Rev A 15 March 2005	JSC Design and Procedural Standard, E-24, Electrical Wire and Cable Acceptance Test		2.8.4			
JPR 8080.5, E-7	Rev A 15 March 2005	JSC Design and Procedural Standards, Section E-7, Electrical Components – Restrictions on Use	CEV-T-027	2.8.6			
JSC 17773	Rev C Dec. 2001	Preparing Hazard Analyses for JSC Ground Operations	CEV-S-008				
JSC 20793	Rev B April 2006	Crewed Space Vehicle Battery Safety Requirements)			LM-ORN-0132	September 2, 2010	Battery Safety Requirements
J-STD-001 DS AMD1	1 Sep 2009	Space Applications Electronic Hardware Addendum to J-STD-001D Requirements for Soldered Electrical and Electronic Assemblies Amendment 1	CEV-S-017	3.5			
MIL-HDBK-6870A	28 Aug. 2001	Inspection Program Requirements Nondestructive for Aircraft and Missile Materials and Parts	CEV-T-023				
MIL-STD-1576	31 July 1984 Notice 1 – 4 Sept. 1992	Electro Explosive Subsystem Safety Requirements and Test Methods for Space Systems	CEV-T-025				

ID	Document Version/ Date	MEETS OR EXCEEDS DOCUMENT TITLE	REFERENCES		Alternate ID	Document Version/ Date	ALTERNATE DOCUMENT TITLE
			DRD	SOW			
MIL-STD-461F	10 Dec 2007	Requirements for the Control of Electromagnetic Interference (EMI) Characteristics of Subsystems and Equipment	CEV-T-025	2.8.5			
ML0303-0014	Rev N 16 June 2004	Electrical Wire Harnesses and Coaxial Cables, Installation Requirements for Electromagnetic Compatibility	CEV-T-025	2.8.5			
MPCV-70017	Baseline, June 11, 2012	Orion MPCV Probabilistic Risk Assessment (PRA) Requirements Document	CEV-S-002, CEV-S-010	3.4			
MPCV-70038	Rev A. Feb 13, 2014	Orion Multi-Purpose Crew Vehicle (MPCV) Program Hazard Analyses Requirements	CEV-S-003, CEV-S-005	3.2, 3.3			
MPCV-70043	Rev A, 2/5/2014	Orion Multi-Purpose Crew Vehicle (MPCV) Program Hardware Failure Modes and Effects Analysis/Critical Items List (FMEA/CIL) Requirements Document	CEV-S-009, CEV-S-011	3.4			
MPCV-70059	Baseline 9/6/12	Multi-Purpose Crew Vehicle (MPCV) Program Safety and Mission Assurance (S&MA) Requirements	S-001	3.1			
MS20003	5 June 2003	Indicator, Humidity, Card, Three Spot, Impregnated Areas		2.6.13			
MSFC-STD-531	Sept. 1978	High Voltage Design Criteria	CEV-T-024	2.8.4			
NAS 412	1997	Foreign Object Damage/ Foreign Object Debris (FOD) Prevention	CEV-T-021	2.8.2			

ID	Document Version/ Date	MEETS OR EXCEEDS DOCUMENT TITLE	REFERENCES		Alternate ID	Document Version/ Date	ALTERNATE DOCUMENT TITLE
			DRD	SOW			
NASA-STD-0005	September 29, 2008	NASA Configuration Management (CM) Standard	CEV-M-003	1.3			
NASA-STD-4003	8 Sept. 2003	Electrical Bonding for NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment	CEV-T-025	2.8.5			
NASA-STD-5002	June 21, 1996	Load Analyses of Spacecraft and Payloads	CEV-T-090				
NASA-STD-(I)-5009	6 Dec. 2005	Nondestructive Evaluation Requirements for Fracture Control Programs	CEV-T-015, CEV-T-023		CEV-T-015	Rev 2, 10/30/2013	Project Orion Nondestructive Evaluation Plan
NASA-STD-5017	Baseline Version 13 June 2006	Design and Development Requirements for Mechanisms, Sections 1-4	CEV-T-061, CEV-T-015	2.6.6, 2.6.9			
NASA-STD-(I)-5019	12 Sep. 2006	Fracture Control Requirements for Space Flight Hardware	CEV-T-023, CEV-T-069, CEV-T-070		CEV-T-069	Rev 3, 1/29/2014	Project Orion Fracture Control Plan
NASA-STD-(I)-6016	11 Sep. 2006	Standard Materials and Processes Requirements for Spacecraft	CEV-T-019, CEV-T-020, CEV-T-021, CEV-T-022, CEV-T-023		CEV-T-019	Rev 5, 2/11/2014	Orion Materials and Process Plan
NASA-STD-7009		Standards for Models and Simulations					
NASA-STD-8719.7 (applicable only to the PA-1 Test Flight)	January 1998	Facility System Safety Guidebook	CEV-S-001	3.1			

ID	Document Version/ Date	MEETS OR EXCEEDS DOCUMENT TITLE	REFERENCES		Alternate ID	Document Version/ Date	ALTERNATE DOCUMENT TITLE
			DRD	SOW			
NASA-STD-8719.9 (with change 1) (applicable only to the PA-1 Test Flight)	May 9, 2002	Standard for Lifting Devices and Equipment	CEV-S-001	3.1			
NASA-STD-8719.11 Revision A (applicable only to the PA-1 Test Flight)	November 19, 2008	Safety Standard for Fire Protection	CEV-S-001	3.1			
NASA-STD-8719.17 (applicable only to the PA-1 Test Flight)	September 22, 2006	NASA Requirements for Ground-Based Pressure Vessels and Pressurized Systems (PV/S)	CEV-S-001	3.1			
NASA-STD-8739.8	28 July 2004	NASA Software Assurance Standard (Chapter 6 and 7)	CEV-S-001, CEV-S-018	3.6, 6.5.2			
NPD 8710.2D (applicable only to the PA-1 Test Flight)	April 24,2002	NASA Safety and Health Program Policy	CEV-S-001	3.1			

ID	Document Version/ Date	MEETS OR EXCEEDS DOCUMENT TITLE	REFERENCES		Alternate ID	Document Version/ Date	ALTERNATE DOCUMENT TITLE
			DRD	SOW			
NPD 8710.5C (applicable only to the PA-1 flight test)	September 26, 2003	NASA Safety Policy for Pressure Vessels and Pressurized Systems	CEV-S-001	3.1			
NPR 7150.2	27 Sept. 2004 – 27 Sept. 2007	NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)	CEV-T-005, CEV-T-006, CEV-T-029, CEV-T-048, CEV-T-049, CEV-T-050, CEV-T-051, CEV-T-052, CEV-T-053, CEV-T-054, CEV-T-055, CEV-T-056, CEV-T-057	1.5- Class E,F,G only , 6.5.2- Chapter 6 & 7 only, 6.5.3 Class C & D			
NPR 7150.2	27 Sept. 2004 – 27 Sept. 2007	NASA Software Engineering Requirements	CEV-D-002				
NPR 8715.1 (applicable only to the PA-1 Test Flight)	August 9, 1999	NASA Occupational Safety and Health Programs with Change 3 (2/13/06)	CEV-S-001	3.1			

ID	Document Version/ Date	MEETS OR EXCEEDS DOCUMENT TITLE	REFERENCES		Alternate ID	Document Version/ Date	ALTERNATE DOCUMENT TITLE
			DRD	SOW			
NPR 8715.3A Chapters 1, 2, 3, 5, 7, 8, and 9 and Appendix E (applicable only to the PA-1 Test Flight)	Septemeber 12, 2006	NASA General Safety Program Requirements	CEV-S-001	3.1			
NSS 1740.12 (applicable only to the PA-1 Test Flight)	August 1993	Safety Standard for Explosives, Propellants, and Pyrotechniques	CEV-S-001	3.1			
NTIA Manual	May 2003 w/ May 2004 Revisions	National Telecommunications and Information Administration (NTIA) Manual of Regulations & Procedures for Federal Radio Frequency Management (May 2003 Edition, May 2005 Revisions) Chapter 10	CEV-T-026	2.6.3, 2.8.5			
OSHA TED 8.4		Voluntary Protection Programs (VPP): Policies and Procedures Manual	CEV-S-008				
Range Commanders Council - Range Safety Group – Standard 319-99	Sept. 1999	Flight Termination Systems Commonality Standard	CEV-D-002				

ID	Document Version/ Date	MEETS OR EXCEEDS DOCUMENT TITLE	REFERENCES		Alternate ID	Document Version/ Date	ALTERNATE DOCUMENT TITLE
			DRD	SOW			
Range Commanders Council - Range Safety Group - Standard 321-02	June 2002	Common Risk Criteria for National Test Ranges	CEV-D-002				
RTCA/DO-160D		Environmental Conditions and Test Procedures for Airborne Equipment (Section 22: Lightning Induced Transient Susceptibility and Section 23:Lightning Direct Effects)	CEV-T-025				
SAE-ARP-5412		Aircraft Lightning Environment	CEV-T-025				
SAE-ARP-5413		Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning	CEV-T-025				
SAE-ARP-5414		Aircraft Lightning Zoning	CEV-T-025				
SAE-ARP-5415		Users Manual for Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning	CEV-T-025				
SAE-ARP-5416		Aircraft Lightning Test Methods	CEV-T-025				
SAE-ARP-5577		Aircraft Lightning Direct Effects Certification	CEV-T-025				

ID	Document Version/ Date	MEETS OR EXCEEDS DOCUMENT TITLE	REFERENCES		Alternate ID	Document Version/ Date	ALTERNATE DOCUMENT TITLE
			DRD	SOW			
WSMR Reg. 385-17		White Sands Missile Range Regulations 385-17, Missile Flight Safety	CEV-D-002				
FED-STD-595		Colors Used in Government Procurement (12/15/89)					

3.0 INFORMATIONAL DOCUMENTS

Informational documents are listed for information purposes only. To obtain current versions of the Informational Documents, reference the NASA WindChill Library.

ID	Document Version/Date	Informational Document Title	References	
			DRD	SOW
CPIA 469		Principles of Solid Propellant Development	CEV-T-071	
CXP-70031	Rev D 10/27/10	Orion to International Space Station Interface Requirements Document	CEV-T-026, CEV-T-058	*2.3. (b),* 10.2.3
CXP-70065	Baseline Release 11 Oct. 2007	Constellation Program Computing Systems Requirements Document		
CXP-70130	Rev A 11/6/2009	Constellation Program Extravehicular Activity Design and Construction Specification	TBD	TBD
CxP-70137	Revision A, 09/05/08	Constellation Program Structural Loads Control Plan		
CXP-70141	Revision B 10/8/10	Constellation Program Electromagnetic Environmental Effects (E3) Control Plan		2.8.5, 2.8.6
CxP 70142	Baseline Release 19 May 2008	Constellation Program Navigation Standards		
CxP-72097	Baseline 01 Mar. 2007 + Errata 1/11/08	Crew Exploration Vehicle Master Verification Plan	CEV-T-015	
D684-101770-01	Revision N 30 September 2009	ISS Mission Build Facility Standard Output Definition Document (SODD)		
DOD 4145.26-M	Sept. 1997	DOD Contractors' Safety Manual for Ammunition and Explosives		2.6.13
ESD 10002	Rev B 1/8/13	ESD Level 1 Requirements		
ESD 10010	Baseline	Cross Program S&MA Plan		

ID	Document Version/Date	Informational Document Title	References	
			DRD	SOW
	9/20/12			
ESD 10011	Baseline 11/5/12	Cross Program PRA		
ESD 10012	Rev B 7/25/13	Exploration System Division Concept of Operations		
ESD 10016	Baseline, 12/4/2013	ESD Verification and Validation Plan		
FAA-HF-STD-001 Sections 14.1 through 14.5		Federal Aviation Administration Human Factors Design Standard		
ISO 2631-1		International Standards Organization (ISO) standard 2631-1:1997 (E)		
ISO 3382		"Measurement of the reverberation time of rooms with reference to other acoustical parameters"		
ITS-HBK 0202	6/19/2007	Security Assessment and Authorization: FIPS 199 Moderate & High Systems		1.1.e
ITS-HBK 0302	4/17/2008	Planning: Information System Security Plan Template, Requirements, Guidance and Examples		1.1.e
ITS-HBK 0402	6/11/2009	Risk Assessment: Procedures for Information System Security Penetration Testing and Rules of Engagement		1.1.e
MIL-P-116	8 April 1988	Preservation, Methods of		2.6.13
MIL-STD-464A	19 Dec. 2002	Electromagnetic Environmental Effects Requirements for Systems	CEV-T-025	2.8.5
MPCV-72008	Baseline July 24, 2012	Orion Multi-Purpose Crew Vehicle (MPCV) Program Plan	CEV-M-005	Scope, 1.4, 2.1, 2.3.(c), 2.4, 2.6, 6.1.1, 6.2.1, 6.4.1, 1.1 (e), 4.10
MPCV-72088	Baseline July 23, 2012	Orion Multi-Purpose Crew Vehicle (MPCV) Systems Engineering Management Plan (SEMP)		
MPCV-72094	Preliminary Baseline CR version MPCV-0031	Multi-Purpose Crew Vehicle (MPCV) Safety and Mission Assurance Plan		
CxP-72213	Rev A, 3 June	Orion Ground Safety Requirements Document		

ID	Document Version/Date	Informational Document Title	References	
			DRD	SOW
	2008			
NASA-HDBK-7005	13 Mar. 2001	Dynamic Environmental Criteria	CEV-T-015	2.6.9, 6.1.3.9. 6.2.3.9, 6.1.4.9
NASA-STD-2818		Digital Television Standards for NASA		
NASA-STD-3000		Volume I, Man-Systems Integration Standards (MSIS), Revision B, 1995, Section 3.3.3.		
NPR 1600.1 (Chapter 7 only)	3 November 2004	NASA Security Program Procedural Requirements w/Change 2 (4/01/2009)		1.1.e
PRAPG	Version 1.1 Aug. 2000	Probabilistic Risk Assessment Procedures Guide for NASA Managers and Practioners, Sections 4 - 14	CEV-S-010	
PRD-5020A	TBD	MPCV/EFT-1 Volume I. Launch and Recovery		
PRD-5020A	TBD	MPCV/EFT-1 Volume II, Flight Operations		
PRD-TBD	TBD	MPCV/AA-2 Volume I, Launch and Recovery		
PRD-TBD	TBD	MPCV/AA-2 Volume II, Flight Operations		
SAEAS-5649		Wire and Cable Marking Process, UV Laser		
S684-13566		System Specification for ISS Common Docking Adapter (CDA)		
SSP 30240	Rev E July 25, 2003	Space Station Grounding Requirements		
SSP 30242	Rev G July 25, 2003	Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility		

Attachment J-3 Applicable Documents
Annex A – Exploration Flight Test 1 (EFT-1)

Document Number/ Revision Number and Date	Document Title	Tailored Application
MPCV 72465 Baseline 4/25/13	“Orion MPCV Program Exploration Flight Test One (EFT-1) And Ascent Abort Two (AA-2) Flight Test Objectives”	Yes*
AFSPCMAN 91-710	“Air Force Space Command Manual Range Safety Requirements,” Volumes 1-6, dated July 1, 2004, and certified current January 4, 2011	No
ORN-CP-12-00048, Enclosure 6	“EFT-1 IFT “Standard Launch Support” Mission Assurance Approach,” dated December 2011	No
NPR 8715.6A	NASA Procedural Requirements for Limiting Debris (w/Change 1 – 5/14/09),” dated May 14,2009	No
NASA-STD-8719.14 (with Change 4)	Process for Limiting Orbital Debris”, dated August 28, 2007 with Change 4 dated September 14, 2009	No

*MPCV 72465 Baseline 4/25/13 is tailored to delete Objective No. OFT 1.112 from paragraph 3.1.1.1 and from Appendix C, Table C1-1 in its entirety.)

ATTACHMENT J-7

AWARD FEE EVALUATION PLAN
CREW EXPLORATION VEHICLE
Contract NNJ06TA25C
Schedule A

I. INTRODUCTION

In accordance with the provisions of the Federal Acquisition Regulation (FAR), and NASA and JSC policies, a performance evaluation procedure is hereby established for determination of award fees payable under this contract. The award fee is designed to provide economic motivation for the Contractor to provide timely, high quality outputs that exceed the minimum requirements of the contract. The intent of this plan is to set up procedures for evaluation of Contractor performance using existing data and systems to the maximum extent while imposing minimum administrative burden on the Government and Contractor. The payment of any award fee is contingent upon compliance with contractual requirements and performance to the degree specified below.

This contract is a hybrid contract consisting of three schedules, Schedules A, B, and C. Award fee evaluation for Schedules A and C are covered by attachments J-7 and J-17, respectively. Schedule B contains separate incentives specific to that contract schedule, and is not subject to award fee provisions.

Effective with Contract Modification 135, a third Fee Pool is established for Schedule A. The available Fee associated with this Contract Modification and beyond is split amongst the following three pools:

1. Period of Performance Award Fee: 35%
2. Performance Milestone Award Fee: 40%
3. Performance Incentive Fee: 25%

The first pool, Period of Performance (POP), Award Fee has set periods of performance for each Award Fee period in order to facilitate the evaluation and billing process outlined in this attachment and Section G, Clause G.3, respectively. POP periods are outlined in Enclosure II, Table A.

The second pool, Performance Milestone Award Fee, establishes Milestones and dates associated with each Milestone as outlined in Enclosure II, Table B

The third pool, Performance Incentive Fee, establishes Performance Incentives with completion criteria and dates associated with each Performance Incentives as outlined in Enclosure II, Table D.

The Contractor's interim performance under Schedule A will be evaluated by NASA at the expiration of each period specified in Enclosure II, Table A, Period of Performance Fee Distribution. The evaluation to be performed by NASA will be based on NASA's assessment of the Contractor's accomplishment of the various areas of work covered by the Statement of Work, in accordance with the factors, weightings, procedures, and other provisions set forth below.

The amount of available Award Fee in each period is subject to equitable adjustments arising from changes or other contract modifications as described in Enclosure III. The amount of the Award Fee to be paid is determined by the Government's evaluation of the Contractor's performance in terms of the criteria stated in the contract. This determination and the methodology for determining the Award Fee are unilateral decisions made solely at the discretion of the Government. The Government may unilaterally change any areas of this plan not otherwise requiring mutual agreement under the contract. Such changes will be made prior to the beginning of an evaluation period to which the changes apply by timely notice to the Contractor in writing. The Contractor will be informed of any changes to the evaluation criteria or the weightings prior to the affected Award Fee period.

Award Fee evaluation and payment criteria are outlined below.

II. PERIOD OF PERFORMANCE (POP) & MILESTONES AWARD FEE ORGANIZATIONAL STRUCTURE

A. Performance Evaluation Board Integration Team (PEB-IT)

The PEB-IT will be composed of selected NASA technical and administrative personnel and headed by the Contracting Officer's Technical Representative (COTR). The COTR will be the focal point for the accumulation and development of Award Fee evaluation reports, reviews, and presentations, as well as discussions with Contractor management on Award Fee matters. The PEB-IT will evaluate the Contractor's performance as related to the criteria listed in paragraph III below.

The PEB-IT will furnish the Contractor performance evaluations at a minimum at the midpoint of the interim evaluation period. The purpose of these communications is to discuss any specific areas where the Contractor has excelled and areas where future improvement is necessary. Routine and timely feedback will be provided to the contractor through the Technical Management Representatives (TMR). The routine feedback will also be reflected in the midpoint and interim evaluations. The Government's failure to provide interim feedback to the contractor during the period shall not preclude the Government from considering any deficiency in the contractor's performance in connection with the performance determination.

The PEB-IT will prepare an evaluation report for review by the PEB for each evaluation period. This report will include a recommendation to the PEB as to the adjective rating and numerical score (Enclosure I) to be assigned for the Contractor's performance for the period evaluated.

B. Performance Evaluation Board (PEB)

The Performance Evaluation Board (PEB) will be comprised of selected technical and administrative personnel of NASA. The PEB will assess the Contractor's performance after each evaluation period to determine whether, and to what extent, the Contractor's performance during the evaluation period (milestone) is deserving of the interim payment of Award Fee. The PEB, at the end of each evaluation period, will consider the PEB-IT report (PEBR) and prepare a summary of the evaluations for review by the Fee Determination Official (FDO). This summary will include a recommendation to the FDO as to the adjective rating and numerical score to be assigned for the Contractor's performance in the preceding evaluation period.

C. Fee Determination Official

A senior NASA official will be the FDO. After considering available pertinent information and recommendations, the FDO will make an interim performance determination for each period in accordance with the provisions of this Attachment J-7 and G.3 "Award Fee for End Item contracts" per the applicable schedule. The same process will be followed for the final performance evaluation period except the determination will be final as defined by the clause.

The FDO will consider the recommendation of the PEB, PEB-IT Report, information provided by the Contractor, if any, and any other pertinent information in determining the performance score. The FDO's determination of the score will be stated in a written Award Fee Determination and will be provided to the Contractor by the Contracting Officer within 45 calendar days after the end of the evaluation period.

III. PERIOD OF PERFORMANCE & MILESTONE AWARD FEE EVALUATION PROCEDURES

Award Fee Periods

Schedule "A" DDT&E

NASA will evaluate this contract schedule in accordance with the clause NFS 1852.216-77, Award Fee for End Item Contracts. Each award fee period will be based on Enclosure II Table A periods of performance. Each interim award fee period and provisional payment is based on the period of performance of the evaluation period and the Contractor's successful completion of the milestone(s) during the evaluation period as identified in Enclosure II, Table B. The award fee distribution tables contained in Enclosure II, Period of Performance Fee Distribution (Table A) and Performance Milestones (Table B), provide the Award Fee periods of performance and list of performance milestones along with the available provisional and interim fee for each period of performance and milestone. The award fee distribution table contained in Enclosure II, Table C, Indefinite Delivery Indefinite Quantity (IDIQ) Delivery Orders, provides a list of issued delivery orders and the maximum award fee available. Award Fee evaluations are considered interim until they are evaluated as Final, in accordance with Section G, Clause G.3, "Award Fee for End Item Contracts."

Objective and Subjective Criteria

No later than 30 calendar days prior to the start of each interim Award Fee evaluation period, the Contractor may submit to the Contracting Officer recommended objective performance metrics, weightings, and Areas of Emphasis (AOE) for consideration by NASA to be used for the ensuing evaluation period.

NASA will establish performance metrics and AOE for each evaluation period and communicate these to the Contractor at least 15 calendar days prior to the start of each evaluation period. NASA may unilaterally change the weightings of the criteria from period to period. However, cost control will be weighted at no less than 25 percent.

Contractor Self Evaluation and Submissions

The Contractor shall furnish a self-evaluation for each evaluation period. The self-evaluation must be received by the Contracting Officer 5-working days prior to the end of the period and shall be limited to no more than 20 pages. At the PEB meeting, the Contractor may provide a self-evaluation presentation (a copy of which shall be provided to the PEB) not to exceed 30 minutes in length.

The Contractor will be furnished a copy of the PEB's findings, conclusions, and fee recommendation. The Contractor will be afforded the opportunity to submit for consideration of the FDO: (a) proposed evaluations or conclusions or (b) exceptions to the evaluations, conclusions, or fee recommendations of the PEB; and (c) supporting reasons for such exceptions or proposed evaluations or conclusions. The Contractor's submissions must be made in writing and must be submitted through the Contracting Officer to the FDO within 5-working days from the date of the Contractor's receipt of the PEB findings. If the Contractor does not provide additional information to the Contracting Officer within the time stated above NASA will conclude that the Contractor concurs with the evaluation and recommended score.

In the event the FDO has not received a submission from the Contractor, the performance determination will not be executed until expiration of the 5-working day period prescribed above for Contractor submission. The Contractor may waive the 5-working day waiting period by providing a written statement that no response will be submitted.

The Contractor shall submit to the Contracting Officer a Corrective Action Plan (CAP) for any weaknesses or failing objective performance areas identified by NASA as part of the evaluation. The CAP should include a description of the non-conformance, determination of the root cause of the non-conformance, action required to correct the weakness and prevent recurrences, and the schedule for completion of the action. The CAP shall be submitted to the Contracting Officer within 30 calendar days after receipt of the each interim performance determination for the evaluation period. Corrective Actions will be closed by concurrence from the Contracting Officer and the COTR. Failure to submit a CAP within the timeframe stated above will result in a weakness in the next evaluation period.

Interim Feedback to the Contractor

During the course of a periodic evaluation period, the PEB-IT will communicate with the evaluation monitors and others as deemed appropriate to ascertain whether there are any areas of the contractor's performance in which significant improvement is required. The PEB-IT will provide prompt written notice to the contractor of any such significant areas known to him, and will also highlight other areas of Government concern. For each such letter issued, the contractor is required to respond in a timely manner, setting forth plans for increasing effectiveness in the areas addressed or explaining why it is not feasible to do so.

The need for such interim feedback will vary according to the circumstances involved, such as the length of the evaluation period, the contractor's performance in previous periods, the nature of the work being done during the period, etc. Hence, the Government's failure to provide interim feedback to the contractor during the period shall not preclude the Government from considering any deficiency in the contractor's performance in connection with the determination of the amount of fee to be awarded to the contractor. Typically, the Government will provide feedback to the contractor at every 3 months during the evaluation period. At a minimum, the Government will provide feedback at the midpoint of the evaluation period.

IV. PERIOD OF PERFORMANCE EVALUATION CRITERIA AND WEIGHTINGS

NASA will use the following subjective factors as a basis for arriving at the interim and final award fee score:

Award Fee Evaluation Criteria	Weight
Technical	45%
Program Management	20%
Cost	25%
Small Business/Small Disadvantaged Business Subcontracting Goals	10%

A. Technical (45%)

This factor will include an evaluation of the Contractor's performance in all areas of Technical performance, both interim and final. This includes:

i. Safety and mission assurance,
ii. Requirements definition and flow down,
ii. Risk management,
iv. Margin management, and
v. Innovation. (Innovation, both here and in Program Management, is defined as innovations that reduce cost, benefit schedule both from a current and future perspective, or result in improved design, coordination, or communication without adverse effects on performance, cost, or schedule.)
vi. Life Cycle Cost

B. Program Management (20%)

This factor will include an evaluation of the Contractor's performance in all areas of Program Management performance, both interim and final. This includes schedule management, subcontract management, responsiveness, innovation, life cycle cost management, and corporate commitment to capital investments and personnel. (Corporate commitment to personnel includes the quantity and quality of personnel assigned to the CEV Phase 2 contract. Quantity includes ramp-up and retention of qualified personnel at adequate levels to meet schedule, cost and performance objectives. Quality of personnel will be evaluated on the Contractor's success in maintaining and replacing key personnel within the CEV Phase 2 contract.)

C. Cost Management (25%)
This factor will include an evaluation of the Contractor's cost performance under the contract. Earned Value Management System data, cost performance reports and other cost data sources will be used in the Cost Management assessment for this factor. Cost performance will be assessed by evaluating the cost expended on the actual work performed during the period being evaluated, including quantitative assessment of the award fee period cumulative Cost Performance Index (CPI). In addition, a qualitative assessment of appropriate earned value variances, cost implications of the Schedule Performance Index (SPI), and other period-specific cost management trend data will be considered.

D. Small Business/Small Disadvantaged Business Subcontracting Goals (10%)
The Contractor's performance will be evaluated against the contract goals for small/small disadvantaged business subcontracting.

V. PERIOD OF PERFORMANCE & MILESTONE AWARD FEE SCORING

The percentage of award fee to be paid for a period of performance is equal to the numerical score assigned. In accordance with the Section G clause for award fee, no award fee will be paid when Contractor performance is determined to be Poor/Unsatisfactory.

Completion criteria for Mission Completion Milestones are detailed in Enclosure II, Table B. In the event that a milestone fails to meet the criteria for completion a NASA Mishap Investigation Board will determine the cause for failure.

Determination for cause of failure, and requisite fee earned will be as follows:

Cause of Failure	**FEE EARNED**
Other than Contractor	(b) (4) [redacted]
Not Determined	
Partially Contractor	
Primarily Contractor	

An overall performance evaluation and fee determination of zero shall be made for any evaluation period when there is a major breach of safety or security as defined in NFS 1852.223-75, Major Breach of Safety or Security.

VI. PERFORMANCE INCENTIVE FEE PERIODS, CRITERIA, AND WEIGHTING

The purpose of the Performance Incentives is to incentivize the Contractor to effectively manage the program. The incentive fee objective determination of earned and payable fee to the Contractor will be considered a final evaluation and will be subject to the "Disputes" clause of the contract, FAR 52.233-1.

For Purposes of making performance incentive fee payments, this agreement recognizes performance targets designed to obtain specific objectives, which will be evaluated at 6 month intervals as detailed in Enclosure II, Table D.

Performance Incentive payment criteria and weightings are applied to the technical performance targets provided in Enclosure II, Table D. Performance Incentive measurement shall be provided annually and updated as necessary to update and/or remove criteria which is no longer applicable. Fee will be awarded in accordance with the Evaluation Criteria for Performance Incentives detailed in Enclosure II, Table D, and Enclosure IV.

VII. LIST OF ENCLOSURES

Enclosure I: Numerical Ranges and Adjective Definitions
Enclosure II: Period of Performance Award Fee Periods, Performance Milestones Award Fee Pool, Award Fee Available for Payment and Earned, and Performance Incentive Fee
Enclosure III: Future Contract Changes – Award Fee Distribution Methodology
Enclosure IV: Performance Incentive Process Schedule

Enclosure I

Numerical Ranges and Adjective Definitions

This enclosure sets forth the adjective ratings, definitions, and associated numerical ranges to be used to define the various levels of performance under the contract.

ADJECTIVE RATING	RANGE OF POINTS	DESCRIPTION
Excellent	100 - 91	Of exceptional merit; exemplary performance in a timely, efficient and economical manner; very minor (if any) deficiencies with no adverse effect on overall performance.
Very Good	90 - 81	Very effective performance, fully responsive to contract; contract requirements accomplished in a timely, efficient and economical manner for the most part; only minor deficiencies.
Good	80 - 71	Effective performance; fully responsive to contract requirements; reportable deficiencies, but with little identifiable effect on overall performance.
Satisfactory	70 - 61	Meets or slightly exceeds minimum acceptable standards; adequate results; reportable deficiencies with identifiable, but not substantial, effects on overall performance.
Poor/Unsatisfactory	60 - 0	Does not meet minimum acceptable standards in one or more areas; remedial action required in one or more areas; deficiencies in one or more areas which adversely affect overall performance.

Enclosure II

<u>Period of Performance Award Fee Periods, Performance Milestones Award Fee Pool, Award Fee</u> Available for Payment and Earned, and Performance Incentive Fee

Provided within this Enclosure are the Tables A, B, C and D, which reflect, respectively, Period of Performance Award Fee Pool, Performance Milestone Award Fee Pool, IDIQ Award Fee Available, and Performance Incentives Fee Pool.

All period of performance and milestone provisional and interim evaluations are subject to a final award fee determination to be made by the Government in accordance with Section G, Clause G.3, "Award Fee for End Item Contracts."

<u>Table A: Period of Performance Award Fee Pool Fee Distribution</u>

Period of Performance Award Fee periods have been be established and reflected in Table A. These periods will remain set as the Award Fee periods to be used for interim and final award fee evaluations. These periods will be used as measurements of performance in accordance with the Award Fee for End Item Contracts.

Award Fee Period	Evaluation Period Schedule	Available Period of Performance Award Fee	Available IDIQ Award Fee**	Total Available Award Fee	Interim Earned Award Fee
1*		[redacted]			
2	9/1/07 - 4/30/09				
3	5/1/09 - 4/30/10				
4	5/1/10 - 4/30/11				
5	5/1/11 - 4/30/12				
6	5/1/12 - 4/30/13				
7	5/1/13 - 4/30/14				
8	5/1/14 - 4/30/15				
9	5/1/15 - 4/30/16				
10	5/1/16 - 4/30/17				
11	5/1/17 - 4/30/18				
12	5/1/18 - 4/30/19				
13	5/1/19 - 4/30/20				
14	5/1/20 - 12/31/20				
Total					

* At the time of Award Fee Period 1 evaluation, all Award Fee was based on Performance Milestones; therefore, all Period 1 Award Fee is reflected in Table B of Attachment J-7 in the contract.

** Starting with Award Fee Period 2, IDIQ Fee is included in Table A, Period of Performance Fee Determination.

<u>Table B: Performance Milestones Award Fee Pool</u>

Performance Milestones have been be established prior to contract award. Milestones measurements and related payments will be made in accordance with Section G, Clause G.3, "Award Fee for End Item Contracts."

For purposes of this plan the EFT-1 Flight Test Completion Milestone will be administered as a Final Event. NASA and LM will process the a final earned fee summary in accordance with NASA FAR Supplement

1816.405-273 and all earned and awarded fee through the EFT-1 D-009 Deliverable milestone will be considered final.

Milestone*	Available Fee	IDIQ Fee***	Interim Earned Fee	Final Fee Earned
SRR, IBR, & SDR	[redacted]	[redacted]	[redacted]	[redacted]
PA-1 Mechanisms Kit	[redacted]	[redacted]	[redacted]	[redacted]
PA-1 LAS	[redacted]	[redacted]	[redacted]	[redacted]
PDR	[redacted]	[redacted]	[redacted]	[redacted]
AA-1	[redacted]	[redacted]	[redacted]	[redacted]
CDR- Component Level	[redacted]	[redacted]	[redacted]	[redacted]
EFT CIR	[redacted]	[redacted]	[redacted]	[redacted]
EFT Initial Power Up	[redacted]	[redacted]	[redacted]	[redacted]
EFT-1 LAS Ready for Integration	[redacted]	[redacted]	[redacted]	[redacted]
EFT-1 Flight Test Completion	[redacted]	[redacted]	[redacted]	[redacted]
EFT-1 D-009 Delivered	[redacted]	[redacted]	[redacted]	[redacted]
EM-1/2 Delta PDR	[redacted]	[redacted]	[redacted]	[redacted]
EM-1 CDR	[redacted]	[redacted]	[redacted]	[redacted]
MPCV Emulator/Simulator DD250	[redacted]	[redacted]	[redacted]	[redacted]
EM-1 Flight H/W (DD250)	[redacted]	[redacted]	[redacted]	[redacted]
EM-1 Mission Completion	[redacted]	[redacted]	[redacted]	[redacted]
EM-2 CDR	[redacted]	[redacted]	[redacted]	[redacted]
AA-2 Flight H/W (DD250)	[redacted]	[redacted]	[redacted]	[redacted]
AA-2 Mission Completion	[redacted]	[redacted]	[redacted]	[redacted]
EM-2 Flight H/W (DD250)	[redacted]	[redacted]	[redacted]	[redacted]
EM-2 Mission Completion	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]

* Mission Completion criteria are described below.
** Milestone Dates are in accordance with Contract Attachment J-9 for DD250 Hardware, and Contract Attachment J-16 for Contract Reviews and Mission Completions.
*** Starting with Award Fee Period 2, IDIQ Award Fee is included in Table A, Period of Performance Award Fee Pool.

MILESTONE COMPLETION CRITERIA:

<u>EFT-1 CIR:</u>

- Completion Criteria: CIR is considered complete at the conclusion of the CIR meeting as evidenced by the out brief by Lockheed Martin Independent Review Board (IRB), and approval to proceed with assembly, integration and testing of components and subsystems into the final vehicle system.

<u>EFT-1 Initial Power UP:</u>

- Completion Criteria: The initial Power Up of the Orion EFT-1 Vehicle will be deemed successful when power is applied from the Test Conductor Console (TCC) in the Operations and Checkout Building at KSC to the spacecraft, commands are sent and telemetry is received back at the TCC and Test Procedure ORN-T-0066-SVA is complete.

EFT-1 LAS Ready for Integration:

- Completion Criteria: Completion of LAS ACM/Nose Cone mate procedure number ORN-A-0147-TPA or equivalent procedure number.[1]

EFT-1 Flight Test Completion:

- Completion Criteria/Evidence: Completion of Lockheed Martin Launch Procedure Number ORN-T-0188-SUA Launch Countdown and EFT-1 mission through re-entry and Splashdown.

EFT-1 Post Flight Report Delivery (DRD CEV-D-009):

- Completion Criteria: Delivery of Quick-look and Final Post Launch Data Reports per the requirements identified in DRD CEV-D-009.

AA-2 MISSION COMPLETION CRITERIA:

- Completion Criteria: Successful abort of Orion vehicle during ascent and splashdown of the test flight article that supports recovery operations.

EM-1/EM-2 MISSION COMPLETION CRITERIA:

- Completion Criteria: Completion of Orion vehicle orbit insertion, re-entry and successful splashdown that supports recovery operations.

Milestones related to PDR, CDR, FRR and Hardware Delivery (DD250):

- Completion Criteria: Completion criteria are detailed Section G, Clause G.3, “Award Fee for End Item Contracts.”

[1] The actual steps will be performed on a production order that is assigned a number automatically by the system when the document is released for work.

Table C: Indefinite Delivery / Indefinite Quantity (IDIQ) Award Fee

The maximum award fee available for IDIQ delivery/task orders is as follows:

Delivery Order Number	Award Fee Period 1: ATP - 8/31/07	Award Fee Period 2: 9/1/07 - 4/30/09	Award Fee Period 3: 5/1/09 - 4/30/10	Award Fee Period 4: 5/1/10 - 4/30/11	Award Fee Period 5: 5/1/11 - 4/30/12	Award Fee Period 6: 5/1/12 - 4/30/13	Award Fee Period 7: 5/1/13 - 4/30/14	Award Fee Period 8: 5/1/14 - 12/31/14	Total
NNJ07TA26T	[redacted]								
NNJ07TA27T	[redacted]								
NNJ07TA28T*	[redacted]								
NNJ07TA29T	[redacted]								
NNJ07TA30T	[redacted]								
NNJ07TA31T*	[redacted]								
NNJ07TA32T*	[redacted]								
NNJ07TA33T*	[redacted]								
NNJ07TA34T*	[redacted]								
NNJ07TA35T	[redacted]								
NNJ08TA15T*	[redacted]								
NNJ08TA16T	[redacted]								
NNJ08TA17T	[redacted]								
NNJ08TA18T	[redacted]								
NNJ08TA19T	[redacted]								
NNJ08TA20T	[redacted]								
NNJ08TA21T	[redacted]								
NNJ09TA01T	[redacted]								
NNJ09TA02T*	[redacted]								
Task Order 20*	[redacted]								
Task Order 21*	[redacted]								
Task Order 22	[redacted]								
Task Order 23	[redacted]								
Task Order 24*	[redacted]								
Task Order 25*	[redacted]								
Task Order 26*	[redacted]								
Task Order 27*	[redacted]								
Task Order 28*	[redacted]								
Task Order 29*	[redacted]								
Total Maximum Award Fee	[redacted]								

*Due to the period of performance for these delivery/task orders, award fee is reflected in multiple award fee periods

Table D: Performance Incentive Fee Pool

Performance Incentives are effective as of Contract Modification 135, and are as follows:

(b) (4)

[redacted]

(b) (4)

Enclosure III

Future Contract Changes – Award Fee Distribution Methodology

This enclosure sets forth the methodology for distributing Award Fee for future contract changes.

Award Fee dollars will be split 35% to the POP Award Fee (Enclosure II, Table A), 40% to Milestones (Enclosure II, Table B), and 25% to Performance Incentives (Enclosure II, Table D); as described in paragraphs I, II, and III below. 100% of the IDIQ Award Fee dollars will be allocated to POP Award Fee (Enclosure II, Table A) evenly by month based on the IDIQ period of performance.

I. POP Award Fee (35%) (Enclosure II, Tables A and C)

POP Award Fee will be spread among the remaining milestones proportionately, based on the percentage for each period. As a period is completed, the aggregate percentages are re-calculated using a ratio based on the percentage values of the remaining periods.

All future ID/IQ Award Fee will be included in the POP Award Fee pool and split evenly by month based upon the awarded Delivery/Task Order period of performance.

Award Fee Period	Period	% of Fee Pool
1*	**	(b) (4) [redacted]
2	9/1/07 - 4/30/09	
3	5/1/09 - 4/30/10	
4	5/1/10 - 4/30/11	
5	5/1/11 - 4/30/12	
6	5/1/12 - 4/30/13	
7	5/1/13 - 4/30/14	
8	5/1/14 - 4/30/15	
9	5/1/15 - 4/30/16	
10	5/1/16 - 4/30/17	
11	5/1/17 - 4/30/18	
12	5/1/18 - 4/30/19	
13	5/1/19 - 4/30/20	
14	5/1/20 - 12/31/20	
	Total	

* This Award Fee Plan was restructured during Award Fee Period 2. At the time of Award Fee Period 1 evaluation, all Award Fee was based on Performance Milestones; therefore, all Period 1 Award Fee is reflected in Enclosure II, Table B of this Enclosure.

** Denotes Period Complete

II. Milestone Award Fee (40%) (Enclosure II, Table B)

Milestone Award Fee shall be spread among all the remaining milestones proportionately, based on the basic percentage for each milestone. As a milestone is completed, the aggregate percentages are recalculated, using a ratio based on the basic percentage values of the remaining milestones.

Should a new milestone be added or deleted, based on a contract change or otherwise, the milestone percentages may be subject to change based on impact of the additional milestone.

TABLE SUBJECT TO CHANGE BASED ON FEE VALUE

Milestone	Allocation Percentages
SRR, IBR, & SDR	(b) (4) [redacted]
PA-1 Mechanisms Kit	[redacted]
PA-1 LAS	[redacted]
PDR	[redacted]
AA-1	[redacted]
EFT CIR	[redacted]
EFT Initial Power Up	[redacted]
EFT-1 LAS Ready for Integration	[redacted]
EFT-1 Flight Test	[redacted]
EFT-1 D-009 Delivered	[redacted]
EM-1/2 Delta PDR	[redacted]
EM-1 CDR	[redacted]
MPCV Emulator/Simulator DD250	[redacted]
EM-1 Flight H/W (DD250)	[redacted]
EM-1 Mission Completion	[redacted]
EM-2 Delta CDR	[redacted]
AA-2 Flight H/W (DD250)	[redacted]
AA-2 Mission Completion	[redacted]
EM-2 Flight H/W (DD250)	[redacted]
EM-2 Mission Completion	[redacted]
Total	[redacted]

** Denotes Milestone Complete

III. Performance Incentives Award Fee (25%) (Enclosure II, Table D)

Performance Incentives Award Fee will be spread among the remaining incentives proportionately based on the basic percentage for each incentive. As a period is completed, the aggregate percentages are re-calculated using a ratio based on the percentage values of the remaining periods.

Should a new incentive be added or deleted, based on a contract change or otherwise, the incentive percentages would be subject to change based on impact of the additional incentive to be allocated in accordance with Enclosure II, Table D weightings.

Example: Remaining Performance Incentive Fee Pool / Number of Incentives / Periods Remaining =

	Target Objective											
Performance Incentive Period	Year 1		Year 2		Year 3		Year 4		Year 5		Year 6	
	11/1 – 4/30	5/1 – 10/31	11/1 – 4/30	5/1 – 10/31	11/1 – 4/30	5/1 – 10/31	11/1 – 4/30	5/1 – 10/31	11/1 – 4/30	5/1 – 10/31	11/1 – 4/30	5/1 – 12/31
Incentive 1	[redacted]											
Incentive 2												

ENCLOSURE IV

Performance Incentives Schedule

This Enclosure outlines the mechanics for implementing the activities necessary to support the Performance Incentives in Enclosure II, Table D.

Establishing Incentives

NASA and the Contractor will work together to establish mutually acceptable Incentives no later than three (3) months prior to the start of the Fiscal Year (FY). The Incentives will be documented through a revision to this document, Contract Attachment J-7, Award Fee Plan, which will then be incorporated into the Orion Project Contract through a Contract Modification.

In addition to establishing the Incentives for the FY, NASA and the Contractor will coordinate no later than thirty (30) days prior to the start of the FY to determine the detailed criteria to be evaluated (i.e. (b) (4) [redacted] Once established this criteria will be provided to the Contractor via a Contracting Officer letter.

Incentives will be established for the entire FY; however, no later than thirty (30) days prior to the end of the first 6 month Incentive period, NASA and LM will evaluate the incentive and detailed criteria to determine if an adjustment is necessary for the subsequent 6 month period. Any adjustments made to the Incentives will be incorporated into the Orion Project Contract through a Contract Modification and adjustments to the detailed criteria will be documented via a Contracting Officer letter. A new Incentive shall not be incorporated during the period it is introduced, but in the subsequent periods to follow.

Any disputes arising in the development of the FY Incentives or the detailed criteria will be resolved by elevation to comparable levels of Program Management at both NASA and the Contractor. Dispute resolution will be reached not-later-than the beginning of the FY. Final settlement on Incentives will be resolved and documented by the NASA Contracting Officer and Contract Management at the Contractor.

Evaluation and Billing

No later than fifteen (15) working days after each of the 6 month Incentive periods, the Contractor shall submit a self-evaluation in Contractor format for the prior Incentive periods activity. NASA will then review the self-evaluation and provide a final evaluation within fifteen (15) working days of receiving the Contractor's submittal.

The Contractor will be afforded the opportunity to submit for consideration (a) proposed evaluations for reconsideration or (b) exceptions to the evaluations; and (c) supporting reasons for such exceptions or proposed evaluations. The Contractor's submissions must be made in writing and must be submitted through the Contracting Officer within five (5) working days from the date of the Contractor's receipt of the findings. If the Contractor does not provide additional information to the Contracting Officer within the time stated above NASA will conclude that the Contractor concurs with the evaluation. The Contractor may waive the 5-working day waiting period by providing a written statement that no response will be submitted.

NASA will document the final evaluation through a modification to the Orion Contract earned Award Fee. This evaluation is considered final and is not subject to further "Look Back" evaluation or billing withhold in accordance with NFS 1816.402-270. The Contractor may invoice upon receipt of the modification documenting the final evaluation.

Disputes

In the event that the Contractor timely submits concerns with NASA's final evaluation, NASA will re-assess and provide a written response within ten (10) working days from receipt of the Contractors notification. If further disagreements exist, they shall be worked through the Contract Disputes Clause, 52.233-1.

INDIVIDUAL

SUBCONTRACTING PLAN

FOR SMALL BUSINESS CONCERNS

Lockheed Martin Proprietary Data

1. In compliance with FAR 52.219-9, Small Business Subcontracting Plan, the following Subcontracting Plan is submitted by Lockheed Martin Space Systems Company, LMSSC, in support of the above referenced requirement.

(b) (4)

(b) (4)

(b) (4)

(b) (4)

(b) (4)

ATTACHMENT J-9

DELIVERABLE ITEMS LIST
11-18-2013

Yellow Highlighting and all of Table 2 are the subject of
ESA SM Update – RECP Version
7/26/2013 and will be definitized with that Supplemental Agreement

ATTACHMENT J-9
DELIVERABLES ITEMS LIST

The Deliverable Items List (Attachment J-9) contains all deliverables described in the Statement of Work (SOW), excluding the DRDs listed in Attachment J-2, Data Procurement Document and the date each deliverable is scheduled. This list includes contractor deliverables, including the Ground Support Equipment to be delivered in support of spacecraft processing, launch and recovery.

A deliverable item is defined as an item which, upon delivery, accountability is transferred to NASA. Each deliverable shall be accompanied by the appropriate transmittal documentation (e.g., DD250 Form or DD149 form, Certificate of Completion/Compliance (COC), Letter of Transmittal).

Table 1 provides the list of deliverables being provided by the contractor to NASA as their final destination.

Table 2 provides the list of deliverables being provided by the contractor to NASA for delivery to ESA. With the addition of the European Space Agency as a partner in the Service Module development, additional hardware and software items will be delivered by the contractor to NASA for immediate delivery to ESA for incorporation into the European SM (ESM).

Flight Hardware Items in Table 2 are incorporated into the ESM and will ultimately be delivered back to NASA and the contractor as part of the ESA delivery of the ESM. Table 2 also includes GSE and Test equipment provided by LM to NASA for delivery to ESA.

Unless otherwise marked in the Tables below, all deliverables shall be submitted via the DD250 Form. For items that are exchanged between NASA and the contractor, or have repeat deliveries, first delivery is on DD250. NASA will return hardware to the Contractor via DD1149 at L+ 1 month, and subsequent deliveries to NASA will be on DD1149.

Note: Revised delivery dates have been provided only for those Schedule A items affected by the scope of Modification 181 (the definitization of CCO 124). For Schedule A items outside this change, a TBD' delivery date was inserted for items with due dates in the past and future dates anticipated to change. These dates will be finalized in a future contract action.

Note: Items marked with (1) are associated with Schedule B. These delivery dates and vehicle designations have not been updated to be consistent with Contract Attachment J-16, and will be revised under a separate contract action prior to the date that the Schedule B and C Options are authorized.

TABLE 1 -	
DELIVERABLE ITEM	**SCHEDULED DELIVERY DATE**
DATA (other than DRDs)	
Initial Operating Plan Budget data	As Requested
Operating Plan Update	Initial submittal + 1 year
Project-wide Budget Data (maximum of three times a year)	As Requested
Crew Station Review Data	5WD prior to Crew Station Review
Information and Technical Data to Support National Environmental Policy Act	As Requested
FACILITIES	
HARDWARE	
PA-1 Test Flight	
Launch Abort System @ WSMR	(Actual)
CM Avionics Kit (Avionics, Power System and Pallet) @ DFRC	(Actual)
EGSE @ DFRC	(Actual)
Mechanisms Kit @ DFRC	(Actual)
MGSE @ DFRC	(Actual)
LAS MGSE @ WSMR	(Actual)
MGSE @ Langley	(Actual)
Article in the Loop Simulator	(Actual)
Software	(Actual)
Final Flight, Ground Support Equipment and Simulation Source Code, Build Procedures, Data and Executables	
AA-2 Test Flight	
Launch Abort System @ KSC LASF	10/15/2018
Crew Module with Separation Ring (SR) mated @ KSC O&C	9/15/2018
CM/SM Kits for Separation Ring @ LaRC	11/15/2017
*R&R and Umbilical Mechanisms, Harnesses, T-0 Ground and Flight Interface Panels, ECLS ATC	
Flight Software @ KSC O&C	9/15/2018
Initial Software version provided with Hardware Delivery	
Final Flight, Ground Support Equipment and Simulation Source Code, Build Procedures, Data and Executables*	
Pad EGSE @ CCAFS LC-46	9/15/2018
MGSE @ KSC	9/15/2018

LAS MGSE @ KSC LASF	10/15/2018
Portable Data Recovery Unit (PDRU) **(DD-1149)**	11/15/2018
MPCV Emulators/Simulators	
Flight Operations (MCC)	9/1/2016
SLS	9/1/16
Ground Operations (LCC)	9/1/2016
ISS	TBD
CMA Simulator	12/2014
SA/SAJ Simulator	12/2014
CM Mass Simulator	12/2014
EM-1 Flight	
Crew Module	3/1/2017
Service Module (includes European Service Module and the Crew Module Adapter, SA and SAJ)	3/1/2017
LAS	3/1/2017
EM-1 LAS MGSE Kit	3/1/2017
EM-1 MGSE Kit	3/1/2017
EM-1 EGSE	8/1/2017
EM-1 Recovery MGSE	11/1/2017
Software	3/1/2017
Final Flight, Ground Support Equipment and Simulation Source Code, Build Procedures, Data and Executables*	
EM 2 Flight	
Crew Module	3/1/2020
Service Module (includes European Service Module and the Crew Module Adapter, SA and SAJ)	3/1/2020
LAS	3/1/2020
EM 2 LAS MGSE Kit	3/1/2020
EM 2 MGSE Kit	3/1/2020
EM-2 EGSE	5/1/2020
Software	3/1/2020
Final Flight, Ground Support Equipment and Simulation Source Code, Build Procedures, Data and Executables*	
**Initial Software version provided with Hardware Delivery*	
MECHANICAL GROUND SUPPORT EQUIPMENT (MGSE)	
GROUND RECOVERY GSE (for EFT-1)	
Delivery to support Recovery Test 1 (DD1149)	3/15/2013
Delivery to support Recovery Test 2 (DD1149)	3/15/2013
Delivery to support Recovery of EFT-1	3/31/2014
***Incremental deliveries include Flight, Ground Support Equipment and Simulation/Test Software (including SoftSim/TRACE Simulation/Test Software) and accompanying data*	

DEVELOPMENTAL PARACHUTE TESTING * *ANY SPECIAL EQUIPMENT NECESSARY FOR FBC AND DROGUE CANISTER INSTALLATION WILL BE PROVIDED AS NEEDED.	
DELIVERABLE ITEM	**SCHEDULED DELIVERY DATE**
LM Parachute Compartment with Flowerpot #1 (refurbished 5 times)	Feb-13 (new)
LM Parachute Compartment with Flowerpot #2	Oct-13
Forward Bay Cover (FBC), FBC Retention and Release Mechanism #1	May-13
Forward Bay Cover (FBC), FBC Retention and Release Mechanism #2	Oct-13

Test Number	Need Date	# LM Drogue Mortars (1)	# LM Pilot Mortars (1)	# LM FBC Mortar	# LM Drogue Riser Cutters	# LM Main Riser Cutters
1	Complete Sept-11	2	3	0	0	0
2	Complete Dec 2011	2	2	0	0	0
3	Complete Feb-12	2	3	0	0	0
4	Complete Jan-12	2	3	0	0	0
5	Complete April-12	2	3	0	0	0
6	Complete May-12	2	3	0	0	0
7	Aug-12	1	2	0	0	0
8	Nov 12	2	3	0	0	0
9	Feb-13	2	3	0	2	0
10	May-13	1	3	3	2	3
11	Aug-13	2	3	0	2	0
12	Oct-13	2	3	3	2	3

13	Dec-13	**2**	**3**	0	**2**	**0**
14	Mar 14	**2**	**3**	0	**2**	**3**
15	May 14	**2**	**3**	0	**2**	**3**
16	Aug 14	**2**	**3**	0	**2**	**3**
17	Oct 14	**2**	**3**	0	**2**	**3**
18	Dec 14	**2**	**3**	0	**2**	**3**

***PROPERTY TRANSFER VIA DD1149 WILL BE USED IN LIEU OF DD250 FOR DEVELOPMENT PARACHUTE TESTING.**	
QUALIFICATION PARACHUTE TESTING *	
Qual Test # 1 Pilot Mortars (3)	5/1/2016
Riser Cutters (2 drogue and 3 main)	
Drogue Mortars (2)	
LM Parachute Compartment with Flowerpot	
Qual Test # 2 – Same configuration as Qual Test # 1	8/2016
Qual Test # 3 – Same configuration as Qual Test # 1	11/2016
Qual Test # 4 – Same configuration as Qual Test # 1	2//2017
Qual Test # 5 – Same configuration as Qual Test # 1	5/2017
Qual Test # 6 – Same configuration as Qual Test # 1	
Qual Test # 7 – Same configuration as Qual Test # 1	
Qual Test # 8 – Same configuration as Qual Test # 1	
ECLSS Test Bed CEIs	**7/1/2017**

TABLE 2 – HARDWARE AND SOFTWARE DELIVERABLES FOR ESM (NOTE 1)	
DELIVERABLE ITEM	**SCHEDULED DELIVERY DATE**
FLIGHT HARDWARE	
EM-1 Flight	
Video Camera – Qty 2 (TBD)	TBD/2015
Video Camera data and control harness – Qty 2 (TBD)	TBD/2016
Pyro activation harness and connectors – Qty 4 (TBD)	TBD/2016
Launch Vehicle Status harness and connectors – Qty 1	TBD/2016
DFI Acquisition Unit – Qty 1	11/2015
Auxiliary Thruster – Aerojet R-4D-11 490N Bipropellant Rocket Engine with Instrumentation– Qty 10 (8 flight units + 2 spares) (Note 2) (Note 5)	TBD/2015
Solar Cells for EM1 wing – Emcore ZTJ-1 or Spectrolab XTJ-1 – Qty 16,635 (15,120 flight units + 1,515 spares) (Note 2) (Note 3)	1/2015
Solar Cells for PVA repair kit – Emcore ZTJ-1 or Spectrolab XTJ-1 – Qty 150	1/2015
EM-2 Flight	
Standard Network Interface Card (SNIC) – Qty 20	TBD
Video Camera – Qty 2 (TBD)	TBD
Video Camera data and control harness – Qty 4 (TBD)	TBD
Pyro activation harness and connectors – Qty 4 (TBD)	TBD
Launch Vehicle Status harness and connectors – Qty 1 (TBD)	TBD
Auxiliary Thruster – Aerojet R-4D-11 490N Bipropellant Rocket Engine with instrumentation– Qty 10 (8 flight units + 2 spares) (Note 2) (Note 5)	TBD
Solar Cells for EM2 wing – Emcore ZTJ-1 or Spectrolab XTJ-1 – Qty 16,635 (15,120 flight units + 1,515 spares) (Note 2) (Note 3)	TBD
Solar Cells for PVA repair kit – Emcore ZTJ-1 or Spectrolab XTJ-1 – Qty 150	TBD
TEST AND GROUND SUPPORT HARDWARE	
Solar cells for Qualification Model Wing 0 Emcore ZTJ-1 or Spectrolab XTJ-1 – Qty 210 (Note 2) (Note 3)	4/2014 (TBC)
Battery Emulator Unit (BEU) – Qty 1	TBD/2015
ODN STE Platform (Personal Computer/Laptop with ODN interface test software, SNIC drivers, and network switches) – Qty 1	4/1/2014 (TBC)
Discrete Commands and Monitors Simulator (TBR) – Qty 1	TBD
CMA Stiffness Simulator – Qty 1 (Note 4)	5/2014
CMA/ESM heat exchanger simulator (IFHX) including pipings/loading IF to ESM interfaces – Qty 1	TBD/2014
SOFTWARE	

ODN STE Software consisting of ODN STE SM Standard Network Load (PDU Tables) ODN STE Driver API Library ODN STE Script Engine	9/30/2013
ODN STE Basic Test Scripts (unit test capability)	12/31/2013
ODN STE Final Test Scripts (subsystem test capability)	7/31/2014
Engineering test VxWorks SNIC Software driver	4/2013
Engineering test ODN configuration table	4/2013

Note 1: REFERENCE MPCV 72527 BHSEALS, REV BASELINE, MARCH 28, 2013 with the following changes:

- Quantities marked as TBD are all TBD in the BHSEALS Rev Baseline
- Added video camera data and control harness, pyro activation harness, launch vehicle status harness, and spares to Aux thrusters and solar arrays for EM-2
- Added quantities of hardware for EM-2
- Did not add DFI Acquisition Unit for EM-2 because SOW says DFI only for EM-1

Note 2: This deliverable will be procured by Lockheed Martin per ESA specification.
Note 3: Solar cells (CICs) come with blocking diodes, resistors, and cover glass (TBC).
Note 4: BHSEALS has a TBC for a CMA + Separation Mechanism Stiffness Simulator and a SA + Separation Mechanism Stiffness Simulator. These will be updated in next revision of BHSEALS to be CMA stiffness simulator only
Note 5: Auxiliary Thruster comes with the pressure and temperature transducers

ATTACHMENT J-10

INSTALLATION PROVIDED SUPPORT/SERVICES

The J-10 is a listing of installation support the Government will make available to Lockheed Martin Space Systems Company (LMSSC) at designated NASA Facilities for performance of the Orion contract. The Contractor is authorized to use the types of services listed in this attachment, to the extent they are available, in the performance of this contract within the physical borders of the installation (per Contract Clause G.11).

In addition to the support/services listed below, for Exploration Flight Test-1 (EFT-1) and Ascent Abort-2 (AA-2), the Program Requirements Document, referenced in the informational documents section of the J-3, contains additional support/services that the government has agreed to provide. The contractor means of request is via the Lockheed-Martin Mission Support Requirements (LMMSR) document.

This Attachment contains the following sections:

ATTACHMENT J-10

INSTALLATION PROVIDED SUPPORT/SERVICES

J-10A INTRODUCTION:

PURPOSE: The following delineates the Installation Provided Services (IPS) to be furnished by the Government at sites listed below. Since the IPS is to be provided on a no-charge-for-use basis, the Contractor shall make every effort to anticipate support requirements so the Government may affect orderly scheduling and requisitioning of services to be furnished hereunder.

INSTRUCTIONS:

1. Requests for specific support to be furnished by the Government in accordance with Clause G.11 and this Attachment shall be made by the Contractor to the NASA Contracting Officer's Technical Representative (COTR). The completion of any forms needed to obtain the services required shall be accomplished by the Contractor.

2. Services will be provided by the Government only within the confines of statutory, regulatory, and contractual limitations and as may be required for performance under this contract.

3. Any support not provided by the Government in this exhibit or elsewhere in the contract will be the responsibility of the Contractor.

4. The responsibilities of the Contractor are defined in the following:

   NFS 1852.245-71, INSTALLATION-ACCOUNTABLE GOVERNMENT PROPERTY (NOV 2004) – ALTERNATE 1 (NOV 2004)

ATTACHMENT J-10-B

INSTALLATION PROVIDED SERVICES

KENNEDY SPACE CENTER

10.1 Utilities

10.2 Communications Services

1. Agency Consolidated End-user Services (ACES) seats

2. Phone/Computer Network Services/Office Space for personnel located in onsite facilities.

Location	Building Number	Workspaces
O&C	(M7-0355)	LM [TBD]
LASF	(M7-0777)	LM [TBD]

3. High Speed Data Transfer Line (T1 or equivalent)

4. **Connectivity with Government Provided Communication Systems** – Provide connectivity to Government provided communication systems (e.g. voice, data, Internet).

10.3 Safety, Fire Protection for Contractor Personnel and Facilities

(1) Hazmat Release/Spill Support
(2) Electrical Disconnect – Lockout tag out coordination
(3) Pressure Regulation for Supplied GFE Gases
(4) Environmental permitting and related chemical use and release authorizations
(5) Regulated waste sampling and disposal to include pick-up, manifest shipment to permitted disposal facility
(6) O&C Tunnel groundwater sumps, maintenance and discharge treatment
(7) Safety Monitoring Equipment calibration
(8) Industrial Hygiene, analysis and reports
(9) Ionizing radiation permitting for X-Ray operations
(10) Electrical grounding to ensure safe ordnance operations and Electrostatic Discharge (ESD) Protection
(11) Lightning Protection

(12) Emergency Lighting
(13) Fixed Eye Wash Stations
(14) Fire Protection Services (response)
(15) Explosive Safety Assessments

10.4 Medical Support
Medical treatment of a first-aid nature for Contractor personnel injuries or illnesses sustained during on-site duty to include ambulance services.

10.5 General Services
The following general services will be provided for onsite activities:

(1) **General and Special Purpose Equipment –** Includes limited furniture for workspaces outlined in 10.2 (2.) above

(2) **Government Telephones** are available for official purposes only.

(3) **Cafeteria Privileges** for Contractor employees during normal operating hours.

(4) **Publications and Blank Forms Stocked By Installation.**

(5) **Moving and Hauling for Office Moves**, movement of large equipment, and delivery of supplies. Moving services shall be provided on-site as approved by the Contracting Officer.

(6) **Transportation Services** - . Provide locally available NASA transportation and handling equipment (e.g. cranes, platforms, rigging, tractor/lowboy trailers, forklifts, Cargo (Aircraft Mobile) Lift Trailer, K-Loader, KAMAG, ECS cart, Orion Transport Pallet). Includes use of Supper Guppy.

(7) **Building Maintenance For Facilities Occupied By Contractor Personnel**

(9) **Building Utilities** – Power, water and sewage in assigned KSC facilities.

(10) **Recycling Services** – Paper, Plastic, Metals

(11) Facility Modification – Provide facility modifications associated with use of Government Furnished facilities provided to meet Program requirements. Examples include: Movement of office walls, installing electrical outlets and facility modifications needed to support Orion Production activities.

10.6 Security Escort – Escort during transportation the movement of oversized loads such as the heat shield, Crew Module, Service Module, GTA, STA, AA-2, OFT-1, EM-1, EM-1 Post Flight Test Article, and EM-2, Mission Adapter, and Service Adapter.

10.7 Chemical Analysis – Provide chemical trace analysis, composition and elemental analysis, spectroscopy and chemical testing.

10.8 Failure Analysis – Provide metallography, microscopy and other characterization (SEM/EDS) services, fracture evaluation, failure mode, fatigue, and stress corrosion cracking.

10.10 Natural Disaster Facility Preparation/Recovery Services - Provide a portable AC power generating capability to support emergency power for natural disaster situations. The AC power generating requirement shall be 480 VAC at 900 KW. The generating capability shall be available prior and through a postulated hurricane natural disaster event.

Provide a portable water chilling capability to support facility HVAC operations. The chilled water capability shall have the capability to re-circulate water at 60 PSIG with a nominal flow capability of 80 GPM. The water discharge temperature shall be 45 Deg F maximum at rated flows. The capability shall be provided at two separate locations. The chiller equipment shall be self-powered or have included electrical power source.

Provide sandbagging of facility entrances and risk areas, securing of portable equipment and materials located in the elements, miscellaneous carpentry to secure and protect openings. Provide recovery services to include removal and cleanup of all elements, facility cleaning and damage securing.

10.11 Human in the Loop Testing at O & C (EM-2) ~~(TBD)Pending Narrative from J. Yagey~~

10.12 Battery Storage – (EFT-1 Only) Provide a separate dedicated area for battery charging..

10.13 Ordnance Handling – (EFT-1 Only) - Ordnance receipt, storage, transportation on KSC/CCAFS, day use facilities and use licensing/permitting (e.g. O&C, LASF).

ATTACHMENT J-10-C

INSTALLATION PROVIDED SERVICES

MICHOUD ASSEMBLY FACILITY

10.1 Communication Services –

1. Agency Consolidated End-user Services (ACES) seats

2. Phone/Computer Network Services/Office Space for personnel located in onsite facilities.

10.2 Information Technology (IT) Services – Provide Installation Accountable Property and Services (NASA mainframe Automated Data Processing Equipment (ADPE) and Infrastructure at Michoud Assembly Facility and Marshall Space Flight)

10.3 Security Escort – Escort during transportation the movement of oversized loads such as the heat shield, LAS components, Crew Module, Service Module, GTA, STA, , OFT-1, EM-1, EM-2 and Service Adapter at Michoud.

10.4 Transportation Services –Transport of Orion oversized loads within the installation using cranes, platforms, rigging, tractor low boy trailers, forklifts, tow tug, etc. Office moves are covered by NASA but only limited unique moves "on center" are covered by NASA that LM cannot accommodate with LM operated equipment at MAF.

10.5 Office and Work Area Space – Office space, office property and services for assigned personnel

10.6 Safety, Fire Protection for Contractor Personnel and Facilities

(1) Hazmat Release/Spill Support

(2) Electrical Disconnect – Lockout tag-out coordination

(3) Pressure Regulation for Supplied GFE Gases

(4) Environmental permitting and related chemical use and release authorizations

(5) Regulated waste sampling and disposal to include pick-up, manifest shipment to permitted disposal facility

(6) Safety Monitoring Equipment Calibration

(7) Industrial Hygiene, analysis and reports

(8) Ionizing radiation permitting for X-Ray operations

(9) Electrical Grounding to ensure safe ordnance operations and Electrostatic Discharge (ESD) Protection

(10) Lightning Protection

(11) Emergency Lighting

(12) Fixed Eye Wash Stations

(13) Fire Protection

(14) Explosive Safety Assessments

10.7 Medical Support – Medical treatment of a first-aid nature for Contractor injuries or illnesses sustained during on-site duty to include ambulance services.

10.8 Recycling Services – Paper, plastic and metals

ATTACHMENT J-10-D

INSTALLATION PROVIDED SERVICES

JOHNSON SPACE CENTER[1]

10.1 Communication Services -

1. Agency Consolidated End-user Services (ACES) seats

2. Phone/Computer Network Services/Office Space for personnel located in onsite facilities.

10.2 Transportation Services

- Super Guppy Airplane Use
- Transportation Support Equipment to load/unload GTA and STA: includes cranes, platforms, rigging, tractor/lowboy trailers, forklifts, cargo (Aircraft Mobile) lift, K-loader, etc.

10.3 Security Escort – Escort during transportation the movement of oversized loads such as GTA and STA.

10.4 Precision Cleaning – Use of JSC Building 9 Precision Cleaning Facility.

10.5 Office and Work Area Space – Office space, office property and services for assigned personnel.

10.5.1 Building -9 Human In the Loop Testing

10. 6 Safety, Fire Protection for Contractor Personnel and Facilities

(1) Hazmat Release/Spill Support

(2) Electrical Disconnect – Lockout tag-out coordination

(3) Pressure Regulation for Supplied GFE Gases

(4) Environmental permitting and related chemical use and release authorizations

(5) Regulated waste sampling and disposal to include pick-up, manifest shipment to permitted disposal facility

(6) Safety Monitoring Equipment Calibration

(7) Industrial Hygiene, analysis and reports

(8) Ionizing radiation permitting for X-Ray operations

(9) Electrical Grounding to ensure safe ordnance operations and Electrostatic Discharge (ESD) Protection

(10) Lightning Protection

(11) Emergency Lighting

(12) Fixed Eye Wash Stations

(13) Fire Protection

(14) Explosive Safety Assessments

10. 7 Medical Support – Medical treatment of a first-aid nature for Contractor injuries or illnesses sustained during on-site duty to include ambulance services.

10. 8 Recycling Services – Paper, plastic and metals

[1]Includes Ellington Field

ATTACHMENT J-10-E

INSTALLATION PROVIDED SERVICES

GLENN RESEARCH CENTER

10.1 Communication Services – Services provided by the government:

1. Agency Consolidated End-user Services (ACES) seats

2. Phone/Computer Network Services/Office Space for personnel located in onsite facilities.

10.2 Transportation Services – Bridge Crane/Installed**,** truck cargo, truck approved for ordnance move, tractor for trailer moves, forklift, Aircraft Mobile Lift, Pallet Mover and crane support[1]. Transport of Orion oversized loads EM-1 Post Flight Test Article, SM fairing Separation hardware, EM-1, and EM-2 within the Center, using locally available NASA transportation and handling equipment.

[1]These services shall be approved by the Contracting Officer.

10.3 Service Module Avionics Ring Pallet Isolator Vibration Testing

10.4 Office and Work Area Space – Office space, office property and services for assigned Orion personnel.

10.5 Vibration Test Services– NASA will provide the Vibration Facility Test Service for vibration testing of MPCV (EM-1 Post Flight Test Article, SM Fairing Separation Hardware and EM-2). Additionally NASA shall provide Vibration Facility Test Service for EM-1 modal testing of the CM/SM. These services include testing related commodities, utilities and data processing support.

10.6 Acoustic Test Services - NASA will provide the Acoustic Facility Test Service for acoustic testing of MPCV (EM-1, EM-1 Post Flight Test Article, and SM Fairing Separation Hardware & EM-2). These services include testing related commodities, utilities and data processing support.

10.7 Thermal Vacuum Services - NASA will provide the Thermal Vacuum Facility Test Service for thermal cycle/thermal vacuum testing of MPCV (EM-1 and EM-2). Note: These services include testing related commodities, utilities, data processing support, plumbing and pumps to: (1) evacuate air from the CM in the Thermal Vaccum Chamber during depression operations; and (2) evacuate water from the CM in Thermal Vaccum Chamber during ARS operations.

10.8 Mechanical Deployment Tests (EM-1 and EM-2). These services include testing related commodities, utilities and data processing support.

10.9 EMI/EMC/Lightning Tests– NASA will provide EMI/EMC Facility Testing Service of CEV and Subsystems– (EM-1, LAS ACM, Components and EM-2). These services include testing related commodities, utilities and data processing support.

10.10 Pyroshock Test – NASA will provide facility for system level pyroshock testing for EM-1 Post Flight Test Article. These services include testing related commodities, utilities and data processing support.

10.11 Heat Flux System Testing Support – NASA will provide power to support Heat Flux Testing.

ATTACHMENT J-10-F

INSTALLATION PROVIDED SERVICES

LANGLEY RESEARCH FACILITY

10.1 Transportation Services – Truck, cargo, tractor for trailer, Forklift, Pallet Mover, platforms, man-lift, tug, K-loader and crane support[1]. Transport of Orion oversized loads (GTA and STA, CM Water Impact Test Article) within the Center, using locally available NASA transportation and handling equipment.

[1]These services shall be approved by the Contracting Officer.

10.2 Security Escort - Escort during transportation the movement of oversized loads such as the GTA and STA Water Impact Test Article

10.3 Office and Work Area Space – Office space, office property and services for one person to support storage and inventory location.

10.4 Safety, Fire Protection for Contractor Personnel and Facilities

(1) Hazmat Release/Spill Support

(2) Electrical Disconnect – Lockout tag-out coordination

(3) Pressure Regulation for Supplied GFE Gases

(4) Environmental permitting and related chemical use and release authorizations

(5) Regulated waste sampling and disposal to include pick-up, manifest shipment to permitted disposal facility

(6) Safety Monitoring Equipment Calibration

(7) Industrial Hygiene, analysis and reports

(8) Ionizing radiation permitting for X-Ray operations

(9) Electrical Grounding to ensure safe ordnance operations and Electrostatic Discharge (ESD) Protection

(10) Lightning Protection

(11) Emergency Lighting

(12) Fixed Eye Wash Stations

(13) Fire Protection

(14) Explosive Safety Assessments

10.5 Medical Support – Medical treatment of a first-aid nature for Contractor injuries or illnesses sustained during on-site duty to include ambulance services.

10.6 Recycling Services – Paper, plastic and metals

10.7 Water Impact Test Facility - Provide instrumentation, Test Procedure Development, Test Performance Support, Facility Operations, and Data Collection for Ground Test Article (GTA) and STA Crew Module water Impact Tests. These services include testing related commodities, utilities and data processing support.

ATTACHMENT J-10-G

INSTALLATION PROVIDED SERVICES

GODDARD SPACE FLIGHT CENTER

10.1 Service Module Advanced Vibration Reduction (AVR) Pallet Isolator Testing

- Provide AVR Pallet Isolator Testing Services *(completed)*

ATTACHMENT J-10-H

INSTALLATION PROVIDED SERVICES

WHITE SANDS TEST FACILITY

10.1 Materials Laboratory Services – Provide Materials Laboratory services in support of crew system activities. *(completed)*

ATTACHMENT J-10-J

INSTALLATION PROVIDED SERVICES

AMES RESEARCH CENTER

10.1 Orbital Flight Test (OFT) Development Flight Instrumentation (DFI) Installation Services – NASA Ames shall support LMA during installation of delivered hardware and shall provide on-site installation support for thermal plugs at Textron and oversight of FADS assembly installation.

10.2 EFT-1 Wind Tunnel Testing – NASA Ames shall provide EFT-1 Force and Moment Wind Tunnel Testing Services.

10.3 Exploration Mission(EM) -1 Development Flight Instrumentation (DFI) Installation Services – NASA Ames shall support LMA during installation of delivered hardware and shall provide on-site installation support for thermal plugs at Textron and oversight of FADS assembly installation.

10.4 Arc Jet Testing – NASA Ames shall provide an Arc-Jet Testing Facility and Test performance support for Orion Thermal Protection System activities.

ATTACHMENT J-11

GOVERNMENT FURNISHED PROPERTY

Guidance for List of Government -Furnished Property (NFS 1852.245-76 Oct 1988) is included in Section G.10 of Orion Contract

The J-11 is a listing of tangible property that the Government transfers to the contractor for use off NASA facilities and the contractor maintains records. The list will be updated annually during the NF1018 reporting process to reflect current Government assets accountable to the contract at that point in time.

GFP = Government Furnished Property
GP = Government Provided
GFM = Government Furnished Material
Consum = Government Furnished Consumables
SW = Software
ST = Special Tooling
STE - Special Test Equipment

Attachment J-11.1 Government Furnished Property

Prop Class	Part/Model #	Serial # (if applicable)	Lot # (if applicable)	Nomenclature	Quantity	Unit of Measure	Cost	Extended cost	Acquisition Date	Government Furnished Property (GFP)	Justification/Comments
	602960193000-02			32" Adjustable Dolly	1	EA	$ 129,882	$ 129,882		GFP	
	SED261001218-301	1009		INITIATOR FIRING UNIT	1	EA	$ 8,000	$ 8,000		GFP	
APP	ZAG120400			CREW MODULE MOCK-UP ASSEMBLY	1	EA	275,096.000	275,096.000	5/4/2009	GFP	
PE	000000100000008544			CRIMP TOOL	1	EA	158.000	158.000	1/1/1997	GFP	
PE	000000100000008547			CRIMP TOOL	1	EA	158.000	158.000	1/1/1997	GFP	
PE	000000100000008548			CRIMP TOOL	1	EA	158.000	158.000	1/1/1997	GFP	
PE	000000100000008553			CRIMP TOOL	1	EA	152.000	152.000	1/1/2000	GFP	
PE	ZAG124766			DATA SERVER	1	EA	3,070.000	3,070.000	2/12/2009	GFP	
PE	ZAG124767			DATA SERVER	1	EA	3,070.000	3,070.000	2/12/2009	GFP	
ST	2235088	None	None	Fixture, Holding	1	EA	6,798.000	6,798.000	01/26/10	GFP	
ST	000000100000008539			BATTERY INSTALLATION FIXTURE	1	EA	500.000	500.000	1/1/1996	GFP	
ST	000000100000008540			PANEL INSTALLATION FIXTURE	1	EA	40,000.000	40,000.000	1/1/1996	GFP	
ST	000000100000008541			PANEL INSTALLATION FIXTURE	1	EA	35,000.000	35,000.000	1/1/1996	GFP	
ST	300117			NOSE CONE RDAU RID03	1	EA	100.000	100.000	04/30/08	GFP	
ST	300118			CANNARD RDAU A RID04	1	EA	100.000	100.000	04/30/08	GFP	
ST	300119			CANARD RDAU B RID05	1	EA	100.000	100.000	04/30/08	GFP	
ST	300120			ADAPTOR CONE RDAU A RID06	1	EA	100.000	100.000	04/30/08	GFP	
ST	300121			ADAPTOR CONE RDAU B RID07	1	EA	100.000	100.000	04/30/08	GFP	
ST	300137			REACTION PLATE	1	EA	63.000	63.000	06/27/08	GFP	
ST	300141			REACTION PLATE	1	EA	$ -	$ -	06/27/08	GFP	
ST	300143			INSTALLATION FIXTURE,	1	EA	756.000	756.000	06/24/08	GFP	
ST	300144			INSTALLATION FIXTURE,	1	EA	738.000	738.000	06/24/08	GFP	
ST	300148			TPS-RACEWAY, ABORT MOTOR MANIFOLD	1	EA	5,752.000	5,752.000	05/07/08	GFP	
ST	300166			FOOT ASSEMBLY, REACTION	1	EA	333.000	333.000	06/27/08	GFP	
ST	300167			FOOT ASSEMBLY, REACTION	1	EA	1,209.000	1,209.000	06/27/08	GFP	
ST	300168			FOOT ASSEMBLY, REACTION	1	EA	584.000	584.000	06/27/08	GFP	
ST	300173			BRACKET, INTERFACE	1	EA	365.000	365.000	06/27/08	GFP	
ST	300176			BRACKET, INTERFACE	1	EA	365.000	365.000	06/27/08	GFP	
ST	300186			INSTALLATION FIXTURE,	1	EA	3,022.000	3,022.000	06/24/08	GFP	
ST	300188			LOAD INDICATOR READOUT,	1	EA	1,212.000	1,212.000	06/27/08	GFP	
ST	300191			LOAD CELL, FLAT	1	EA	1,256.000	1,256.000	06/24/08	GFP	
ST	300196			RDAU INSTALLATION FIXTURE	1	EA	5,000.000	5,000.000	05/27/08	GFP	
ST	300197			REACTION FOOT ASSEMBLY,	1	EA	330.000	330.000	09/09/08	GFP	
ST	300198			REACTION FOOT ASSEMBLY,	1	EA	330.000	330.000	09/09/08	GFP	
ST	300199			BRACKET, INTERFACE	1	EA	487.000	487.000	06/27/08	GFP	
ST	300200			BRACKET, INTERFACE	1	EA	487.000	487.000	06/27/08	GFP	
ST	300212			SHEAR LIP BLOCK,	1	EA	1,743.000	1,743.000	08/01/08	GFP	
ST	300213			SHEAR LIP BLOCK,	1	EA	1,483.000	1,483.000	08/01/08	GFP	
ST	300214			SHEAR LIP BLOCK,	1	EA	1,173.000	1,173.000	08/01/08	GFP	
ST	300215			SHEAR LIP BLOCK,	1	EA	1,173.000	1,173.000	08/01/08	GFP	
ST	300216			SHEAR LIP BLOCK,	1	EA	1,608.000	1,608.000	08/01/08	GFP	
ST	300217A			SHEAR LIP BLOCK,	1	EA	717.000	717.000	08/01/08	GFP	
ST	300217B			SHEAR LIP BLOCK,	1	EA	717.000	717.000	08/01/08	GFP	
ST	GT005377			19K FLEXURE, TRANSFERED	1	EA	17,980.000	17,980.000	09/11/07	GFP	
ST	GT005378			19K FLEXURE, TRANSFERED	1	EA	17,980.000	17,980.000	09/11/07	GFP	
ST	GT005379			19K FLEXURE, TRANSFERED	1	EA	17,980.000	17,980.000	09/11/07	GFP	
ST	GT005380			19K FLEXURE, TRANSFERED	1	EA	17,980.000	17,980.000	09/11/07	GFP	
ST	GT005385			19K FLEXURE, TRANSFERED	1	EA	17,980.000	17,980.000	09/11/07	GFP	
ST	GT005386			19K FLEXURE, TRANSFERED	1	EA	17,980.000	17,980.000	09/11/07	GFP	
ST	GT005387			19K FLEXURE, TRANSFERED	1	EA	17,980.000	17,980.000	09/11/07	GFP	
ST	GT005388			19K FLEXURE, TRANSFERED	1	EA	17,980.000	17,980.000	09/11/07	GFP	
ST	GT014542			FIXTURE LOCATING	1	EA	6,376.600	6,376.600	03/17/08	GFP	
ST	GT014675			MOLD RING	1	EA	59,613.660	59,613.660	04/03/08	GFP	
ST	GT019397			DOLLY,	1	EA	63,012.000	63,012.000	05/15/08	GFP	
ST	GT019719			DOLLY	1	EA	$ 129,882	$ 129,882	07/02/08	GFP	
ST	GT019720			DOLLY,	1	EA	63,012.000	63,012.000	07/02/08	GFP	
ST	GT019751			ADAPTER RING ASSEMBLY,	1	EA	23,701.000	23,701.000	07/16/08	GFP	
ST	T1187003-001			VALVE & PACK	1	EA	14,373.000	14,373.000	08/27/09	GFP	
ST	T7460819-001			INSTALLATION TOOL	1	EA	990.000	990.000	07/28/08	GFP	
ST	T7460820-001			BURNISHING TOOL SEAT	1	EA	8,415.000	8,415.000	07/28/08	GFP	
ST	T7460829-001			LEAK CHECK FIXTURE VALVE	1	EA	165.000	165.000	07/28/08	GFP	
ST	T7460843-001			POSITIONING TOOL	1	EA	1,650.000	1,650.000	07/28/08	GFP	
ST	T7460844-001			RACK ALIGN TOOL	1	EA	9,240.000	9,240.000	07/28/08	GFP	
ST	T7460847-001			ASSY FIXTURE SPRING	1	EA	14,355.000	14,355.000	07/28/08	GFP	
ST	T7460848-001			ASSY TOOL ACT ASSY	1	EA	5,445.000	5,445.000	07/28/08	GFP	
ST	T7460851-001			ALIGN FIXTURE BPV ASSY	1	EA	4,950.000	4,950.000	07/28/08	GFP	
ST	T7460853-001			TORQUE WRENCH ADAPTER	1	EA	1,155.000	1,155.000	07/28/08	GFP	
ST	T7460854-001			STAND LEGS	1	EA	2,475.000	2,475.000	07/28/08	GFP	
ST	T7460857-001			SEAL REMOVAL TOOL	1	EA	660.000	660.000	07/28/08	GFP	
ST	T7460865-001			LEAKAGE ADAPTER	1	EA	4,125.000	4,125.000	07/28/08	GFP	
ST	T7460868-001			LEAK CHECK FIXTURE	1	EA	8,240.000	8,240.000	07/28/08	GFP	
ST	T7460871-001			HOLDING FIXTURE	1	EA	5,775.000	5,775.000	07/28/08	GFP	
ST	T7460872-001			PROTECTIVE CLOSURES	1	EA	4,950.000	4,950.000	07/28/08	GFP	
ST	T7460873-001			SEAL INSTALLATION TOOL	1	EA	3,300.000	3,300.000	07/28/08	GFP	
ST	T7460884-001			TORQUE WRENCH ADAPTER	1	EA	660.000	660.000	07/28/08	GFP	
ST	T7460886-001			ASSEMBLY FIXTURE	1	EA	24,090.000	24,090.000	07/28/08	GFP	
ST	T7460903-001			CARTRIDGE RETAINER	1	EA	2,310.000	2,310.000	07/28/08	GFP	
ST	T7460913-001			SPRING RETENTION TOOL	1	EA	10,230.000	10,230.000	07/28/08	GFP	
ST	T7460916-002			LEAK TEST ADAPTER	1	EA	925.000	925.000	07/28/08	GFP	
ST	T7460937-001			SEAL COMP ASSY COMP TOOL	1	EA	2,145.000	2,145.000	07/28/08	GFP	
ST	T7460941-001			GAUGE RING	1	EA	2,145.000	2,145.000	07/28/08	GFP	
ST	T7460946-001			ASSEMBLY TOOL	1	EA	3,960.000	3,960.000	07/28/08	GFP	
ST	T7476641-001			PROTECTIVE PLUG	1	EA	165.000	165.000	07/28/08	GFP	
ST	T7476646-001			PROTECTIVE PLUG	1	EA	165.000	165.000	07/28/08	GFP	
ST	T7492007-001			BEARING SIMULATOR	1	EA	2,475.000	2,475.000	07/28/08	GFP	
ST	T7492008-001			BURNISHING TOOL	1	EA	3,135.000	3,135.000	07/28/08	GFP	
ST	TE36875-301-001			DISPLACEMENT LEAK METER	1	EA	1,650.000	1,650.000	07/28/08	GFP	
STE	C106130	002	2319326-500	DOCKING CAMERA, ORION, NSS-POC, W/ 2 CABLES	1	EA	51,500.000	51,500.000		GFP	

Attachment J-11.1.2 Government Furnished Property

Part/Model #	Nomenclature	Justification
~~Electrical Test GSE for L DS~~	~~2.3, 2.10, 6.1.2, 6.1 3.6, 6.1 6, 10 6 (Table 10.1 and 10.2)~~	~~TBD~~
~~Test Cables for LIDS~~	~~2.3, 2.10, 6.1.2, 6.1 3.6, 6.1 6, 10 6 (Table 10.1 and 10 2)~~	~~TBD~~
~~Handling Equipment for the L DS Mass Simulator (Lift points, Guides, sling spreaders Covers etc.)~~	~~2.3, 2.10, 6.1.2, 6.1 3.6, 6.1 6, 10 6 (Table 10.1 and 10.2)~~	~~(2 sets) 4 months prior to GTA Test Commencement. {Hardware to be shared between Michoud Assembly Facility (MAF), Glen Research Center (GRC), Denver AI&P and WSMR. All Hardware to eventually reside at AI&P}~~
~~Handling Equipment for the L DS Flight Hardware (Lift points, Guides, sling spreaders, covers etc.)~~	~~2.3, 2.10, 6.1.2, 6.1 3.6, 6.1 6, 10 6 (Table 10.1 and 10.2)~~	~~TBD~~
~~Handling Equipment for the L DS Simulator for Flt Tests (Lift points, Guides sling spreaders Covers etc.)~~	~~2.3, 2.10, 6.1.2, 6.1 3.6, 6.1 6, 10 6 (Table 10.1 and 10.2)~~	~~TBD~~
CEV Parachute Assembly System (CPAS) handling equipment Note: If handling equipment changes between Gen-1, Pre-Production, and Production, updates to this hardware deliverable need to be provided.	2.3, 2.6.13, 2.10, 6.1 2, 6.1.3.14, 6.1 6, 10 6 (Table 10.1 and 10.2), 10.6 8	(1 set) 1 month prior to EFT-1 AI&P All Hardware to reside at AI&P. Note: No dedicated set. Delivered with flight assets and then returned to NASA after installation.
T-O Umbilical for Purge/Vent/Drain Requires 2 lines and supporting equipment		Prelaunch at Rollout (not required for EFT-1). Required for AA-1 and Orion 2. A/K/A "Collet". Collet for interface compatibility 24 months prior to EM-1 delivery.
Recovery GSE for Processing the CM at Landing Site and Transportation		1 month prior to EFT -1 (Duration: through Schedule B)
Distribution Lines for Reaction Control Equipment (RCE) Test (Part No. D010199)	6.1, 6.2, 10.3	external Airlock Handling Equipment for miscellaneous handling/lifting , 39 months prior to System Qual through Schedule A
Bay Assembly for RCE Test (Part No. D010200)	6.1, 6.2, 10.3	April 2007 through Program End
Bay Assembly for RCE Test (Part No. D010201)	6.1, 6.2, 10.3	April 2007 through Program End
NASA PROVIDED GSE	Kennedy Space Center	Lifting Devices (Hydrasets, Crane hooks, and up) SSPF Bridge Crane, Hydrasets
NASA PROVIDED GSE	Kennedy Space Center	Integrated Stack Command, Control and Monitoring System
NASA PROVIDED GSE	K-mag Transporter	A/R
~~NASA PROVIDED GSE~~	~~Marshall Space Flight Center Michoud Assembly Facility~~	~~NASA mainframe Automated Data Processing Equipment (ADPE) and Infrastructure, ATP through Aug 07~~
NASA PROVIDED GSE	Marshall Space Flight Center - Michoud Assembly Facility	External Airlock Handling Equipment for miscellaneous handling/lifting , 39 months prior to System Qual through Schedule A

Attachment J-11.2 Custor

Attachment J-11.2 Government Furnished F

Part Name/Model#	SOW Paragraph(s)
~~Low Impact Docking System (LIDS)~~	~~2.3, 2.10, 6.1.2, 6.1.3.6, 6.1.6, 10.6 (Table 10.1 and 10.2)~~
~~Low Impact Docking System (LIDS) Simulator for Ground Testing. (Flight Like Mass, CG, and interfaces to CEV and the CEV to ISS Docking Adaptor with Representative OML and Stiffness)~~	~~2.3, 2.10, 6.1.2, 6.1.3.6, 6.1.6, 10.6 (Table 10.1 and 10.2)~~
~~LIDS Simulator for Flt Tests. (Flight Like Mass, CG, and interfaces to CEV with Representative OML and Stiffness)~~	~~2.3, 2.10, 6.1.2, 6.1.3.6, 6.1.6, 10.6 (Table 10.1 and 10.2)~~
~~LIDS for Flt Tests. (Flight Like Mass, CG, and interfaces to CEV with Representative OML and Stiffness)~~	~~2.3, 2.10, 6.1.2, 6.1.3.6, 6.1.6, 10.6 (Table 10.1 and 10.2)~~
CPAS	
~~Pyrotechnic Reefing Line Cutters~~	~~6.1.3.13~~
Flight CPAS (mains)	2.3, 2.6.13, 2.10, 6.1.2, 6.1.3.14, 6.1.6, 10.6 (Table 10.1 and 10.2), 10.6.8
Flight CPAS FBC Parachutes (Delivered to Mortar Supplier for Integration into Mortar)	2.3, 2.6.13, 2.10, 6.1.2, 6.1.3.14, 6.1.6, 10.6, (Table 10.1 and 10.2), 10.6.8
Flight CPAS Drogue Parachutes (Delivered to Mortar Supplier for Integration into Mortar)	2.3, 2.6.13, 2.10, 6.1.2, 6.1.3.14, 6.1.6, 10.6, (Table 10.1 and 10.2), 10.6.8
Flight CPAS Pilots (Delivered to Mortar Supplier for Integration into Mortar)	2.3, 2.6.13, 2.10, 6.1.2, 6.1.3.14, 6.1.6, 10.6, (Table 10.1 and 10.2), 10.6.8
Mass simulators for CPAS mains and drogues only	2.3, 2.6.13, 2.10, 6.1.2, 6.1.3.14, 6.1.6, 10.6 (Table 10.1 and 10.2), 10.6.8
Avionics/Power/Wiring	
~~ABCU Switches~~	~~TBD~~
~~Capacitors~~	~~TBD~~
Coarse Optical Alignment Sensor	
Thermal Protection System Heat Shield Development Flight Instrumentation (DFI)	

DFI Heat Shield Sensors (Thermal Plugs, FADS Sensors, Radiometer)	6.1.3.8
~~BTA Heat Shield~~	
Environmental Control and Life Support System (ECLSS)	
Radiation Area Monitors (Dosimeters)	2.6.12, 6.1.3.12
~~Radiation Area Monitors (Dosimeters) Active~~	~~2.6.12, 6.1.3.12~~
Battery-Operated Independent Radiation Detector (BIRD)	2.6.12, 6.1.3.12
Hybrid Environment Radiation Assessor (HERA, i.e. REM) 'Lite'	2.6.12, 6.1.3.12
Hybrid Environment Radiation Assessor (HERA, i.e. REM) - 'Integrated'	2.6.12, 6.1.3.12
Post Landing LiOH	2.6.12, 6.1.3.12
Portable fire extinguisher	2.6.12, 6.1.3.12
Contingency breathing App	2.6.12, 6.1.3.12
Smoke Detector	2.6.12, 6.1.3.12
Smoke Eater	2.6.12, 6.1.3.12
Contingency Water Removal Device	2.6.12, 6.1.3.12
Positive Pressure Relief Assembly	2.6.12 - ECLS
Heat Exchanger	2.6.12 - ECLS
ECLS Labels	2.6.12 - ECLS
Flight Crew Equipment	
~~Representative Set~~ Mass simulators of flight crew equipment (Note: Not required to be Class I). Wall mounted items to be Flight Like where defined Examples of FCE: Food System, Crew Survival, Exercise, Countermeasures, Medical, Personal Hygiene, Sleeping, Photography, Housekeeping, Clothing & Crew Preferences, Maintenance, Operational Supplies, Trash Stowage, Cargo Support Equipment	2.3, 2.6.11, 2.6.12, 2.7, 2.10, 6.1.3.11, 6.1.3.12, 6.1.6, 6.2.3.11
~~Mass, Volume, and interface simulated set of flight crew equipment (For O&C fit check)~~	~~2.3, 2.6.11, 2.6.12, 2.7, 2.10, 6.1.3.11, 6.1.3.12, 6.1.6, 6.2.3.11~~
~~EVA~~ Suits and Survival Crew Equipment	
~~Representative set of EVA equipment to adequately replicate the size, mass and functionality of Flight Hardware~~	
~~4 Launch and Entry Suits~~	~~2.6.11, 6.1.3.11~~
~~4 IVA umbilicals~~	~~2.6.11, 6.1.3.11~~
~~Standard Tools~~	~~2.6.11, 6.1.3.11~~
~~Minimal set of EVA equipment to adequately replicate the size, mass and functionality of prestowed Flight Hardware~~	
~~EVA Multiple Connector~~	
~~EVA MC Integration Kit~~	
Propulsion	

~~Orbiter Maneuvering System Engine (OMS) Flight Certified~~	~~2.6.10, 6.1.3.10~~
PYROS	
LAS/CM R&R Frangible Nuts	2.3, 2.6.13, 2.7, 2.10, 6.1.2, 6.1.6.2, 10.6.6.9
LAS/CM R&R Frangible Nuts	2.3, 2.6.13, 2.7, 2.10, 6.1.2, 6.1.6.2, 10.6.6.9
LAS/CM R&R Frangible Nuts	2.3, 2.6.13, 2.7, 2.10, 6.1.2, 6.1.6.2, 10.6.6.9
Pyrotechnics Initiators - NASA Standard Initiators (NSIs)	2.3, 2.6.13, 2.7, 2.10, 6.1.2, 6.1.3.13, 6.2.3.13, 6.4.3.13, 10.6.6.9
Spacecraft Separation Frange Nut	2.3, 2.6.13, 2.7, 2.10, 6.1.2, 6.1.6.2, 10.6.6.9
Textile Riser Cutters (Kevlar)	2.3, 2.6.13, 2.7, 2.10, 6.1.2, 6.1.6.2, 10.6.6.9
GFP FOR EMULATORS FOR DEVELOPMENT, VERIFICATION & VALIDATION T	
~~CLV High Fidelity Emulator for CEV Hardware/Software Integration and Mission Support~~ SLS EDU based emulator (high fidelity) to the ITL	2.6.1, 10.2.1, 10.3.2, 10.3.5.3
~~CLV Low Fidelity for CEV Hardware/Software Integration and Mission Support.~~ SLS Interface Unit to the O&C	2.6.1, 10.2.1, 10.3.2, 10.3.5.3
~~ISS Emulator for CEV Hardware/Software Integration And Mission Support~~	~~2.6.1, 10.2.1, 10.3.2, 10.3.5.3~~
~~Low fidelity LCC Front End Processor that will support scripting~~	~~2.6.1, 10.2.1, 10.3.2, 10.3.5.3~~
~~Medium fidelity LCC Emulator for CEV Hardware/Software Integration and Mission Support~~	~~2.6.1, 10.2.1, 10.3.2, 10.3.5.3~~
~~MCC Emulator for CEV Hardware/Software Integration and Mission Support~~	~~2.6.1, 10.2.1, 10.3.2, 10.3.5.3~~
~~CTN Emulator for CEV Hardware/Software Integration and Mission Support~~	~~2.6.1, 10.2.1, 10.3.2, 10.3.5.3~~
PEPC Emulator for CEV Hardware/Software Integration and Mission Support (PEPC Avionics, Emulators, Telemetry, and Comm)	2.6.1, 10.2.1, 10.3.2, 10.3.5.3
~~EVA Emulator for CEV Hardware/Software Integration (EVA Avionics Emulators — EVA Project Office Biomedical Telemetry and Comm)~~	~~2.6.1, 10.2.1, 10.3.2, 10.3.5.3~~
~~LIDS Emulators for CAIL~~	~~2.6.1, 10.2.1, 10.3.2, 10.3.5.3~~
~~CEV to ISS Docking Adaptor Emulator (Existing Brassboard system and any special cables unique to Brass Board and simulate Pwr and Data xfer path)~~	~~2.6.1, 10.2.1, 10.3.2, 10.3.5.3~~

~~SAIL Training Tracker Tool~~	~~2.6.1, 10.2.1, 10.3.2, 10.3.5.3~~
~~Altair Power Source Emulator and Power Load Emulator for EEST~~	~~10.3.3, 10.3.5.3, 10.3.2~~
~~Altair Power Source Emulator and Power Load Emulator for EEST~~	~~2.6.1, 10.2.1, 10.3.2, 10.3.5.3~~
~~LIDS Flight specific cabling and Connectors for EEST~~	~~2.6.1, 10.2.1, 10.3.2, 10.3.5.3~~
~~LIDS Power Load Emulator For EEST~~	~~2.6.1, 10.2.1, 10.3.2, 10.3.5.3~~
~~APAS Flight Specific Cabling and Connectors for EEST~~	~~2.6.1, 10.2.1, 10.3.2, 10.3.5.3~~
~~CEV to ISS Docking Adaptor Flight specific cabling and Connectors for EEST~~	~~2.6.1, 10.2.1, 10.3.2, 10.3.5.3~~
~~EVA Flight Specific Cabling and Connectors for EEST~~	~~10.3.3~~
PEPC Flight Specific Cabling and Connectors to/from PEPC for ITL	
PEPC Power Load Emulator for ITL	10.3.3
~~CEV to ISS Docking Adaptor Flight Like Emulator to represent vehicle Load. (For EEST)~~	~~2.6.1, 10.2.1, 10.3.2, 10.3.5.3~~
GFP FOR DEVELOPMENT AND QUAL TEST SERVICES	
~~CLV~~ SLS ~~Upper Stage Dome and Instrumentation Unit~~	
GFP FOR EFT-1	
Mission Support Adapter	Annex 4
GFP for AA-2	
Integrated Sep Ring	
Abort Test Booster-to-Flight Test Article Emulator	
HOTH GFE ITEMS (all are Qty 1)	
Global Positioning System Receiver	10.3.2, 10.3.2.4
C&T Emulator	10.3.2, 10.3.2.4
Serial Conversion Procesor	10.3.2, 10.3.2.4
TDRSS Simulator	10.3.2, 10.3.2.4
Command and Telemetry Unit	10.3.2, 10.3.2.4
Command Control and Monitoring System - Telemetry and Archive Group Rig Rack	10.3.2, 10.3.2.4
Ground Power Unit	10.3.2, 10.3.2.4
HOTH Power Switching Unit & Cables	10.3.2, 10.3.2.4
Battery Interface box	10.3.2, 10.3.2.4
Spacecraft Interface Unit	10.3.2, 10.3.2.4
EGSE Cable Group	10.3.2, 10.3.2.4
Pyro Signal Test Set	10.3.2, 10.3.2.4
Breakout Box Set	10.3.2, 10.3.2.4
RF Support Set	10.3.2, 10.3.2.4
Propulsion Valve Emulator	10.3.2, 10.3.2.4
GPS Simulator Unit	10.3.2, 10.3.2.4
Navigation System Test Set	10.3.2, 10.3.2.4
ODN Recording System	10.3.2, 10.3.2.4
HOTH I/O Pump	10.3.2, 10.3.2.4
Nominal Load Emulator Rack 1	10.3.2, 10.3.2.4
Nominal Load Emulator Rack 1 Cabling	10.3.2, 10.3.2.4
Lab Cable Harnesses	10.3.2, 10.3.2.4
Flight System Platform	10.3.2, 10.3.2.4

SW Licenses	10.3.2, 10.3.2.4
ATB Simulator	10.3.2, 10.3.2.4
~~GFP for ETA~~	
~~Integrated Sep Ring (Simplified) for ETA~~	
OTHER (moved from 'Pending' tab)	
NASA PROVIDED GSE	Dryden Flight Research Center and White Sands Missile Range
NASA PROVIDED GSE	Kennedy Space Center
NASA PROVIDED GSE	Marshall Space Flight Center - Michoud Assembly Facility
NASA PROVIDED GSE	Marshall Space Flight Center - Michoud Assembly Facility
NASA PROVIDED GSE	Marshall Space Flight Center - Michoud Assembly Facility
NASA PROVIDED GSE	Marshall Space Flight Center - Michoud Assembly Facility
NASA PROVIDED GSE	Marshall Space Flight Center - Michoud Assembly Facility
NASA PROVIDED GSE	Marshall Space Flight Center - Michoud Assembly Facility
NASA PROVIDED GSE	Marshall Space Flight Center - Michoud Assembly Facility
NASA PROVIDED GSE	Marshall Space Flight Center - Michoud Assembly Facility

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ner Supplied Property/GFE

light Hardware

ESM Related Changes - In scope but not priced

Justification, Delivery Date Needed
~~2 months prior to System Qual Test commencement~~ ~~10 months prior to Orion 2~~
~~4 months prior to Ground Test Article (GTA) Test Commencement~~ ~~5 months prior to STA Test Commencement~~
~~8 months prior to AA-2~~
~~TBD~~
~~5/31/2014 (11 months prior to OFT1)~~ ~~12/1/2016 (12 months prior to EM-1)~~ ~~12/15/2017 (12 Months prior to AA-2)~~ ~~9/1/2019 (12 months prior to EM-2)~~
6/31/2014 (10 months prior to EFT-1) 12/1/2016 (12 months prior to EM-1) 12/15/2017 (12 Months prior to AA-2) 9/1/2019 (12 months prior to EM-2)
7/31/2014 (9 months prior to EFT-1) 12/1/2016 (12 months prior to EM-1) 12/15/2017 (12 Months prior to AA-2) 9/1/2019 (12 months prior to EM-2)
5/31/2014 (11 months prior to EFT-1) 12/1/2016 (12 months prior to EM-1) 12/15/2017 (12 Months prior to AA-2) 9/1/2019 (12 months prior to EM-2)
5/31/2014 (11 months prior to EFT-1) 12/1/2019 (12 months prior to EM-2) 12/5/2017 (12 Months prior to AA-2) 9/1/2019 (12 months prior to EM-2)
5 months prior to GTA. Reconfiguration update 5 months prior to STA testing.
~~30 months prior to Orion Flight Test 1~~
~~30 months prior to Orion Flight Test 1~~
3/1/2020 (6 months prior to EM-2)

~~5~~ 9/30/2013 (11 months prior to EFT-1) 1/2/2017 (11 months prior to EM-1)
~~Apr 13~~
~~3~~ 8/30/2014 (for EFT1), 11/1/2017 (for EM-1), 8/1/2020 for EM-2 (1 month prior to EFT 1, EM-1 and EM-2)
~~2/1/2020 (7 Months prior to EM 2)~~
~~3~~ 8/30/2014 (1 month prior to EFT-1)
3/1/2017 for EM1 (9 month prior to EM-1)
9/1/2019 for EM2 (12 months prior to EM-2)
9/1/2019 (12 months prior to EM-2)
9/1/2019 (12 months prior to EM-2)
9/1/2019 (12 months prior to EM-2)
9/1/2019 (12 months prior to EM-2)
6/1/2020 (3 months prior to EM-2)
6/1/2020 (3 months prior to EM-2)
10/30/2012 (18 months prior to EFT-1)
10/30/2012 (18 months prior to EFT-1)
10/30/2012 (18 months prior to EFT-1)
12/1/2015 (24 Months prior to EM-1), to be used for other events as needed. (NOTE: No deliveries required for EM-2 as the flight FCE is installed into the vehicle after delivery to NASA.)
~~9/1/2018 (24 Months prior to EM 2)~~
~~TBD~~
~~5/1/2019 (Available 16 months prior to EM 2)~~
~~5/1/2019 (Available 16 months prior to EM-2)~~
~~5/1/2019 (Available 16 months prior to EM 2)~~
~~TBD~~
~~TBD~~
~~TBD~~

~~6/1/2015 for EM1, 3/1/2018 for EM2 (30 Months prior to EM-1 and EM-2)~~
8/13/2012 - QTY 3 nuts and Qty 6 Boosters for GTA Shock Testing. 12/28/2012 - QTY 6 nuts and QTY 12 Boosters for LAS R&R Qualification and Shock Discovery Testing
6/28/2013 - QTY 6 nuts and QTY 12 Boosters for EFT-1
9/1/2015 - Qty 5 for Development, Qty 26 Flight, Qty 6 Inert
Qty 300 NSI's on 6/30/2013 for EFT-1 testing 9/15/2014 - Qty 400 TBD - Qty 800
Qty 40 - TBD for EM1 and EM2. (Note: NET Jan 2015. LM to provide bolt size and load requirements to NASA. Delivery is ~12 months from receipt of this data.)
12/1/2015 (L-24) for EM1, Qty 3 Main, 2 Drogue 9/1/2018 (L-24) for EM2, Qty 3 Main, 2 Drogue
ESTING
6 months prior to EM-1 configuration ITL activation
3 months prior EM-1 O&C activation
~~TBD~~
~~12 months prior to EM-1 configuration ITL activation~~
~~6 months prior to EM-1 configuration ITL activation. Reconfiguration update 6 months prior to EM-2 configuration ITL activation~~
~~6 months prior to EM-1 configuration ITL activation. Reconfiguration update 6 months prior to EM-2 configuration ITL activation~~
~~6 months prior to EM-1 configuration ITL activation. Reconfiguration update 6 months prior to EM-2 configuration ITL activation~~
6 months prior to EM-2 configuration ITL activation
~~TBD~~
~~TBD~~
~~TBD~~

~~TBD~~
~~TBD~~
~~TBD~~
~~TBD~~
~~TBD~~
~~TBD~~
~~TBD~~
~~TBD~~
6 months prior to EM-2 configuration ITL activation
6 months prior to EM-2 configuration ITL activation
~~TBD~~
~~1 month prior to Commencement of System Qual Testing (Duration 6 months)~~
~~6/30/2013~~ 2/1/2014
6/15/2018 (6 Months prior to AA-2 Launch)
6/15/2018 (6 Months prior to AA-2 Launch)
12/31/2016 (24 months prior to AA-2 Launch), Reuse of EFT-1
6/30/16 (30 months prior to AA-2 Launch), Reuse of EFT-1
6/30/16 (30 months prior to AA-2 Launch), Reuse of EFT-1
6/30/16 (30 months prior to AA-2 Launch), Reuse of EFT-1
6/30/16 (30 months prior to AA-2 Launch), Upgraded
6/30/16 (30 months prior to AA-2 Launch), New
6/30/16 (30 months prior to AA-2 Launch), New
6/30/16 (30 months prior to AA-2 Launch), New
6/30/16 (30 months prior to AA-2 Launch), New
6/30/16 (30 months prior to AA-2 Launch), Upgraded
6/30/16 (30 months prior to AA-2 Launch), New
6/30/16 (30 months prior to AA-2 Launch), New
6/30/16 (30 months prior to AA-2 Launch), New
6/30/16 (30 months prior to AA-2 Launch), Reuse EFT-1 RFSS functionality
9/30/16 (27 months prior to AA-2 Launch), New
12/31/2016 (24 months prior to AA-2 Launch), Reuse of EFT-1
12/31/2016 (24 months prior to AA-2 Launch), Reuse of EFT-1
6/30/16 (30 months prior to AA-2 Launch), Reuse of EFT-1 with upgrades
6/30/16 (30 months prior to AA-2 Launch), Upgraded
6/30/16 (30 months prior to AA-2 Launch), New
6/30/16 (30 months prior to AA-2 Launch), New
6/30/16 (30 months prior to AA-2 Launch), New
6/30/16 (30 months prior to AA-2 Launch), New

Annual Renewals
12/31/2016 (24 months prior to AA-2 Launch), New
Custom 14 Foot Trailer to house Special Test Equipment (STE) during the integration and checkout activities of the Abort Flight Test (AFT) Crew Module (CM). The trailer will be used to protect the STE from the outside environment at Dryden Flight Research Center (DFRC) and White Sands Missile Range (WSMR). STE includes Article In the Loop (AIL) simulator, Pyro Test Set (PTS), LAS Interface Emulator (LAS IFE Details in Memo: STE Trailer Requirements, April 7, 2008, Rev C.
Lifting Devices (Hydrasets, Crane hooks, and up) O&C Bridge Crane, Hydrasets
(Multipurpose Logistics Module (MPLM) Mobile Surveillance Vehicle (MSV) for Flight Test Mobile Group Communication, 12 months prior to PA-1 through Schedule A
Payload Bay Interior Access Universal Sling for miscellaneous handling/lifting, 12 months prior to PA-1 through Schedule A
Payload Bay Ballast Pallet Sling for miscellaneous handling/lifting, 12 months prior to SDU through Schedule A
(MUR) & (FSS) Container Cover 4 Point Sling for miscellaneous handling/lifting, 12 months prior to SDU through Schedule A
Adjustable Span Hoist Beam Assembly for miscellaneous handling/lifting, 4 months prior to PA-1 through Schedule A
Payload Ground Support Equipment (GSE) Container Sling Assembly for miscellaneous handling/lifting, 4 months prior to PA-1 through Schedule A
Variable CG Lifting Fixture for miscellaneous handling/lifting ,4 months prior to PA-1 through Schedule A
Personnel Stand for access to CEV processing, 4 months prior to PA-1 through Schedule A

Attachment J.11.3 Government Provided Materials

Part/Model #	Nomenclature	Justification
39-2887-42000	Glass Frit - Shuttle residual material	Backshell Tile Effort
5912-0025-001	Strain Isolator Pad(.160 SIP) Shuttle residual material	Backshell Tile Effort
5912-0021-001	Strain Isolator Pad(.090 SIP) Shuttle residual material	Backshell Tile Effort
39-3300-00200	Silica Fiber - Shuttle residual material	Backshell Tile Effort
39-2847-15001	Tetraboron Silicide (SIB 4) - Shuttle residual material	Backshell Tile Effort
39-2848-16000	Nextel Filament - Shuttle residual material	Backshell Tile Effort
Fused Silica	TBD	24 months prior to Orion Flight-Test 1

(Transfer Glass frit from Contract NNJ06V01C to NNJ06TA25C for usage)

Glass Type	Box description	Slice SN	Grade	Dims	Type
MC332-0006 REV. E, F01					
	USA 62				
		529040142		44" x 1.516" Th	7980 Thermal
		529040131		44" x 1.323" Th	7980 Thermal
		529040141		44" x 1.514" Th	7980 Thermal
MC332-0006-0002/-0006					
	BOX 1				
		24118-001	5G	48" x 1.9" Thk	7940 Thermal
		24118-002	5G	48" x 1.9" Thk	7940 Thermal
		24120-002	5G	48" x 1.9" Thk	7940 Thermal
		24120-001	5G	48" x 1.9" Thk	7940 Thermal
	BOX 2				
		24116-001	5G	48" x 1.9" Thk	7940 Thermal
		24111-002	5G	48" x 1.9" Thk	7940 Thermal
		24110-001	5G	48" x 1.9" Thk	7940 Thermal
		24111-001	5G	48" x 1.9" Thk	7940 Thermal
	BOX 3				
		24114-002	5G	48" x 1.9" Thk	7940 Thermal
		24114-001	5G	48" x 1.9" Thk	7940 Thermal
MC332-0006-0026/-0027/-0028/-0029					
	USA 16				
		25822-002	3G	44" x 1.125" Thk	7940 Thermal
		33810-001	3G	44" x 1.125" Thk	7940 Thermal
		25822-001	3G	44" x 1.125" Thk	7940 Thermal

Glass Type	Box description	Slice SN	Grade	Dims	Type
		25816-001	3G	44" x 1.125" Thk	7940 Thermal
		25816-002	3G	44" x 1.125" Thk	7940 Thermal
	USA 17				
		25820-001	3G	44" x 1.125" Thk	7940 Thermal
		25821-002	3G	44" x 1.125" Thk	7940 Thermal
		25821-001	3G	44" x 1.125" Thk	7940 Thermal
		25819-002	3G	44" x 1.125" Thk	7940 Thermal
		25819-001	3G	44" x 1.125" Thk	7940 Thermal
	USA 18				
		25827-002	3G	44" x 1.125" Thk	7940 Thermal
		25827-003	3G	44" x 1.125" Thk	7940 Thermal
		33811-001	3G	44" x 1.125" Thk	7940 Thermal
		33812-001	3G	44" x 1.125" Thk	7940 Thermal
		33816-002	3G	44" x 1.125" Thk	7940 Thermal
	USA 19				
		25827-001	3G	44" x 1.125" Thk	7940 Thermal
		25824-001	3G	44" x 1.125" Thk	7940 Thermal
		33816-001	3G	44" x 1.125" Thk	7940 Thermal
		25731-001	3G	44" x 1.125" Thk	7940 Thermal
		33812-002	3G	44" x 1.125" Thk	7940 Thermal
	USA 20				
		25820-002	3G	44" x 1.125" Thk	7940 Thermal
		25729-002	3G	44" x 1.125" Thk	7940 Thermal
		33814-002	3G	44" x 1.125" Thk	7940 Thermal
		25826-001	3G	44" x 1.125" Thk	7940 Thermal
		25823-002	3G	44" x 1.125" Thk	7940 Thermal
	USA 21				
		25825-001	3G	44" x 1.125" Thk	7940 Thermal
		33811-002	3G	44" x 1.125" Thk	7940 Thermal
		33813-002	3G	44" x 1.125" Thk	7940 Thermal
		25823-001	3G	44" x 1.125" Thk	7940 Thermal
		33818-001	3G	44" x 1.125" Thk	7940 Thermal
	USA 22				
		33814-001	3G	44" x 1.125" Thk	7940 Thermal
		25825-002	3G	44" x 1.125" Thk	7940 Thermal
		25824-002	3G	44" x 1.125" Thk	7940 Thermal
		25825-003	3G	44" x 1.125" Thk	7940 Thermal
		25826-002	3G	44" x 1.125" Thk	7940 Thermal
	USA 23				
		33812-003	3G	44" x 1.125" Thk	7940 Thermal
		33820-002	3G	44" x 1.125" Thk	7940 Thermal
		25831-001	3G	44" x 1.125" Thk	7940 Thermal
		25833-001	3G	44" x 1.125" Thk	7940 Thermal
		25839-001	3G	44" x 1.125" Thk	7940 Thermal
	USA 24				

Glass Type	Box description	Slice SN	Grade	Dims	Type
		33820-001	3G	44" x 1.125" Thk	7940 Thermal
		33818-002	3G	44" x 1.125" Thk	7940 Thermal
		33814-003	3G	44" x 1.125" Thk	7940 Thermal
		25824-003	3G	44" x 1.125" Thk	7940 Thermal
		33811-003	3G	44" x 1.125" Thk	7940 Thermal
	USA 30				
		25844-002	3G	44" x 1.125" Thk	7940 Thermal
		25835-001	3G	44" x 1.125" Thk	7940 Thermal
		25835-002	3G	44" x 1.125" Thk	7940 Thermal
		25844-001	3G	44" x 1.125" Thk	7940 Thermal
		33828-002	3G	44" x 1.125" Thk	7940 Thermal
	USA 31				
		25830-002	3G	44" x 1.125" Thk	7940 Thermal
		25830-003	3G	44" x 1.125" Thk	7940 Thermal
		25842-003	3G	44" x 1.125" Thk	7940 Thermal
		33828-001	3G	44" x 1.125" Thk	7940 Thermal
		25845-001	3G	44" x 1.125" Thk	7940 Thermal
MC332-0006-0035					
	USA 32				
		33834-006	2C	16" x 26.5" x 1"	7940 Photographic
	USA 50				
		0.062114	2C	16" x 26.5" x 1"	7980 Photographic
MC332-0006-0036/-0037					
	BOX 4				
		24113-008	2C	12.4" x 22.9" x 1"	7940 photographic
		24113-007	2C	12.4" x 22.9" x 1"	7940 photographic

Attachment J-11.3 Government Furnished Material

Prop Class	Part/Model #	Serial # (if applicable)	Lot # (if applicable)	Nomenclature	Quantity	Unit of Measure	Cost	Extended cost	Acquisition Date	Government Furnished Property (GFP)	Justification
MAT	8259539	Not Serialized	055975A	BRACKET FILTER	1.000	EA	84.150	84.150		GFP	
MAT	0473007	N/A	N/A	FUSE SLOW 7A 125V	242.000	EA	1.190	287.980		GFP	
MAT	0473007	N/A	N/A	FUSE SLOW 7A 125V	78.000	EA	1.190	92.820		GFP	
MAT	15310	N/A	N/A	TERMINAL BOARD 13.13IN LG	16.000	EA	16.950	271.200		GFP	
MAT	15310	N/A	N/A	TERMINAL BOARD 13.13IN LG	8.000	EA	16.950	135.600		GFP	
MAT	15310	N/A	N/A	TERMINAL BOARD 13.13IN LG	8.000	EA	16.950	135.600		GFP	
MAT	1N4005G	N/A	N/A	DIODE, RECT, LOW PWR, 600V	75.000	EA	0.170	12.750		GFP	
MAT	1N5402RLG	N/A	N/A	DIODE, RECT, LOW PWR, 200V	16.000	EA	0.050	0.800		GFP	
MAT	1V5KE43CA	N/A	N/A	DIODE	176.000	EA	0.210	36.960		GFP	
MAT	20097-98C-12	N/A	N/A	SCREW, SHC, .164-32X.75	200.000	EA	4.460	892.000		GFP	
MAT	275025L	N/A	N/A	FUSE FAST 25A 32V	64.000	EA	164.770	10 545.280		GFP	
MAT	275025L	N/A	N/A	FUSE FAST 25A 32V	18.000	EA	164.770	2 965.860		GFP	
MAT	3140 493G MIL-A-46146	N/A	N/A	3140 RTV COATING	2.000	EA	70.490	140.980		GFP	
MAT	3145	N/A	N/A	RTV SEALANT THIS PART NUMBER	5.000	EA	35.980	179.900		GFP	
MAT	34142	N/A	N/A	TERMINAL RING TNG #6	98.000	EA	13.000	1 274.000		GFP	
MAT	34142	N/A	N/A	TERMINAL RING TNG #6	20.000	EA	13.000	260.000		GFP	
MAT	504222B00000G	N/A	N/A	HEAT SINK	40.000	EA	0.410	16.400		GFP	
MAT	504222B00000G	N/A	N/A	HEAT SINK	20.000	EA	0.410	8.200		GFP	
MAT	53408-1	N/A	N/A	GRINDING TERM LUG	661.000	EA	0.920	608.120		GFP	
MAT	53408-1	N/A	N/A	GRINDING TERM LUG	120.000	EA	0.920	110.400		GFP	
MAT	53417-1	N/A	N/A	TERMINAL LUG	173.000	EA	1.080	186.840		GFP	
MAT	53417-1	N/A	N/A	TERMINAL LUG	40.000	EA	1.080	43.200		GFP	
MAT	53424-1	N/A	N/A	GRND LUG #8	344.000	EA	1.080	371.520		GFP	
MAT	53424-1	N/A	N/A	GRND LUG #8	50.000	EA	1.080	54.000		GFP	
MAT	808060W	N/A	N/A	LACING TAPE	8.000	EA	93.170	745.360		GFP	
MAT	8259678-001	Not Serialized	058638A	FILTER LOW PASS	4.000	EA	65.840	263.360		GFP	
MAT	8272775-802	22889046	99000204	FT-RIU ASSEMBLY	1.000	EA	200 000.000	200 000.000		GFP	
MAT	948421750222-014	N/A	N/A	FAN BRACE PDU	2.000	EA	338.470	676.940		GFP	
MAT	948421750222-016	N/A	N/A	BUSHING BUS BAR	15.000	EA	66.450	996.750		GFP	
MAT	948421750232-501	N/A	N/A	PDU TERMINAL BOARD	16.000	EA	16.950	271.200		GFP	
MAT	94864320300-501		GM43275	PTS Circuit Card	7.000	EA	35 000.000	245 000.000		GFM	
MAT	948SEICEV00005-301	N/A	N/A	PDU TESTER CABLE	1.000	EA	541.250	541.250		GFP	
MAT	948SEICEV00005-303	N/A	N/A	PDU TESTER CABLE	1.000	EA	541.250	541.250		GFP	
MAT	948SEICEV00005-305	N/A	N/A	PDU TESTER CABLE	1.000	EA	541.250	541.250		GFP	
MAT	948SEICEV00005-307	N/A	N/A	PDU TESTER CABLE	1.000	EA	541.250	541.250		GFP	
MAT	948SEICEV00005-309	N/A	N/A	PDU TESTER CABLE	1.000	EA	541.250	541.250		GFP	
MAT	948SEICEV00005-311	N/A	N/A	PDU TESTER CABLE	1.000	EA	541.250	541.250		GFP	
MAT	948SEICEV00005-313	N/A	N/A	PDU TESTER CABLE	1.000	EA	541.250	541.250		GFP	
MAT	948SEICEV00005-317	N/A	N/A	PDU TESTER CABLE	1.000	EA	541.250	541.250		GFP	
MAT	A18-10	N/A	N/A	LUG TERMINAL	80.000	EA	0.250	20.000		GFP	
MAT	A18-4	N/A	N/A	TERMINAL	96.000	EA	0.240	23.040		GFP	
MAT	A18-6	N/A	N/A	TERMINAL LUG	92.000	EA	0.250	23.000		GFP	
MAT	AS21919WCJ04	N/A	N/A	CLAMP & CLIP LOOP	100.000	EA	2.170	217.000		GFP	
MAT	AS21919WCJ06	N/A	N/A	CLAMP CUSHIONED LOOP .375	100.000	EA	1.080	108.000		GFP	
MAT	BK1/MCRW2A	N/A	N/A	FUSE, FAST, 2A, 125V	20.000	EA	0.730	14.600		GFP	
MAT	BK1/MCRW2A	N/A	N/A	FUSE, FAST, 2A, 125V	2.000	EA	0.730	1.460		GFP	
MAT	BR231D-450B3-28V	N/A	N/A	RELAY	22.000	EA	593.750	13,062.500		GFP	
MAT	C10-516	N/A	N/A	BARE RING	76.000	EA	0.300	22.800		GFP	
MAT	CEC-12	N/A	N/A	DUST CAP	2.000	EA	1.080	2.160		GFP	
MAT	CEC-14	N/A	N/A	DUST CAP	14.000	EA	1.080	15.120		GFP	
MAT	CEC-16	N/A	N/A	ESD CAP	18.000	EA	1.080	19.440		GFP	
MAT	CEC-19	N/A	N/A	DUST CAP THREADED	6.000	EA	1.080	6.480		GFP	
MAT	CEC-26	N/A	N/A	ESD CAP	2.000	EA	1.080	2.160		GFP	
MAT	D06D100	N/A	N/A	SWITCH	15.000	EA	73.820	1 107.300		GFP	
MAT	D38999/20FJ19SN	N/A	N/A	CONNECTOR	2.000	EA	79.830	159.660		GFP	
MAT	D38999/20FJ19SN	N/A	N/A	CONNECTOR	1.000	EA	79.830	79.830		GFP	
MAT	D38999/24FB35PN	N/A	N/A	RECEPTACLE, JAM NUT	6.000	EA	34.820	208.920		GFP	
MAT	D38999/24FB35PN	N/A	N/A	RECEPTACLE, JAM NUT	2.000	EA	34.820	69.640		GFP	
MAT	D38999/24FC35PN	N/A	N/A	RECEPTACLE JAM NUT	6.000	EA	34.510	207.060		GFP	
MAT	D38999/24FC35SN	N/A	N/A	CONNECTOR	6.000	EA	38.070	228.420		GFP	
MAT	D38999/24FC4PN	N/A	N/A	CONNECTOR, RCPT, 4P, CIRC, STF	5.000	EA	56.540	282.700		GFP	
MAT	D38999/24FC4PN	N/A	N/A	CONNECTOR RCPT 4P CIRC STF	2.000	EA	56.540	113.080		GFP	
MAT	D38999/24FC4SN	N/A	N/A	CONNECTOR	7.000	EA	32.050	224.350		GFP	
MAT	D38999/24FC4SN	N/A	N/A	CONNECTOR	1.000	EA	32.050	32.050		GFP	
MAT	D38999/24FC98SN	N/A	N/A	CONNECTOR	7.000	EA	35.010	245.070		GFP	
MAT	D38999/24FC98SN	N/A	N/A	CONNECTOR	1.000	EA	35.010	35.010		GFP	
MAT	D38999/24FD15SN	N/A	N/A	CONNECTOR	6.000	EA	44.720	268.320		GFP	
MAT	D38999/24FD15SN	N/A	N/A	CONNECTOR	2.000	EA	44.720	89.440		GFP	
MAT	D38999/24FD18SN	N/A	N/A	CONNECTOR	6.000	EA	43.030	258.180		GFP	
MAT	D38999/24FD18SN	N/A	N/A	CONNECTOR	2.000	EA	43.030	86.060		GFP	
MAT	D38999/24FD19SN	N/A	N/A	CONNECTOR	6.000	EA	44.390	266.340		GFP	
MAT	D38999/24FD35PN	N/A	N/A	RECEPTACLE	6.000	EA	44.570	267.420		GFP	
MAT	D38999/24FD35SN	N/A	N/A	RECEPTACLE	6.000	EA	44.570	267.420		GFP	
MAT	D38999/24FD97SN	N/A	N/A	CONNECTOR	7.000	EA	44.860	314.020		GFP	
MAT	D38999/24FD97SN	N/A	N/A	CONNECTOR	1.000	EA	44.860	44.860		GFP	
MAT	D38999/24FE26SN	N/A	N/A	CONNECTOR SHELL	4.000	EA	47.500	190.000		GFP	
MAT	D38999/24FE26SN	N/A	N/A	CONNECTOR SHELL	3.000	EA	47.500	142.500		GFP	
MAT	D38999/24FE26SN	N/A	N/A	CONNECTOR SHELL	1.000	EA	47.500	47.500		GFP	
MAT	D38999/24FE35PN	N/A	N/A	RECEPTACLE JAM NUT	6.000	EA	41.640	249.840		GFP	
MAT	D38999/24FG11PN	N/A	N/A	CONN. JAM NUT	6.000	EA	42.250	253.500		GFP	
MAT	D38999/24FG11SA	N/A	N/A	CONNECTOR	6.000	EA	126.050	756.300		GFP	
MAT	D38999/24FG11SB	N/A	N/A	CONN RCPT 11S CIRC	7.000	EA	100.100	700.700		GFP	
MAT	D38999/24FG11SB	N/A	N/A	CONN, RCPT, 11S, CIRC	1.000	EA	100.100	100.100		GFP	
MAT	D38999/24FG11SC	N/A	N/A	CONN, RCPT, 11S, CIRC	6.000	EA	65.720	394.320		GFP	
MAT	D38999/24FG11SC	N/A	N/A	CONN, RCPT, 11S, CIRC	2.000	EA	65.720	131.440		GFP	
MAT	D38999/24FG11SN	N/A	N/A	CONNECTOR, CIRCULAR THREADI	7.000	EA	65.810	460.670		GFP	
MAT	D38999/24FG11SN	N/A	N/A	CONNECTOR CIRCULAR THREADI	1.000	EA	65.810	65.810		GFP	
MAT	D38999/24FJ19PN	N/A	N/A	CONNECTOR	7.000	EA	51.150	358.050		GFP	
MAT	D38999/24FJ19PN	N/A	N/A	CONNECTOR	1.000	EA	51.150	51.150		GFP	
MAT	D38999/26FD15SN	N/A	N/A	CONNECTOR SHELL SIZE 15	1.000	EA	39.050	39.050		GFP	
MAT	D38999/26FD35SN	N/A	N/A	CONNECTOR PLUG	1.000	EA	39.210	39.210		GFP	
MAT	D38999/26FG11SN	N/A	N/A	CONNECTOR	2.000	EA	128.230	256.460		GFP	
MAT	D38999/26FJ19PN	N/A	N/A	ASSEMBLY ITEM	2.000	EA	171.990	343.980		GFP	
MAT	D38999/26FJ19SN	N/A	N/A	CONNECTOR	1.000	EA	189.540	189.540		GFP	
MAT	M22759/11-12-9	N/A	N/A	WIRE	1470.000	FT	1.080	1,587.600		GFP	
MAT	M22759/11-16-9	N/A	N/A	WIRE 16AWG WHITE	830.000	FT	0.290	240.700		GFP	
MAT	M22759/11-16-9	N/A	N/A	WIRE 16AWG WHITE	700.000	FT	0.290	203.000		GFP	
MAT	M22759/11-20-9	N/A	N/A	WIRE 20 AWG	999.000	FT	1.080	1,078.920		GFP	
MAT	M22759/11-22-9	N/A	N/A	WIRE 22GA HIGH TEMPERATURE	1999.000	FT	1.080	2,158.920		GFP	
MAT	M22759/11-8-9	N/A	N/A	WIRE WHITE	500.000	EA	1.330	665.000		GFP	
MAT	M22759/11-8-9	N/A	N/A	WIRE WHITE	215.000	EA	1.330	285.950		GFP	
MAT	M39029/56-348	N/A	N/A	CONTACT SOCKETS SZ 22D	378.000	EA	0.990	374.220		GFP	
MAT	M39029/56-348	N/A	N/A	CONTACT SOCKETS SZ 22D	179.000	EA	0.990	177.210		GFP	
MAT	M39029/56-348	N/A	N/A	CONTACT SOCKETS SZ 22D	18.000	EA	0.990	17.820		GFP	
MAT	M39029/56-351	N/A	N/A	CONTACT SOCKET SIZE 20	589.000	EA	1.030	606.670		GFP	
MAT	M39029/56-351	N/A	N/A	CONTACT SOCKET SIZE 20	195.000	EA	1.030	200.850		GFP	
MAT	M39029/56-352	N/A	N/A	SOCKET SIZE 16 SERIES III	182.000	EA	0.990	180.180		GFP	
MAT	M39029/56-352	N/A	N/A	SOCKET SIZE 16 SERIES III	56.000	EA	0.990	55.440		GFP	
MAT	M39029/56-352	N/A	N/A	SOCKET SIZE 16 SERIES III	30.000	EA	0.990	29.700		GFP	
MAT	M39029/56-353	N/A	N/A	SOCKET CONTACT	268.000	EA	1.090	292.120		GFP	
MAT	M39029/56-353	N/A	N/A	SOCKET CONTACT	216.000	EA	1.090	235.440		GFP	
MAT	M39029/56-353	N/A	N/A	SOCKET CONTACT	69.000	EA	1.090	75.210		GFP	
MAT	M39029/58-360	N/A	N/A	CRIMP PIN 22AWG AMP 204370-2	635.000	EA	1.030	654.050		GFP	
MAT	M39029/58-360	N/A	N/A	CRIMP PIN 22AWG AMP 204370-2	228.000	EA	1.030	234.840		GFP	
MAT	M39029/58-360	N/A	N/A	CRIMP PIN 22AWG AMP 204370-2	58.000	EA	1.030	59.740		GFP	
MAT	M39029/58-364	N/A	N/A	PIN SIZE 16 SERIES II III	92.000	EA	0.840	77.280		GFP	
MAT	M39029/58-364	N/A	N/A	PIN SIZE 16 SERIES II III	42.000	EA	0.840	35.280		GFP	
MAT	M39029/58-364	N/A	N/A	PIN SIZE 16 SERIES II III	15.000	EA	0.840	12.600		GFP	
MAT	M39029/58-364	N/A	N/A	PIN SIZE 16 SERIES II III	8.000	EA	0.840	6.720		GFP	
MAT	M39029/58-365	N/A	N/A	PIN	170.000	EA	1.020	173.400		GFP	
MAT	M39029/58-365	N/A	N/A	PIN	150.000	EA	1.020	153.000		GFP	
MAT	M39029/58-365	N/A	N/A	PIN	69.000	EA	1.020	70.380		GFP	
MAT	M85049/38S17N	N/A	N/A	BACKSHELL	10.000	EA	43.280	432.800		GFP	
MAT	M85049/38S25N	N/A	N/A	BACKSHELL	2.000	EA	25.350	50.700		GFP	
MAT	MLA-100-50	N/A	N/A	SHUNT 100A 50MV	70.000	EA	10.970	767.900		GFP	
MAT	MLA-100-50	N/A	N/A	SHUNT 100A 50MV	10.000	EA	10.970	109.700		GFP	
MAT	MMS14100A012	N/A	N/A	.125" THK OXYGEN FREE C10200 (1	2325.000	"	0.300	697.500		GFP	
MAT	MMSEWZD312A012	N/A	N/A	12AWG SOLID BUS BAR WIRE	795.000	FT	12.500	9 937.500		GFP	
MAT	MMSJ1078A050	N/A	N/A	.50" POLYIMIDE TAPE 966 ACRYLIC	2.000	RL	55.050	110.100		GFP	
MAT	MMSK786A100	N/A	N/A	POLYURETHANE 1GL	1.000	KT	27.060	27.060		GFP	
MAT	MMSL1015A100	N/A	N/A	EPOXY RESIN(EPON 828)	1.000	EA	72.090	72.090		GFP	
MAT	MMSL514A025	N/A	N/A	SILICON DIOXIDE MICR	1.000	BG	60.270	60.270		GFP	
MAT	MMSM1011A100	N/A	N/A	LOCKING COMPOUND, 1 OZ BOTTL	10.000	EA	1.080	10.800		GFP	

MAT	MMSM1047A500	N/A	N/A	500 GRM ADH. KIT THEM CONDUCT	2.000	KT	1,366.120	2,732.240		GFP
MAT	MMSM453A025	N/A	N/A	HIGH TEMP SILICONE	2.000	TU	18.770	37.540		GFP
MAT	MMSM453A025	N/A	N/A	HIGH TEMP SILICONE	1.000	TU	18.770	18.770		GFP
MAT	MMSM660D103	N/A	N/A	ADHESIVE, SILICON, CLEAR, 10.3 C	3.000	EA	70.170	210.510		GFP
MAT	MMSM660D103	N/A	N/A	ADHESIVE SILICON CLEAR 10.3 C	1.000	EA	70.170	70.170		GFP
MAT	MMSY451R015	N/A	N/A	SOLDER .015 DIA	3.000	EA	56.860	170.580		GFP
MAT	MMSY451R015	N/A	N/A	SOLDER .015 DIA	2.000	EA	56.860	113.720		GFP
MAT	MMSY451R020	N/A	N/A	.020 DIA SOLDER	3.000	LB	18.180	54.540		GFP
MAT	MMSY451R032	N/A	N/A	SOLDER .032DIA	2.000	EA	14.130	28.260		GFP
MAT	MMSY451R032	N/A	N/A	SOLDER .032DIA	1.000	EA	14.130	14.130		GFP
MAT	MMSY493A100	N/A	N/A	SOLDERING FLUX 611	1.000	LB	43.520	43.520		GFP
MAT	MMSY817E025	N/A	N/A	INK MARKING BLACK 1 QT	2.000	QT	10.830	21.660		GFP
MAT	MMSY839E200	N/A	N/A	WHITE EXPOXY INK	2.000	CN	306.740	613.480		GFP
MAT	MMSY839H050	N/A	N/A	BLACK EPOXY INK 6OZ	6.000	CN	95.950	575.700		GFP
MAT	MMSY839H100	N/A	N/A	BLACK EPOXY INK 1 QT	1.000	KT	208.920	208.920		GFP
MAT	MMSY839H100	N/A	N/A	BLACK EPOXY INK 1 QT	1.000	KT	208.920	208.920		GFP
MAT	MS15795-846	N/A	N/A	WASHER FLAT	156.000	EA	0.420	65.520		GFP
MAT	MS15795-846	N/A	N/A	WASHER FLAT	100.000	EA	0.420	42.000		GFP
MAT	MS15795-852	N/A	N/A	WASHER FLAT	200.000	EA	2.170	434.000		GFP
MAT	MS15795-856	N/A	N/A	WASHER FLAT .172 DIA X .312 DIA X	241.000	EA	1.080	260.280		GFP
MAT	MS16995-19	N/A	N/A	SCREW CAP SOCKET HEAD	123.000	EA	1.350	166.050		GFP
MAT	MS16995-20	N/A	N/A	SCREW CAP 1/4-20	96.000	EA	1.080	103.680		GFP
MAT	MS16995-20	N/A	N/A	SCREW CAP 1/4-20	16.000	EA	1.080	17.280		GFP
MAT	MS21043-06	N/A	N/A	NUT SELF LOCKING	190.000	EA	0.890	169.100		GFP
MAT	MS21043-06	N/A	N/A	NUT SELF LOCKING	20.000	EA	0.890	17.800		GFP
MAT	MS21043-08	N/A	N/A	NUT, SELF-LOCKING HEX	101.000	EA	1.100	111.100		GFP
MAT	MS21043-08	N/A	N/A	NUT, SELF-LOCKING HEX	3.000	EA	1.100	3.300		GFP
MAT	MS21043-3	N/A	N/A	NUT, SELF-LOCKING, EXTENDED W	182.000	EA	0.330	60.060		GFP
MAT	MS21043-3	N/A	N/A	NUT, SELF-LOCKING, EXTENDED W	5.000	EA	0.330	1.650		GFP
MAT	MS24693-C50	N/A	N/A	SCREW MACHINE	1000.000	EA	0.160	160.000		GFP
MAT	MS24693-C6	N/A	N/A	SCREW FLAT HEAD 100 DEG 4-40U	800.000	EA	0.110	88.000		GFP
MAT	MS35338-135	N/A	N/A	WASHER LOCK SPLIT #4	16.000	EA	0.390	6.240		GFP
MAT	MS35649-244	N/A	N/A	NUT PLAIN HEXAGON SS 4-40	243.000	EA	3.850	935.550		GFP
MAT	MS35649-244	N/A	N/A	NUT PLAIN HEXAGON SS 4-40	231.000	EA	3.850	889.350		GFP
MAT	MS35649-244	N/A	N/A	NUT PLAIN HEXAGON SS 4-40	25.000	EA	3.850	96.250		GFP
MAT	MS35649-264	N/A	N/A	NUT PLAIN HEXAGON	12.000	EA	0.140	1.680		GFP
MAT	MS35649-284	N/A	N/A	NUT PLAIN HEX SS 8-32	1908.000	EA	0.520	992.160		GFP
MAT	MS35649-284	N/A	N/A	NUT PLAIN HEX SS 8-32	86.000	EA	0.520	44.720		GFP
MAT	MS35650-384	N/A	N/A	NUT, PLAIN, HEX, CRES.	150.000	EA	1.080	162.000		GFP
MAT	MS51957-15	N/A	N/A	SCREW,MACHINE SS 4-40 X 3/8	20.000	EA	0.810	16.200		GFP
MAT	MS51957-17	N/A	N/A	SCREW,MACHINE SS 4-40 X 1/2	16.000	EA	0.020	0.320		GFP
MAT	MS51957-27	N/A	N/A	SCREW MACHINE PAN HEAD	188.000	EA	0.490	92.120		GFP
MAT	MS51957-27	N/A	N/A	SCREW MACHINE PAN HEAD	29.000	EA	0.490	14.210		GFP
MAT	MS51957-27	N/A	N/A	SCREW MACHINE PAN HEAD	15.000	EA	0.490	7.350		GFP
MAT	MS51957-30	N/A	N/A	SCREW MACHINE SS 6-32 X 1/2	12.000	EA	0.160	1.920		GFP
MAT	MS51957-31	N/A	N/A	SCREW MACHINE SS 6-32 X 5/8	150.000	EA	0.810	121.500		GFP
MAT	MS51957-42	N/A	N/A	SCREW	82.000	EA	1.010	82.820		GFP
MAT	MS51957-44	N/A	N/A	SCREW	646.000	EA	0.320	206.720		GFP
MAT	MS51957-45	N/A	N/A	SCREW MACHINE SS 8-32 X 1/2 #8	1596.000	EA	0.370	590.520		GFP
MAT	MS51957-45	N/A	N/A	SCREW MACHINE SS 8-32 X 1/2 #8	402.000	EA	0.370	148.740		GFP
MAT	MS51957-45	N/A	N/A	SCREW,MACHINE SS 8-32 X 1/2, #8	400.000	EA	0.370	148.000		GFP
MAT	MS51957-46	N/A	N/A	SCREW,MACHINE SS 8-32 X 5/8	1000.000	EA	0.430	430.000		GFP
MAT	MS51957-47	N/A	N/A	SCREW,MACHINE,PAN HD	921.000	EA	0.500	460.500		GFP
MAT	MS51957-47	N/A	N/A	SCREW,MACHINE,PAN HD	79.000	EA	0.500	39.500		GFP
MAT	MS51957-51	N/A	N/A	SCREW	200.000	EA	1.240	248.000		GFP
MAT	MS51957-51	N/A	N/A	SCREW	98.000	EA	1.240	121.520		GFP
MAT	MS51957-52	N/A	N/A	SCREW MACHINE PAN 8-32X 1 3/4 S	50.000	EA	2.790	139.500		GFP
MAT	MS51957-54	N/A	N/A	SCREW PAN .1640-32X2.250	400.000	EA	1.080	432.000		GFP
MAT	NAS1149CN432R	N/A	N/A	WASHER NO. 4 PASS	1000.000	EA	0.050	50.000		GFP
MAT	NAS1149CN432R	N/A	N/A	WASHER NO. 4 PASS	16.000	EA	0.050	0.800		GFP
MAT	NAS1149CN632R	N/A	N/A	WASHER	12.000	EA	0.040	0.480		GFP
MAT	NAS1149CN832R	N/A	N/A	WASHER #8	2000.000	EA	0.050	100.000		GFP
MAT	NAS1149CN832R	N/A	N/A	WASHER #8	6.000	EA	0.050	0.300		GFP
MAT	NAS1291C08M		438386	NUT,HEX,SL,LOW HGT,CRES,8-32	4.000	EA	6.500	26.000		GFM
MAT	NAS1802-3-12	N/A	N/A	SCREW	189.000	EA	2.390	451.710		GFP
MAT	NAS1802-3-12	N/A	N/A	SCREW	40.000	EA	2.390	95.600		GFP
MAT	NAS1802-3-14	N/A	N/A	SCREW	228.000	EA	1.060	241.680		GFP
MAT	NAS1802-3-14	N/A	N/A	SCREW	2.000	EA	1.060	2.120		GFP
MAT	NAS1992C4T	N/A	N/A	BOLT FLAT RDC HD	43.000	EA	1.080	46.440		GFP
MAT	NAS1992C4T	N/A	N/A	BOLT FLAT RDC HD	20.000	EA	1.080	21.600		GFP
MAT	NAS620C4L	N/A	N/A	WASHER FLAT .115 ID X .209 OD .0	128.000	EA	0.040	5.120		GFP
MAT	NAS620C4L	N/A	N/A	WASHER FLAT .115 ID X .209 OD .0	25.000	EA	0.040	1.000		GFP
MAT	NAS620C6	N/A	N/A	WASHER FLAT	264.000	EA	0.150	39.600		GFP
MAT	NAS620C6	N/A	N/A	WASHER FLAT	12.000	EA	0.150	1.800		GFP
MAT	NAS620C6L	N/A	N/A	WASHER #6	94.000	EA	0.060	5.640		GFP
MAT	NAS620C6L	N/A	N/A	WASHER #6	27.000	EA	0.060	1.620		GFP
MAT	NAS8100U6	N/A	N/A	SCREW	150.000	EA	1.180	177.000		GFP
MAT	NAS8100U6	N/A	N/A	SCREW	30.000	EA	1.180	35.400		GFP
MAT	NAS8101U13	N/A	N/A	SCREW, PAN, .138-32 X .8125	145.000	EA	2.710	392.950		GFP
MAT	NAS8101U14	N/A	N/A	SCREW, PAN, 138-32X.875	45.000	EA	16.570	745.650		GFP
MAT	NAS8101U14	N/A	N/A	SCREW PAN 138-32X.875	4.000	EA	16.570	66.280		GFP
MAT	NAS8101U5	N/A	N/A	SCREW	263.000	EA	2.710	712.730		GFP
MAT	NAS8101U7	N/A	N/A	SCREW PAN .138-32 X .4375	341.000	EA	4.190	1 428.790		GFP
MAT	NAS8101U7	N/A	N/A	SCREW PAN .138-32 X .4375	127.000	EA	4.190	532.130		GFP
MAT	NAS8101U8	N/A	N/A	SCREW PAN HD A-286	147.000	EA	5.410	795.270		GFP
MAT	NAS8101U9	N/A	N/A	SCREW PAN HD CRES	132.000	EA	5.410	714.120		GFP
MAT	NAS8102U10	N/A	N/A	SCREW PAN HD	81.000	EA	1.080	87.480		GFP
MAT	NAS8102U12	N/A	N/A	SCREW PAN .164-32 X .75	39.000	EA	1.080	42.120		GFP
MAT	NAS8102U24	N/A	N/A	SCREW, PAN, .164-32 X 1.500	79.000	EA	2.040	161.160		GFP
MAT	NAS8102U24	N/A	N/A	SCREW, PAN, .164-32 X 1.500	6.000	EA	2.040	12.240		GFP
MAT	NAS8102U26	N/A	N/A	SCREW, PAN, .164-32 X 1.6	49.000	EA	1.080	52.920		GFP
MAT	NAS8102U28	N/A	N/A	SCREW, PAN, .164-32 X 1.75	50.000	EA	2.710	135.500		GFP
MAT	NAS8102U6	N/A	N/A	SCREW PAN HD CRES	663.000	EA	1.080	716.040		GFP
MAT	NAS8103U6	N/A	N/A	SCREW P.H. #10 X 3.8	206.000	EA	1.620	333.720		GFP
MAT	NAS8103U7	N/A	N/A	SCREW P.H. #10 X .44	172.000	EA	1.080	185.760		GFP
MAT	NBS9GE8-2SE		GM537864	CONN NSI	1.000	EA	100.000	100.000		GFM
MAT	NBS9GE8-2SF		GM537512	CONNECTOR PLUG ELEC	3.000	EA	100.000	300.000		GFM
MAT	NBS9GE8-2SH		GM537861	CONNECTOR PLUG ELEC	1.000	EA	100.000	100.000		GFM
MAT	NH0504R000FC02	N/A	N/A	RES 4.0 OHM	11.000	EA	5.100	56.100		GFP
MAT	OD172SAPL-24HTB	N/A	N/A	FAN 24V 0.97A	5.000	EA	63.970	319.850		GFP
MAT	OD172SAPL-24HTB	N/A	N/A	FAN 24V 0.97A	2.000	EA	63.970	127.940		GFP
MAT	PLT1M-C76	N/A	N/A	TIE TEFZEL CABLE NEWARK #94F3	1300.000	EA	1.430	1,859.000		GFP
MAT	PLT1M-C76	N/A	N/A	TIE TEFZEL CABLE NEWARK #94F3	750.000	EA	1.430	1,072.500		GFP
MAT	RN60D1802FB14	N/A	N/A	RES, FILM, 18.0 KOHM	174.000	EA	0.660	114.840		GFP
MAT	RN60D2001FB14	N/A	N/A	RES, FILM1 2.0 KOHM	160.000	EA	1.020	163.200		GFP
MAT	RN65D1802FB14	N/A	N/A	RES 18.0 KOHM	100.000	EA	2.710	271.000		GFP
MAT	SDH26152123-001		440455	FOAM INSERT 1.5 Flangible nut (GF	30.000	EA	87.000	2 610.000		GFM
MAT	SJH36152820		553385	MAIN PARACHUTE	1.000	EA	130 000.000	130 000.000		GFM
MAT	SJH36152820		553385	MAIN PARACHUTE	2.000	EA	120 000.000	240 000.000		GFM
MAT	ST58D172-021	N/A	N/A	LUG TERMINAL INSULATED NICKE	103.000	EA	2.030	209.090		GFP
MAT	ST58D172-021	N/A	N/A	LUG TERMINAL INSULATED NICKE	57.000	EA	2.030	115.710		GFP
MAT	ST58D172-021	N/A	N/A	LUG TERMINAL INSULATED NICKE	5.000	EA	2.030	10.150		GFP
MAT	STPS6045CW	N/A	N/A	DIODE RECT PWR 45V	80.000	EA	1.440	115.200		GFP
MAT	SV767350-3			FAN IMU	1.000	EA	150 000.000	150 000.000		GFP
MAT	TFD-ENB-2W-40	N/A	N/A	SENSOR, FILM, 2 WIRE	8.000	EA	76.360	610.880		GFP
MAT	TFD-ENB-2W-40	N/A	N/A	SENSOR, FILM, 2 WIRE	2.000	EA	76.360	152.720		GFP
MAT	THQ1100192	N/A	N/A	CAPACITOR	9.000	EA	305.530	2,749.770		GFP
MAT	THQ1100192	N/A	N/A	CAPACITOR	1.000	EA	305.530	305.530		GFP
MAT	TYZ525M	N/A	N/A	TIE CABLE	1780.000	EA	1.080	1 922.400		GFP
MAT	TYZ525M	N/A	N/A	TIE CABLE	40.000	EA	1.080	43.200		GFP
MAT	WMG172B	N/A	N/A	FAN FILTER 6.7IN	13.000	EA	4.850	63.050		GFP
MAT	WMG172B	N/A	N/A	FAN FILTER 6.7IN	4.000	EA	4.850	19.400		GFP
MAT	WMG60B	N/A	N/A	FAN FILTER 2.36IN	40.000	EA	3.780	151.200		GFP
MAT	WMG60B	N/A	N/A	FAN FILTER 2.36IN	5.000	EA	3.780	18.900		GFP

NOTE Per the J-1 SOW paragraph 2.3c (h), 'All GFE product teams will deliver data equivalent to CFE deliverables'. A boilerplate list of data items required for each GFE item is provided below however, not all items are required for each piece of GFE provided. Each GFE item has different requirements for documentation. Specific data contents and deliverables, and delivery schedule, are jointly agreed upon at the GEMCP as each GFE project is initiated. This ensures adequate documentation to support integration of the GFE hardware, while also minimizing costs. Data will be delivered in NASA native format to meet the intent of the product/document requested, and will be updated as required to provide current data.

Attachment J-11.4 Government Furnished Equipment (GFE) DRD Boilerplate Contents

		Anticipated Delivery Milestone			
Product/ Document	CEV DRD No	PDR	CDR	SAR	Other
EA Project Approval Form (EA-002) with attached Feasibility Assessment	CEV-G-003	X	X		X
Project Management Plan (PMP)	CEV-G-004				
Concept of Operations Doc.	CEV-G-005	X	X		
Architecture Design Document	CEV-G-006	X			X
Project Technical Requirements Specification (PTRS)	CEV-G-007	X			X
Project Requirements and Verification Doc (PRVD) for IVA non-critical GFE (only for non-PTRS approved Projects)	CEV-G-008	X			X
Interface Control Documents (ICDs)	CEV-G-009	X	X		X
End Item Specification	CEV-G-013	X	X		X
Software Development Plan	CEV-G-014	X	X		X
Software Requirements Specification	CEV-G-015	X			X
Software Design Document	CEV-G-016	X	X		X
Version Description Document (Software and/or firmware; see EA-WI-025 f t l)	CEV-G-017		X		X
Peer Review and Inspection Results	CEV-G-019				X
Software Test Plan	CEV-G-020	X	X		X
Software Test Report	CEV-G-021		X	X	
Software Test Description	CEV-G-022		X		X
Verification and Validation Document	CEV-G-023	X	X		
Safety Data Package (which includes the prelim hazard analysis and failure modes & effects analyses for Phase 1 and a final version for Phase 2 & 3)	CEV-G-024	X	X	X	X
Hazardous, Key Operators List	CEV-G-025	X	X		
Risk Management Plan	CEV-G-026	X			X
Risk Management Reports	CEV-G-027				X
Fault Tree Analysis	CEV-G-028	X	X		
QA Audit Reports	CEV-G-029				X
Probabilistic Risk Assessment Results	CEV-G-030			X	X
Ground Safety Analysis Report (as required by KSC)	CEV-G-031	X	X	X	X
Specification Tree	CEV-G-032	X	X		X
Drawing Tree	CEV-G-033	X	X		X
Engineering Drawings	CEV-G-034	X	X		X
CAD Models	CEV-G-035	X	X		X
Engineering Models/Sims	CEV-G-036	X	X		X
Integrated Models/Sims	CEV-G-037	X	X		X
Design Analyses Reports	CEV-G-038				X
Sustaining Engineering Plan	CEV-G-039	X	X	X	X
Qualfiication and Acceptance Procedures	CEV-G-040		X		X
Qual and Acceptance Reports	CEV-G-041				X
Acceptance Data Package or JSC Project Parts Tag JF911 (See Section	CEV-G-042			X	X
Certification Plan	CEV-G-043	X	X		
Certification Data Package w/GCAR (See Section7 1 6 3 for list of required	CEV-G-044			X	
User's Guide	CEV-G-045	X	X		X
Updates for Data Books	CEV-G-046	X	X	X	X
As-Built EEE Parts List	CEV-G-047				X
Spectrum Management Documents	CEV-G-048	X	X		X
Fracture Control Report	CEV-G-049		X	X	
Materials Identification and Usage List	CEV-G-050	X	X		
Materials Usage Agreements	CEV-G-051	X	X		
Stress Analysis Reports	CEV-G-052	X	X	X	X
Mass Properties Reports	CEV-G-053	X	X	X	X
GFE Handling and Transportation Plan	CEV-G-054	X	X		
GFE Imagery Plan/Imagery Deliverables	CEV-G-055	X			X
R&M Analysis Report	CEV-G-056	X	X	X	
Problem Reporting and Corrective Action Reports	N/A				X
Critical Manufacturing Processes	CEV-G-0XX	X	X		
GFE Failure Mode Effects Analysis (FMEA)	CEV-G-0XX	X	X		

Attachment J-11.5 Rent Free Non-Interference Basis Property

ASSETS FOR CEV CM & SM STRUCTURAL DEVELOPMENT, TEST AND FINAL ASSEMBLY Under RFNIU with ET	
Asset / System	**SOW Reference**
50-T Mobile Crane	6.6, 6.2, 10.3
Bio-system PHD Plus	6.6, 6.2, 10.3
Borescope w/case	6.6, 6.2, 10.3
Card Test Set-up (CTS) - for Card Level I/O & Processor Testing	6.6, 6.2, 10.3
Checker, Magnification	6.6, 6.2, 10.3
Comparator, Optical	6.6, 6.2, 10.3
Current Tester, Eddy	6.6, 6.2, 10.3
Detector, Gas, Port w/	6.6, 6.2, 10.3
Engineering Development Fixture (EDF) - for Development Testing	6.6, 6.2, 10.3
Environmental Test Fixture (ETF) #1, #2, #3 and #4 - for Environmental End Item Test	6.6, 6.2, 10.3
Forklift-NS150159	6.6, 6.2, 10.3
Forklift-NS150199	6.6, 6.2, 10.3
General Purpose Dolly (ET)	6.6, 6.2, 10.3
Goniometer - used for Display Unit (DU) testing	6.6, 6.2, 10.3
International Space Station (ISS) Programmable Modular Test Equipment (PMTE) #1, #2 and #3 - for Ambient End Item Test	6.6, 6.2, 10.3
Level, Optical	6.6, 6.2, 10.3
MAF LN2/GN2 System	6.6, 6.2, 10.3
Measurement Equipment	6.6, 6.2, 10.3
Meter, Carbon Dioxide	6.6, 6.2, 10.3
Monitor, Heat Stress	6.6, 6.2, 10.3
Monitor, Personal	6.6, 6.2, 10.3
Multifunction Electronic Display Subsystem (MEDS) Acceptance Test Fixture (ATF) - used for DU testing	6.6, 6.2, 10.3
Polly-6x25 - NS113122	6.6, 6.2, 10.3
Polly-6x30 - NS113124	6.6, 6.2, 10.3
Polly-6x30 - NS113127	6.6, 6.2, 10.3
Power Supply Test Fixture (PSTF) #1 and #2 - for Card Level PS Testing	6.6, 6.2, 10.3
Psychrometer	6.6, 6.2, 10.3
Pump, Sampling	6.6, 6.2, 10.3
Sampler, Hi Flow	6.6, 6.2, 10.3
Solid State Mass Memory Unit Test Fixture (STF) #1 and #2 - for Card Level Memory Testing	6.6, 6.2, 10.3
Tow Tractor - NS150031	6.6, 6.2, 10.3
Tow Tractor-NS150032	6.6, 6.2, 10.3
Worksaver, 24 volt	6.6, 6.2, 10.3

**Justification of need is primary structure and identified secondary structure design, development, test and evaluation (DDT&E), fabrication, production and assembly. Heat-shield substrate DDT&E, fabrication, production and assembly and SLA fabrication and testing. Manufacturing support for integration, assembly and Checkout (IA&C) of all subsystems into the CEV Crew Module and Service Module.*

The following list is being used at the Michoud Assembly Facility by Lockheed Martin on a Rent – Free / Non-Interference Basis owning contract - External Tank

Property Tag #	EQUIP. DESCRIP.	Description	EST. COST	Owning Contract
EQUIP ID	Prop Type	DESCRIPTION	TOTAL COST	CONTRACT
F78-1399-001	STE	LO2 ULLAGE PRESXDUCER	$ 25 164.00	LM ET Contract 00016
F78-1399-002	STE	LO2 ULLAGE PRESXDUCER	$ 25,164.00	LM ET Contract 00016
F78-1399-003	STE	LO2 ULLAGE PRESXDUCER	$ 25,161.00	LM ET Contract 00016
F78-1399-004	STE	LO2 ULLAGE PRESXDUCER	$ 106,557.00	LM ET Contract 00016
F78-1399-005	STE	LO2 ULLAGE PRESXDUCER	$ 112 528.00	LM ET Contract 00016
F78-1399-006	STE	LO2 ULLAGE PRESXDUCER	$ 108,329.00	LM ET Contract 00016
F78-1479-001	STE	ET LOW PRESSURETRANSDUCE	$ 15,175.00	LM ET Contract 00016
F78-1479-002	STE	ET LOW PRESSURETRANSDUCE	$ 15 175.00	LM ET Contract 00016
F78-1479-003	STE	ET LOW PRESSURETRANSDUCE	$ 15,171.00	LM ET Contract 00016
F78-1479-004	STE	ET LOW PRESSURETRANSDUCE	$ 15,171.00	LM ET Contract 00016
NS092531-05	PE	MONITOR	$ 624.00	LM ET Contract 00016
NS102314-00	PE	MONITOR,TV	$ 181.00	LM ET Contract 00016
NS102315-00	PE	MONITOR,TV	$ 181.00	LM ET Contract 00016
NS103955-00	PE	CONTROL,TV CAMERA	$ 243.00	LM ET Contract 00016
NS105920-00	PE	WELDER,ARC	$ 3,513.00	LM ET Contract 00016
NS106168-06	PE	TRIPOD	$ 988.00	LM ET Contract 00016
NS106168-07	PE	TRIPOD	$ 988.00	LM ET Contract 00016
NS107648-00	PE	RADIO,R/T,HEAD,CH20	$ 776.00	LM ET Contract 00016
NS107651-00	PE	RADIO,R/T,HEAD,CH20	$ 776.00	LM ET Contract 00016
NS107652-00	PE	RADIO,R/T,HEAD,CH20	$ 776.00	LM ET Contract 00016
NS107653-00	PE	RADIO,R/T,HEAD,CH20	$ 776.00	LM ET Contract 00016
NS115183-00	PE	CAMERA,VIDEO,COLOR	$ 935.00	LM ET Contract 00016
NS115198-00	PE	MONITOR,VIDEO,COLOR	$ 388.00	LM ET Contract 00016
NS115201-00	PE	MONITOR,VIDEO,COLOR	$ 388.00	LM ET Contract 00016
NS115203-00	PE	MONITOR,VIDEO,COLOR	$ 388.00	LM ET Contract 00016
NS115204-00	PE	MONITOR,VIDEO,COLOR	$ 388.00	LM ET Contract 00016
NS116519-00	PE	PRINTER	$ 373.00	LM ET Contract 00016
NS121632-00	PE	MONITOR,PRESSURE DECAY	$ 21,656.00	LM ET Contract 00016
NS122495-00	PE	LENS,FOCAL LENGTH	$ 176.00	LM ET Contract 00016
NS122580-00	PE	CAMERA,CCTV	$ 657.00	LM ET Contract 00016
NS122581-00	PE	LENS,TV CAMERA	$ 254.00	LM ET Contract 00016
NS122582-00	PE	LENS,TV CAMERA	$ 89.00	LM ET Contract 00016
NS123629-00	PE	MONITOR,VIDEO,COLOR	$ 449.00	LM ET Contract 00016
NS123630-00	PE	MONITOR,VIDEO,COLOR	$ 449.00	LM ET Contract 00016
NS123631-00	PE	MONITOR,VIDEO,COLOR	$ 449.00	LM ET Contract 00016
NS123632-00	PE	MONITOR,VIDEO,COLOR	$ 449.00	LM ET Contract 00016
NS123633-00	PE	CAMERA,VIDEO COLOR	$ 848.00	LM ET Contract 00016

Attachment J-11.5 Rent Free Non-Interference Basis Property

NS123635-00	PE	CAMERA,VIDEO COLOR	$ 848.00	LM ET Contract 00016
NS123636-00	PE	CAMERA,VIDEO COLOR	$ 848.00	LM ET Contract 00016
NS127146-00	PE	LENS,ZOOM,TV CAMERA	$ 2,392.00	LM ET Contract 00016
NS133625-00	PE	CAMERA,VIDEO,CCD	$ 822.00	LM ET Contract 00016
NS133627-00	PE	CAMERA,VIDEO,CCD	$ 822.00	LM ET Contract 00016
NS135418-00	PE	DATA ACQUISITION	$ 162,475.00	LM ET Contract 00016
NS135419-00	PE	DATA ACQUISITION	$ 162,475.00	LM ET Contract 00016
NS135798-00	PE	CAMERA,CCD-TV	$ 972.00	LM ET Contract 00016
NS142546-00	PE	MONITOR,12 IN.	$ 520.00	LM ET Contract 00016
NS149724-00	PE	COMPUTOR,TOWER,W/KEYBOAR	$ 4,472.00	LM ET Contract 00016
NS151462-00	PE	BACKPACK, CD-RW DRIVE	$ 290.00	LM ET Contract 00016
NS153101-00	PE	REPEATER, DUPLEX BASE	$ 1,612.00	LM ET Contract 00016
NS153102-00	PE	REPEATER, DUPLEX BASE	$ 1,612.00	LM ET Contract 00016
NS153103-00	PE	TRANSCEIVER, PORTABLE	$ 600.00	LM ET Contract 00016
NS153104-00	PE	TRANSCEIVER, PORTABLE	$ 600.00	LM ET Contract 00016
NS153105-00	PE	TRANSCEIVER, PORTABLE	$ 600.00	LM ET Contract 00016
NS153106-00	PE	TRANSCEIVER, PORTABLE	$ 600.00	LM ET Contract 00016
NS153107-00	PE	TRANSCEIVER, PORTABLE	$ 600.00	LM ET Contract 00016
NS153108-00	PE	TRANSCEIVER, PORTABLE	$ 600.00	LM ET Contract 00016
NS153109-00	PE	TRANSCEIVER, PORTABLE	$ 600.00	LM ET Contract 00016
NS153110-00	PE	TRANSCEIVER, PORTABLE	$ 600.00	LM ET Contract 00016
NS153120-00	PE	HEADSET, UNDER HELMET	$ 208.00	LM ET Contract 00016
NS153121-00	PE	HEADSET, UNDER HELMET	$ 208.00	LM ET Contract 00016
NS153122-00	PE	HEADSET, UNDER HELMET	$ 208.00	LM ET Contract 00016
NS153123-00	PE	HEADSET, UNDER HELMET	$ 208.00	LM ET Contract 00016
NS153124-00	PE	HEADSET, UNDER HELMET	$ 208.00	LM ET Contract 00016
NS153125-00	PE	HEADSET, UNDER HELMET	$ 208.00	LM ET Contract 00016
NS153126-00	PE	HEADSET, UNDER HELMET	$ 208.00	LM ET Contract 00016
NS153127-00	PE	HEADSET, UNDER HELMET	$ 208.00	LM ET Contract 00016
NS158813-00	PE	COPIER/PLOTTER,	$ 18,166.00	LM ET Contract 00016
NS158813-01	PE	CPU	$ 6,318.00	LM ET Contract 00016
NS158813-02	PE	MONITOR, 15" FLAT	$ 980.00	LM ET Contract 00016
NS158813-03	PE	SCANNER	$ 7 650.00	LM ET Contract 00016
NS162449-00	PE	CAMERA, DIGITAL W/CDU	$ 20,562.00	LM ET Contract 00016
NS168073-00	PE	PLOTTER , ENGINEERING	$ 27,612.00	LM ET Contract 00016
NS168073-01	PE	SCANNER	$ 13,191.00	LM ET Contract 00016
NS168073-02	PE	CPU	$ 890.00	LM ET Contract 00016
NS168073-03	PE	17" MONITOR	$ 183.00	LM ET Contract 00016
ST000856	STE	GAUGE,PRESSURE	$ 45.00	LM ET Contract 00016
ST000857	STE	GAUGE,PRESSURE	$ 45.00	LM ET Contract 00016
ST002034	STE	GAUGE,PRESSURE	$ 226.00	LM ET Contract 00016
ST002069	STE	FLOWMETER	$ 1,889.00	LM ET Contract 00016
STE00521-00	STE	FIXTURE, COMPRESSION	$ 3,022.00	LM ET Contract 00016
STE00544-00	STE	FIXTURE, TEST	$ 504.00	LM ET Contract 00016
STE00548-00	STE	TEST CONSOLE,HYDRAULIC	$ 8,562.00	LM ET Contract 00016
STE00762-00	STE	TRANSDUCER,1.00IN	$ 178.00	LM ET Contract 00016
STE00769-00	STE	TRANSDUCER,1.00IN	$ 178.00	LM ET Contract 00016
STE00826-00	STE	TRANSDUCER,500 PSIG	$ 680.00	LM ET Contract 00016
STE00829-00	STE	TRANSDUCER,500 PSIG	$ 680.00	LM ET Contract 00016
STE00851-00	STE	TRANSDUCER,5000 PSIA	$ 504.00	LM ET Contract 00016
STE00865-00	STE	TRANSDUCER,100 PSIA	$ 590.00	LM ET Contract 00016
STE00872-00	STE	TRANSDUCER,1000PSIA	$ 383.00	LM ET Contract 00016
STE00900-00	STE	TRANSDUCER,5000 PSIG	$ 414.00	LM ET Contract 00016
STE00911-00	STE	TRANSDUCER,30.0 IN	$ 403.00	LM ET Contract 00016
STE00915-00	STE	TRANSDUCER,30.0 IN	$ 403.00	LM ET Contract 00016
STE00918-00	STE	TRANSDUCER,30.0 IN	$ 403.00	LM ET Contract 00016
STE00920-00	STE	TRANSDUCER,30.0 IN	$ 403.00	LM ET Contract 00016
STE01016-00	STE	GAUGE,0-60 PSIG	$ 1,105.00	LM ET Contract 00016
STE01023-00	STE	HYDROSTATIC TEST SET	$ 10,770.00	LM ET Contract 00016
STE01068-00	STE	TRANSDUCER,22.0 IN	$ 335.00	LM ET Contract 00016
STE01069-00	STE	TRANSDUCER,22.0 IN	$ 335.00	LM ET Contract 00016
STE01071-00	STE	TRANSDUCER,22.0 IN	$ 335.00	LM ET Contract 00016
STE01074-00	STE	TRANSDUCER,22.0 IN	$ 335.00	LM ET Contract 00016
STE01077-00	STE	TRANSDUCER,26.0 IN	$ 335.00	LM ET Contract 00016
STE01078-00	STE	TRANSDUCER,26.0 IN	$ 335.00	LM ET Contract 00016
STE01084-00	STE	TRANSDUCER,12.0 IN	$ 335.00	LM ET Contract 00016
STE01088-00	STE	TRANSDUCER,18.0 IN	$ 335.00	LM ET Contract 00016
STE01090-00	STE	TRANSDUCER,18.0 IN	$ 335.00	LM ET Contract 00016
STE01101-00	STE	TRANSDUCER, 10.0 IN	$ 335.00	LM ET Contract 00016
STE01104-00	STE	TRANSDUCER,24.0 IN	$ 335.00	LM ET Contract 00016
STE01105-00	STE	TRANSDUCER, 10.0 IN	$ 335.00	LM ET Contract 00016
STE01128-00	STE	TRANSDUCER, 12.0 IN	$ 335.00	LM ET Contract 00016
STE01130-00	STE	TRANSDUCER, 14.0 IN	$ 335.00	LM ET Contract 00016
STE01142-00	STE	TRANSDUCER, 14.0 IN	$ 335.00	LM ET Contract 00016
STE01186-00	STE	TRANSDUCER,LINEAR	$ 621.00	LM ET Contract 00016
STE01197-00	STE	TRANSDUCER, 2.00 IN	$ 621.00	LM ET Contract 00016
STE01200-00	STE	TRANSDUCER,2.00IN	$ 621.00	LM ET Contract 00016
STE01201-00	STE	TRANSDUCER,2.00IN	$ 621.00	LM ET Contract 00016
STE01203-00	STE	TRANSDUCER, 2.00 IN	$ 621.00	LM ET Contract 00016
STE01204-00	STE	TRANSDUCER, 2.00 IN	$ 621.00	LM ET Contract 00016
STE01208-00	STE	TRANSDUCER,2.00IN	$ 621.00	LM ET Contract 00016
STE01218-00	STE	TRANSDUCER, 2.00 IN	$ 621.00	LM ET Contract 00016
STE01338	STE	CLINOMETER, BIAXIAL	$ 340.00	LM ET Contract 00016
T02A5388-001	ST	MAINTENANCE PLATFORMS	$ 6,129.00	LM ET Contract 00016
T02A5388-002	ST	MAINTENANCE PLATFORMS	$ 6,129.00	LM ET Contract 00016
T13S0299-001	ST	SLING,DOME CAP ASSY	$ 4,893.00	LM ET Contract 00016
T13S0299-004	ST	SLING DOME CAP ASSY	$ 5 534.00	LM ET Contract 00016
T14S0255-001	ST	SLING,FWD OGIVE ASSY	$ 21,301.00	LM ET Contract 00016
T39S0259-002	ST	TRANSFER FIXTURE, FWD	$ 35,019.00	LM ET Contract 00016
T39S0259-004	ST	TRANSFER FIXTURE FWD	$ 35 017.00	LM ET Contract 00016
TGU-001	ST	Two leg wire rope bridle sling		LM ET Contract 00016
TGU-002	ST	Two leg wire rope bridle sling		LM ET Contract 00016

**Just fication of need is primary structure and identified secondary structure design, development, test and evaluation (DDT&E), fabrication,*

The following list is being requested for use at the Michoud Assembly Facility (MAF)

Attachment J-11.5 Rent Free Non-Interference Basis Property

by Lockheed Martin on a Rent Free Non-Interference basis under JACOB's SFOC Contract

Property Tag #	Equipment Description	Equipment Purpose	Estimated Cost	Owning Contract
NS130595-00	PE	MONITOR,COLOR,14IN	$ 468.00	Jacobs SFOC Contract 9AA20C
NS137387-01	PE	PRINTER	$ 312.00	Jacobs SFOC Contract 9AA20C
NS142132-00	PE	MONITOR,COLOR,500 FGX,	$ 364.00	Jacobs SFOC Contract 9AA20C
NS142133-00	PE	MONITOR,COLOR,500 FGX,	$ 364.00	Jacobs SFOC Contract 9AA20C
NS125421-00	PE	POWER SUPPLY CENTER	$ 9,444.00	Jacobs SFOC Contract 9AA20C
NS125425-00	PE	POWER SUPPLY CENTER	$ 9,444.00	Jacobs SFOC Contract 9AA20C
NS125426-00	PE	POWER SUPPLY CENTER	$ 9,444.00	Jacobs SFOC Contract 9AA20C
NS125427-00	PE	POWER SUPPLY CENTER	$ 9,444.00	Jacobs SFOC Contract 9AA20C
NS143099-00	PE	MONITOR,COLOR,17 IN.	$ 416.00	Jacobs SFOC Contract 9AA20C
NS143909-00	PE	MONITOR,COLOR,17 IN.	$ 496.00	Jacobs SFOC Contract 9AA20C
NS146538-00	PE	PRINTER,6 PXI	$ 985.00	Jacobs SFOC Contract 9AA20C
NS146853-00	PE	COMPUTER,TOWER,PENTIUM	$ 1,657.00	Jacobs SFOC Contract 9AA20C
NS147537-00	PE	MONITOR,COLOR,17 IN.	$ 378.00	Jacobs SFOC Contract 9AA20C
NS147539-00	PE	MONITOR,COLOR,17 IN.	$ 378.00	Jacobs SFOC Contract 9AA20C
NS147547-00	PE	MONITOR,COLOR,17 IN.	$ 378.00	Jacobs SFOC Contract 9AA20C
NS147555-00	PE	MONITOR,COLOR,17 IN.	$ 378.00	Jacobs SFOC Contract 9AA20C
NS147559-00	PE	MONITOR,COLOR,17 IN.	$ 378.00	Jacobs SFOC Contract 9AA20C
NS148494-00	PE	PRINTER,LASERJET,6P	$ 747.00	Jacobs SFOC Contract 9AA20C
NS149725-00	PE	MONITOR,COLOR,17 IN	$ 832.00	Jacobs SFOC Contract 9AA20C
NS149727-00	PE	MONITOR,COLOR,15 IN	$ 520.00	Jacobs SFOC Contract 9AA20C
NS149728-00	PE	PRINTER,LASER-JET,	$ 3,640.00	Jacobs SFOC Contract 9AA20C
NS151622-00	PE	PLOTTER, 36"	$ 6,022.00	Jacobs SFOC Contract 9AA20C
NS152557-00	PE	CPU, W/KEYBOARD, MOUSE	$ 1,572.00	Jacobs SFOC Contract 9AA20C
NS002965-00	PE	RESISTOR,DECADE	$ 110.00	Jacobs SFOC Contract 9AA20C
NS007283-00	PE	MICROBRAZER	$ 185.00	Jacobs SFOC Contract 9AA20C
NS007348-00	PE	GUN,HEAT	$ 20.00	Jacobs SFOC Contract 9AA20C
NS014258-00	PE	HOIST,CHAIN,5 TON	$ 237.00	Jacobs SFOC Contract 9AA20C
NS014846-00	PE	GRINDER,TOOL	$ 184.00	Jacobs SFOC Contract 9AA20C
NS017258-00	PE	SCALE,PLATFORM	$ 120.00	Jacobs SFOC Contract 9AA20C
NS020944-00	PE	VIBRATION TABLE	$ 1,353.00	Jacobs SFOC Contract 9AA20C
NS020945-00	PE	VIBRATION TABLE	$ 1,353.00	Jacobs SFOC Contract 9AA20C
NS037466-00	PE	BORESCOPE	$ 317.00	Jacobs SFOC Contract 9AA20C
NS041944-00	PE	GAUGE,PRESSURE,50 PSIA	$ 395.00	Jacobs SFOC Contract 9AA20C
NS042863-00	PE	JACK,HYDRAULIC,15K	$ 142.00	Jacobs SFOC Contract 9AA20C
NS042867-00	PE	JACK,HYDRAULIC,7K	$ 183.00	Jacobs SFOC Contract 9AA20C
NS042868-00	PE	JACK,HYDRAULIC,7K	$ 183.00	Jacobs SFOC Contract 9AA20C
NS043191-00	PE	GAUGE,PRESSURE,BOURBON	$ 210.00	Jacobs SFOC Contract 9AA20C
NS043287-00	PE	CELL,LOAD,25K	$ 399.00	Jacobs SFOC Contract 9AA20C
NS043288-00	PE	CELL,LOAD,25K	$ 399.00	Jacobs SFOC Contract 9AA20C
NS043289-00	PE	CELL,LOAD,25K	$ 399.00	Jacobs SFOC Contract 9AA20C
NS043290-00	PE	CELL,LOAD,25K	$ 399.00	Jacobs SFOC Contract 9AA20C
NS043329-00	PE	CELL,LOAD,10K	$ 791.00	Jacobs SFOC Contract 9AA20C
NS043579-00	PE	TABLE,VIBRATION	$ 1,353.00	Jacobs SFOC Contract 9AA20C
NS043854-00	PE	GAUGE,PRESSURE	$ 249.00	Jacobs SFOC Contract 9AA20C
NS045376-00	PE	RESERVOIR,PNEUMATIC	$ 423.00	Jacobs SFOC Contract 9AA20C
NS047280-00	PE	COLLECTOR,DUST	$ 318.00	Jacobs SFOC Contract 9AA20C
NS049070-00	PE	CELL,LOAD,50K	$ 573.00	Jacobs SFOC Contract 9AA20C
NS049071-00	PE	CELL,LOAD,50K	$ 573.00	Jacobs SFOC Contract 9AA20C
NS049072-00	PE	CELL,LOAD,50K	$ 573.00	Jacobs SFOC Contract 9AA20C
NS049073-00	PE	CELL,LOAD,10K	$ 446.00	Jacobs SFOC Contract 9AA20C
NS049074-00	PE	CELL,LOAD,10K	$ 446.00	Jacobs SFOC Contract 9AA20C
NS049081-00	PE	CELL,LOAD,100K	$ 913.00	Jacobs SFOC Contract 9AA20C
NS049126-00	PE	CELL,LOAD,25K	$ 488.00	Jacobs SFOC Contract 9AA20C
NS049127-00	PE	CELL,LOAD,25K	$ 488.00	Jacobs SFOC Contract 9AA20C
NS049186-00	PE	CELL,LOAD,25K	$ 488.00	Jacobs SFOC Contract 9AA20C
NS052744-00	PE	JACK,HYDRAULIC,10K	$ 651.00	Jacobs SFOC Contract 9AA20C
NS052745-00	PE	JACK,HYDRAULIC,10K	$ 650.00	Jacobs SFOC Contract 9AA20C
NS052747-00	PE	JACK,HYDRAULIC,10K	$ 650.00	Jacobs SFOC Contract 9AA20C
NS052748-00	PE	JACK,HYDRAULIC,10K	$ 650.00	Jacobs SFOC Contract 9AA20C
NS052749-00	PE	JACK,HYDRAULIC,10K	$ 650.00	Jacobs SFOC Contract 9AA20C
NS052750-00	PE	JACK,HYDRAULIC,100K	$ 650.00	Jacobs SFOC Contract 9AA20C
NS052751-00	PE	JACK,HYDRAULIC,100K	$ 650.00	Jacobs SFOC Contract 9AA20C
NS052752-00	PE	JACK,HYDRAULIC,100K	$ 650.00	Jacobs SFOC Contract 9AA20C
NS052753-00	PE	JACK,HYDRAULIC,100K	$ 650.00	Jacobs SFOC Contract 9AA20C
NS052755-00	PE	JACK,HYDRAULIC,100K	$ 651.00	Jacobs SFOC Contract 9AA20C
NS052757-00	PE	JACK,HYDRAULIC,250K	$ 650.00	Jacobs SFOC Contract 9AA20C
NS052783-00	PE	JACK,HYDRAULIC,25K	$ 650.00	Jacobs SFOC Contract 9AA20C
NS052784-00	PE	JACK,HYDRAULIC,25K	$ 650.00	Jacobs SFOC Contract 9AA20C
NS052785-00	PE	JACK,HYDRAULIC,25K	$ 650.00	Jacobs SFOC Contract 9AA20C
NS052786-00	PE	JACK,HYDRAULIC	$ 657.00	Jacobs SFOC Contract 9AA20C
NS052787-00	PE	JACK,HYDRAULIC,25K	$ 650.00	Jacobs SFOC Contract 9AA20C
NS052788-00	PE	JACK,HYDRAULIC,25K	$ 650.00	Jacobs SFOC Contract 9AA20C
NS052789-00	PE	JACK,HYDRAULIC,25K	$ 651.00	Jacobs SFOC Contract 9AA20C
NS052790-00	PE	JACK,HYDRAULIC,25K	$ 650.00	Jacobs SFOC Contract 9AA20C
NS052795-00	PE	JACK,HYDRAULIC,50K	$ 650.00	Jacobs SFOC Contract 9AA20C
NS052796-00	PE	JACK,HYDRAULIC,50K	$ 650.00	Jacobs SFOC Contract 9AA20C
NS052797-00	PE	JACK,HYDRAULIC,50K	$ 650.00	Jacobs SFOC Contract 9AA20C
NS052798-00	PE	JACK,HYDRAULIC,50K	$ 650.00	Jacobs SFOC Contract 9AA20C
NS052848-00	PE	CELL,LOAD,250K	$ 1,886.00	Jacobs SFOC Contract 9AA20C
NS059911-00	PE	JACK,HYDRAULIC,10K	$ 393.00	Jacobs SFOC Contract 9AA20C
NS059912-00	PE	JACK,HYDRAULIC,10K	$ 393.00	Jacobs SFOC Contract 9AA20C
NS059913-00	PE	JACK,HYDRAULIC,10K	$ 393.00	Jacobs SFOC Contract 9AA20C
NS059914-00	PE	JACK,HYDRAULIC,10K	$ 393.00	Jacobs SFOC Contract 9AA20C
NS059915-00	PE	JACK,HYDRAULIC,10K	$ 393.00	Jacobs SFOC Contract 9AA20C
NS059916-00	PE	JACK,HYDRAULIC,10K	$ 393.00	Jacobs SFOC Contract 9AA20C
NS059917-00	PE	JACK,HYDRAULIC,10K	$ 393.00	Jacobs SFOC Contract 9AA20C
NS059918-00	PE	JACK,HYDRAULIC,10K	$ 393.00	Jacobs SFOC Contract 9AA20C
NS059920-00	PE	JACK,HYDRAULIC,10K	$ 393.00	Jacobs SFOC Contract 9AA20C
NS059921-00	PE	JACK,HYDRAULIC,25K	$ 422.00	Jacobs SFOC Contract 9AA20C
NS059922-00	PE	JACK,HYDRAULIC,25K	$ 422.00	Jacobs SFOC Contract 9AA20C
NS059923-00	PE	JACK,HYDRAULIC,25K	$ 422.00	Jacobs SFOC Contract 9AA20C
NS059924-00	PE	JACK,HYDRAULIC,25K	$ 422.00	Jacobs SFOC Contract 9AA20C
NS059925-00	PE	JACK,HYDRAULIC,25K	$ 422.00	Jacobs SFOC Contract 9AA20C
NS059926-00	PE	JACK,HYDRAULIC,25K	$ 422.00	Jacobs SFOC Contract 9AA20C
NS059927-00	PE	JACK,HYDRAULIC,25K	$ 422.00	Jacobs SFOC Contract 9AA20C

Attachment J-11.5 Rent Free Non-Interference Basis Property

NS059928-00	PE	JACK,HYDRAULIC,25K	$	422.00	Jacobs SFOC Contract 9AA20C
NS059929-00	PE	JACK,HYDRAULIC,25K	$	422.00	Jacobs SFOC Contract 9AA20C
NS059930-00	PE	JACK,HYDRAULIC,25K	$	422.00	Jacobs SFOC Contract 9AA20C
NS060021-00	PE	BENDER,TUBE	$	136.00	Jacobs SFOC Contract 9AA20C
NS060317-00	PE	JACK,HYDRAULIC,100K	$	870.00	Jacobs SFOC Contract 9AA20C
NS060323-00	PE	JACK,HYDRAULIC,100K	$	870.00	Jacobs SFOC Contract 9AA20C
NS060324-00	PE	JACK,HYDRAULIC,100K	$	870.00	Jacobs SFOC Contract 9AA20C
NS060325-00	PE	JACK,HYDRAULIC,50K	$	528.00	Jacobs SFOC Contract 9AA20C
NS060326-00	PE	JACK,HYDRAULIC,50K	$	528.00	Jacobs SFOC Contract 9AA20C
NS060327-00	PE	JACK,HYDRAULIC,50K	$	528.00	Jacobs SFOC Contract 9AA20C
NS060328-00	PE	JACK,HYDRAULIC,50K	$	528.00	Jacobs SFOC Contract 9AA20C
NS060329-00	PE	JACK,HYDRAULIC,50K	$	528.00	Jacobs SFOC Contract 9AA20C
NS060330-00	PE	JACK,HYDRAULIC,50K	$	528.00	Jacobs SFOC Contract 9AA20C
NS060331-00	PE	JACK,HYDRAULIC,50K	$	528.00	Jacobs SFOC Contract 9AA20C
NS060333-00	PE	JACK,HYDRAULIC,50K	$	528.00	Jacobs SFOC Contract 9AA20C
NS060334-00	PE	JACK,HYDRAULIC,50K	$	528.00	Jacobs SFOC Contract 9AA20C
NS060855-00	PE	TABLE,VIBRATION	$	1,801.00	Jacobs SFOC Contract 9AA20C
NS060858-00	PE	TABLE,VIBRATION	$	1,801.00	Jacobs SFOC Contract 9AA20C
NS060860-00	PE	TABLE,VIBRATION	$	1,353.00	Jacobs SFOC Contract 9AA20C
NS060864-00	PE	TABLE,VIBRATION	$	1,353.00	Jacobs SFOC Contract 9AA20C
NS061127-00	PE	METER,WIRE & CORDAGE	$	64.00	Jacobs SFOC Contract 9AA20C
NS065158-00	PE	TABLE,VIBRATION	$	1,801.00	Jacobs SFOC Contract 9AA20C
NS067853-00	PE	TESTER,DEAD WEIGHT	$	625.00	Jacobs SFOC Contract 9AA20C
NS068509-01	PE	COOLER,WATER	$	165.00	Jacobs SFOC Contract 9AA20C
NS080590-00	PE	FILTER, R.F.I.	$	60.00	Jacobs SFOC Contract 9AA20C
NS081441-00	PE	PUMP,TRANSFER	$	199.00	Jacobs SFOC Contract 9AA20C
NS081469-00	PE	JACK,HYDRAULIC,7.5K	$	125.00	Jacobs SFOC Contract 9AA20C
NS081470-00	PE	JACK,HYDRAULIC,12K	$	75.00	Jacobs SFOC Contract 9AA20C
NS081471-00	PE	JACK,HYDRAULIC,12K	$	75.00	Jacobs SFOC Contract 9AA20C
NS081472-00	PE	JACK,HYDRAULIC,7K	$	75.00	Jacobs SFOC Contract 9AA20C
NS081473-00	PE	JACK,HYDRAULIC,7K	$	75.00	Jacobs SFOC Contract 9AA20C
NS081479-00	PE	JACK,HYDRAULIC,12K	$	81.00	Jacobs SFOC Contract 9AA20C
NS081480-00	PE	JACK,HYDRAULIC,3K	$	125.00	Jacobs SFOC Contract 9AA20C
NS090583-00	PE	CLEANER,VACUUM	$	43.00	Jacobs SFOC Contract 9AA20C
NS090979-00	PE	CELL,LOAD,400K	$	1,685.00	Jacobs SFOC Contract 9AA20C
NS090982-00	PE	CELL,LOAD,400K	$	1,685.00	Jacobs SFOC Contract 9AA20C
NS090984-00	PE	CELL,LOAD,650K	$	2,912.00	Jacobs SFOC Contract 9AA20C
NS090986-00	PE	CELL,LOAD,650K	$	2,912.00	Jacobs SFOC Contract 9AA20C
NS090987-00	PE	CELL,LOAD,400K	$	1,685.00	Jacobs SFOC Contract 9AA20C
NS090989-00	PE	JACK,HYDRAULIC,570K	$	3,134.00	Jacobs SFOC Contract 9AA20C
NS090990-00	PE	JACK,HYDRAULIC,570K	$	3,134.00	Jacobs SFOC Contract 9AA20C
NS090991-00	PE	JACK,HYDRAULIC,570K	$	3,134.00	Jacobs SFOC Contract 9AA20C
NS090992-00	PE	JACK,HYDRAULIC,570K	$	3,134.00	Jacobs SFOC Contract 9AA20C
NS090993-00	PE	JACK,HYDRAULIC,570K	$	3,134.00	Jacobs SFOC Contract 9AA20C
NS090994-00	PE	JACK,HYDRAULIC,570K	$	3,134.00	Jacobs SFOC Contract 9AA20C
NS090995-00	PE	JACK,HYDRAULIC,570K	$	3,134.00	Jacobs SFOC Contract 9AA20C
NS091000-00	PE	JACK,HYDRAULIC,570K	$	3,134.00	Jacobs SFOC Contract 9AA20C
NS091001-00	PE	JACK,HYDRAULIC,570K	$	3,134.00	Jacobs SFOC Contract 9AA20C
NS091002-00	PE	RACK,HYD.JACK,570K	$	156.00	Jacobs SFOC Contract 9AA20C
NS091003-00	PE	RACK,HYD.JACK,570K	$	1,261.00	Jacobs SFOC Contract 9AA20C
NS091004-00	PE	RACK,HYD.JACK,570K	$	1,261.00	Jacobs SFOC Contract 9AA20C
NS092264-00	PE	JACK,HYDRAULIC,440K	$	2,035.00	Jacobs SFOC Contract 9AA20C
NS092265-00	PE	JACK,HYDRAULIC,440K	$	2,035.00	Jacobs SFOC Contract 9AA20C
NS092266-00	PE	JACK,HYDRAULIC,440K	$	2,035.00	Jacobs SFOC Contract 9AA20C
NS092267-00	PE	JACK,HYDRAULIC,440K	$	2,035.00	Jacobs SFOC Contract 9AA20C
NS092277-00	PE	RACK,HYD.JACK,440K	$	1,261.00	Jacobs SFOC Contract 9AA20C
NS092278-00	PE	POWER SUPPLY,HYDRAUL	$	4,417.00	Jacobs SFOC Contract 9AA20C
NS092279-00	PE	CONSOLE,PNEUMATIC TEST	$	5,674.00	Jacobs SFOC Contract 9AA20C
NS092280-00	PE	POWER SUPPLY,HYDRAUL	$	10,158.00	Jacobs SFOC Contract 9AA20C
NS092626-00	PE	INDICATOR,VELOCITY	$	182.00	Jacobs SFOC Contract 9AA20C
NS093331-00	PE	JACK,HYDRAULIC,180K	$	667.00	Jacobs SFOC Contract 9AA20C
NS093332-00	PE	JACK,HYDRAULIC,140K	$	646.00	Jacobs SFOC Contract 9AA20C
NS093551-00	PE	SINE PLATE 10X20 IN	$	2,513.00	Jacobs SFOC Contract 9AA20C
NS093580-00	PE	MACHINE,DRILLING	$	14,792.00	Jacobs SFOC Contract 9AA20C
NS093974-00	PE	PUMP,VACUUM	$	255.00	Jacobs SFOC Contract 9AA20C
NS094198-00	PE	CHAMBER,ENVIRONMENTAL	$	38,566.00	Jacobs SFOC Contract 9AA20C
NS094198-01	PE	CONTROLLER,RECORDER	$	2,080.00	Jacobs SFOC Contract 9AA20C
NS094198-02	PE	CONTROLLER,RECORDER	$	2,080.00	Jacobs SFOC Contract 9AA20C
NS094198-03	PE	RECORDER,TEMPERATURE	$	1,248.00	Jacobs SFOC Contract 9AA20C
NS094198-04	PE	RECORDER,TEMPERATURE	$	1,248.00	Jacobs SFOC Contract 9AA20C
NS094508-00	PE	TESTER,STRAIN GAGE	$	364.00	Jacobs SFOC Contract 9AA20C
NS094776-00	PE	CELL,LOAD,300K	$	1,685.00	Jacobs SFOC Contract 9AA20C
NS095553-00	PE	SCAFFOLD,PORTABLE	$	483.00	Jacobs SFOC Contract 9AA20C
NS095975-00	PE	RESISTOR,DECADE	$	148.00	Jacobs SFOC Contract 9AA20C
NS095999-00	PE	GAGE,0-30 PSIG	$	208.00	Jacobs SFOC Contract 9AA20C
NS096030-00	PE	CELL,LOAD,300K	$	1,685.00	Jacobs SFOC Contract 9AA20C
NS096031-00	PE	CELL,LOAD,250K	$	1,685.00	Jacobs SFOC Contract 9AA20C
NS096032-00	PE	CELL,LOAD,250K	$	1,685.00	Jacobs SFOC Contract 9AA20C
NS096078-00	PE	CONTAINER,NITROGEN	$	801.00	Jacobs SFOC Contract 9AA20C
NS096415-00	PE	JACK,HYDRAULIC,180K	$	667.00	Jacobs SFOC Contract 9AA20C
NS096416-00	PE	JACK,HYDRAULIC,180K	$	667.00	Jacobs SFOC Contract 9AA20C
NS096417-00	PE	JACK,HYDRAULIC,180K	$	667.00	Jacobs SFOC Contract 9AA20C
NS096418-00	PE	JACK,HYDRAULIC,180K	$	667.00	Jacobs SFOC Contract 9AA20C
NS096467-00	PE	JACK,HYDRAULIC,180K	$	10,667.00	Jacobs SFOC Contract 9AA20C
NS096468-00	PE	JACK,HYDRAULIC,180K	$	817.00	Jacobs SFOC Contract 9AA20C
NS096469-00	PE	CELL,LOAD,300K	$	1,685.00	Jacobs SFOC Contract 9AA20C
NS096470-00	PE	CELL,LOAD,250K	$	1,685.00	Jacobs SFOC Contract 9AA20C
NS096471-00	PE	CELL,LOAD,300K	$	1,638.00	Jacobs SFOC Contract 9AA20C
NS096473-00	PE	CELL,LOAD,200K	$	1,638.00	Jacobs SFOC Contract 9AA20C
NS096475-00	PE	CELL,LOAD,250K	$	1,685.00	Jacobs SFOC Contract 9AA20C
NS096476-00	PE	CELL,LOAD,150K	$	1,685.00	Jacobs SFOC Contract 9AA20C
NS096514-00	PE	TESTER,PRESSURE	$	3,359.00	Jacobs SFOC Contract 9AA20C
NS097403-00	PE	TESTER,STRAIN GAGE	$	879.00	Jacobs SFOC Contract 9AA20C
NS098261-00	PE	WORKSAVER,24VOLT	$	6,864.00	Jacobs SFOC Contract 9AA20C
NS098343-00	PE	CONSOLE,HYDROSTATIC	$	11,724.00	Jacobs SFOC Contract 9AA20C
NS098751-00	PE	TRICYCLE	$	286.00	Jacobs SFOC Contract 9AA20C
NS099410-00	PE	TRICYCLE	$	286.00	Jacobs SFOC Contract 9AA20C
NS099718-00	PE	AMMETER,DIGITAL	$	619.00	Jacobs SFOC Contract 9AA20C
NS099936-00	PE	CARRIER,DRUM	$	1,119.00	Jacobs SFOC Contract 9AA20C
NS100239-00	PE	WRENCH,IMPACT,3/4	$	361.00	Jacobs SFOC Contract 9AA20C

Attachment J-11.5 Rent Free Non-Interference Basis Property

NS101431-00	PE	GENERATOR,WAVEFORM	$	1,828.00	Jacobs SFOC Contract 9AA20C
NS102047-00	PE	SANDER,DISC,30IN	$	7,130.00	Jacobs SFOC Contract 9AA20C
NS103050-00	PE	CLEANER,VACUUM,WET/DRY	$	118.00	Jacobs SFOC Contract 9AA20C
NS103253-00	PE	CHAMBER,ENVIRONMENTAL	$	13,032.00	Jacobs SFOC Contract 9AA20C
NS103811-00	PE	BICYCLE	$	163.00	Jacobs SFOC Contract 9AA20C
NS104762-00	PE	TABLE,TRACING	$	592.00	Jacobs SFOC Contract 9AA20C
NS105823-00	PE	DEHUMIDIFIER	$	96.00	Jacobs SFOC Contract 9AA20C
NS106076-00	PE	LATHE	$	28,857.00	Jacobs SFOC Contract 9AA20C
NS106152-00	PE	SAW,BAND,HORIZONTAL	$	4,950.00	Jacobs SFOC Contract 9AA20C
NS106302-00	PE	CELL,LOAD,2K	$	1,168.00	Jacobs SFOC Contract 9AA20C
NS106303-00	PE	CELL,LOAD,2K	$	1,168.00	Jacobs SFOC Contract 9AA20C
NS106315-00	PE	MACHINE,MILLING	$	12,856.00	Jacobs SFOC Contract 9AA20C
NS106406-00	PE	MOTOR,DRILL,1/2 INCH	$	62.00	Jacobs SFOC Contract 9AA20C
NS106573-10	PE	RACK,EQUIP	$	1,040.00	Jacobs SFOC Contract 9AA20C
NS107113-03	PE	MANIFOLD,HYDRAULIC	$	25,970.00	Jacobs SFOC Contract 9AA20C
NS107114-03	PE	MANIFOLD,HYDRAULIC	$	25,970.00	Jacobs SFOC Contract 9AA20C
NS108258-00	PE	BICYCLE	$	171.00	Jacobs SFOC Contract 9AA20C
NS108608-08	PE	CONSOLE,ELECTRONICS	$	3,120.00	Jacobs SFOC Contract 9AA20C
NS108895-00	PE	HYDRA-SET	$	8,299.00	Jacobs SFOC Contract 9AA20C
NS108896-00	PE	HYDRA-SET	$	8,299.00	Jacobs SFOC Contract 9AA20C
NS109300-00	PE	KIT,TOOLS W/CASE	$	496.00	Jacobs SFOC Contract 9AA20C
NS109428-00	PE	CELL,LOAD,400K	$	13,913.00	Jacobs SFOC Contract 9AA20C
NS109429-00	PE	CELL,LOAD,400K	$	13,913.00	Jacobs SFOC Contract 9AA20C
NS109634-00	PE	CABINET,TOOL STORAGE	$	487.00	Jacobs SFOC Contract 9AA20C
NS109678-00	PE	GENERATOR,TIME/DATE	$	514.00	Jacobs SFOC Contract 9AA20C
NS110404-00	PE	JACK,HYDRAULIC,570K	$	3,134.00	Jacobs SFOC Contract 9AA20C
NS110406-00	PE	JACK,HYDRAULIC,570K	$	3,134.00	Jacobs SFOC Contract 9AA20C
NS110498-00	PE	LIFT,SCISSOR	$	13,755.00	Jacobs SFOC Contract 9AA20C
NS111314-00	PE	SAW,BAND	$	15,257.00	Jacobs SFOC Contract 9AA20C
NS111529-00	PE	CUT OFF MACHINE	$	10,020.00	Jacobs SFOC Contract 9AA20C
NS111720-00	PE	FIBERSCOPE	$	8,502.00	Jacobs SFOC Contract 9AA20C
NS111720-01	PE	LIGHT,COLD,SUPPLY	$	515.00	Jacobs SFOC Contract 9AA20C
NS112861-00	PE	PRESS,DRILL	$	2,165.00	Jacobs SFOC Contract 9AA20C
NS113337-00	PE	KIT,TERMINATION	$	1,040.00	Jacobs SFOC Contract 9AA20C
NS113381-00	PE	DETECTOR,FLAW	$	11,440.00	Jacobs SFOC Contract 9AA20C
NS113381-01	PE	IMPACTOR	$	3,900.00	Jacobs SFOC Contract 9AA20C
NS113381-02	PE	IMPACTOR	$	3,900.00	Jacobs SFOC Contract 9AA20C
NS113542-00	PE	CONDITIONER,POWER	$	2,075.00	Jacobs SFOC Contract 9AA20C
NS113833-00	PE	LEVEL,MICRO	$	515.00	Jacobs SFOC Contract 9AA20C
NS113838-00	PE	POWER SUPPLY/MONITOR	$	3,801.00	Jacobs SFOC Contract 9AA20C
NS113838-01	PE	ALARM	$	676.00	Jacobs SFOC Contract 9AA20C
NS113838-02	PE	FLOWMETER,MASS	$	806.00	Jacobs SFOC Contract 9AA20C
NS113838-03	PE	FLOWMETER	$	946.00	Jacobs SFOC Contract 9AA20C
NS113838-04	PE	FLOWMETER,MASS	$	806.00	Jacobs SFOC Contract 9AA20C
NS113838-05	PE	FLOWMETER,MASS	$	1,300.00	Jacobs SFOC Contract 9AA20C
NS113997-00	PE	TANK,STORAGE,NITROGE	$	13,757.00	Jacobs SFOC Contract 9AA20C
NS114277-00	PE	TRAILER,FLATBED,6X12	$	2,288.00	Jacobs SFOC Contract 9AA20C
NS114374-00	PE	RECORDER,CHART	$	2,132.00	Jacobs SFOC Contract 9AA20C
NS114380-00	PE	CHAMBER,TEST	$	51,205.00	Jacobs SFOC Contract 9AA20C
NS114380-01	PE	CONTROLLER, CHAMBER	$	6,240.00	Jacobs SFOC Contract 9AA20C
NS114979-00	PE	PUMP,VACUUM	$	723.00	Jacobs SFOC Contract 9AA20C
NS117611-00	PE	RECORDER,WAVE FORM	$	17,160.00	Jacobs SFOC Contract 9AA20C
NS117611-01	PE	PLOTTER,8 PEN	$	9,880.00	Jacobs SFOC Contract 9AA20C
NS117611-02	PE	AMPLIFIER,ISOLATION	$	5,200.00	Jacobs SFOC Contract 9AA20C
NS120703-00	PE	RECORDER,TEMPERATURE	$	3,011.00	Jacobs SFOC Contract 9AA20C
NS120963-00	PE	METER,FLOW	$	477.00	Jacobs SFOC Contract 9AA20C
NS121844-00	PE	GAGE,STRAIN,DIGITAL	$	884.00	Jacobs SFOC Contract 9AA20C
NS121845-00	PE	GAGE,STRAIN,DIGITAL	$	884.00	Jacobs SFOC Contract 9AA20C
NS122098-00	PE	DETECTOR,LEAK,W/PROBE	$	13,364.00	Jacobs SFOC Contract 9AA20C
NS122098-01	PE	CART,DETECTOR,LEAK	$	997.00	Jacobs SFOC Contract 9AA20C
NS125745-00	PE	SYSTEM,COOLER,OIL	$	2,413.00	Jacobs SFOC Contract 9AA20C
NS126252-00	PE	TRACTOR,TOW	$	33,280.00	Jacobs SFOC Contract 9AA20C
NS126998-00	PE	CELL,LOAD,5000 LBS CAP.	$	389.00	Jacobs SFOC Contract 9AA20C
NS132867-00	PE	KIT,CABLE,SMART	$	156.00	Jacobs SFOC Contract 9AA20C
NS132877-00	PE	CONTROLLER,TEMPERATURE	$	301.00	Jacobs SFOC Contract 9AA20C
NS132884-00	PE	MODULE,THEROCOUPLE	$	114.00	Jacobs SFOC Contract 9AA20C
NS132887-00	PE	THERMOMETER,PORTABLE	$	936.00	Jacobs SFOC Contract 9AA20C
NS132911-00	PE	RECORDER,VIDEO,VHS	$	881.00	Jacobs SFOC Contract 9AA20C
NS132912-00	PE	RECORDER,VIDEO,VHS	$	881.00	Jacobs SFOC Contract 9AA20C
NS132916-00	PE	INDICATOR,PRESSURE	$	307.00	Jacobs SFOC Contract 9AA20C
NS132919-00	PE	TRANSDUCER,PRESSURE	$	515.00	Jacobs SFOC Contract 9AA20C
NS135299-00	PE	RECORDER,CASSETTE,VIDEO	$	881.00	Jacobs SFOC Contract 9AA20C
NS136197-00	PE	DATA LOGGER,HYDRA SERIES	$	5,306.00	Jacobs SFOC Contract 9AA20C
NS136660-00	PE	TRUCK,FORKLIFT,EXTEND-	$	20,951.00	Jacobs SFOC Contract 9AA20C
NS137859-00	PE	CUTTER,PAPER,W/STAND AND	$	1,096.00	Jacobs SFOC Contract 9AA20C
NS139105-00	PE	INDICATOR,PRESSURE,	$	862.00	Jacobs SFOC Contract 9AA20C
NS140117-00	PE	CAMCORDER,VHS,W/CASE,	$	874.00	Jacobs SFOC Contract 9AA20C
NS141148-00	PE	CAMERA,DIGITAL	$	1,194.00	Jacobs SFOC Contract 9AA20C
NS148883-00	PE	LOGGER,DATA,HYDRA	$	3,427.00	Jacobs SFOC Contract 9AA20C
NS148884-00	PE	LOGGER,DATA,HYDRA	$	3,427.00	Jacobs SFOC Contract 9AA20C
NS148885-00	PE	LOGGER,DATA,HYDRA	$	3,427.00	Jacobs SFOC Contract 9AA20C
NS149059-00	PE	TRACTOR,TOW	$	155,742.00	Jacobs SFOC Contract 9AA20C
NS149061-00	PE	TRUCK,FORKLIFT	$	29,730.00	Jacobs SFOC Contract 9AA20C
NS149721-00	PE	CABINET,EQUIPMENT,	$	146,205.00	Jacobs SFOC Contract 9AA20C
NS149722-00	PE	CABINET,EQUIPMENT,	$	146,205.00	Jacobs SFOC Contract 9AA20C
NS149731-00	PE	MANIFOLD,SERVICE,	$	36,660.00	Jacobs SFOC Contract 9AA20C
NS149732-00	PE	MANIFOLD,SERVICE,	$	36,660.00	Jacobs SFOC Contract 9AA20C
NS149798-00	PE	TRACTOR,TOW	$	155,742.00	Jacobs SFOC Contract 9AA20C
NS150532-00	PE	MONITOR, OXYGEN	$	392.00	Jacobs SFOC Contract 9AA20C
NS150535-00	PE	MONITOR, OXYGEN	$	392.00	Jacobs SFOC Contract 9AA20C
NS150536-00	PE	MONITOR, OXYGEN	$	392.00	Jacobs SFOC Contract 9AA20C
NS152203-00	PE	FORK LIFT, 11,000 LB.	$	44,663.00	Jacobs SFOC Contract 9AA20C
NS154514-00	PE	CONTROLLER, DIGITAL	$	26,100.00	Jacobs SFOC Contract 9AA20C
NS154514-01	PE	PRINTER	$	470.00	Jacobs SFOC Contract 9AA20C
NS154514-02	PE	CPU	$	18,825.00	Jacobs SFOC Contract 9AA20C
NS154514-03	PE	MONITOR	$	313.00	Jacobs SFOC Contract 9AA20C
NS154514-04	PE	CONTROLLER, REMOTE	$	3,863.00	Jacobs SFOC Contract 9AA20C
NS156475-00	PE	SYSTEM, DATA ACQUISITION	$	23,114.00	Jacobs SFOC Contract 9AA20C
NS156475-01	PE	CHASSIS, EXPANSION	$	929.00	Jacobs SFOC Contract 9AA20C
NS156475-02	PE	CHASSIS, EXPANSION	$	3,298.00	Jacobs SFOC Contract 9AA20C

Attachment J-11.5 Rent Free Non-Interference Basis Property

NS156475-05	PE	MONITOR	$	875.00	Jacobs SFOC Contract 9AA20C
NS156475-06	PE	DRIVE, STORAGE, EXTERNAL	$	6,352.00	Jacobs SFOC Contract 9AA20C
NS156475-07	PE	EXTENDER, BUS	$	929.00	Jacobs SFOC Contract 9AA20C
NS156475-08	PE	EXTENDER, BUS	$	929.00	Jacobs SFOC Contract 9AA20C
NS156475-09	PE	FIXTURE,CALIBRATION,CF-7	$	1,621.00	Jacobs SFOC Contract 9AA20C
NS156475-10	PE	FIXTURE,CALIBRATION,CF-8	$	1,621.00	Jacobs SFOC Contract 9AA20C
NS156475-11	PE	FIXTURE,CALIBRATION,CF-9	$	1,621.00	Jacobs SFOC Contract 9AA20C
NS156475-12	PE	FIXTURE,CALIBRATION,CF-	$	1,621.00	Jacobs SFOC Contract 9AA20C
NS156476-00	PE	SYSTEM, DATA ACQUISITION	$	23,114.00	Jacobs SFOC Contract 9AA20C
NS156476-01	PE	CHASSIS, EXPANSION	$	3,298.00	Jacobs SFOC Contract 9AA20C
NS156476-02	PE	CHASSIS, EXPANSION	$	3,298.00	Jacobs SFOC Contract 9AA20C
NS156476-04	PE	PRINTER	$	1,683.00	Jacobs SFOC Contract 9AA20C
NS156476-05	PE	MONITOR	$	875.00	Jacobs SFOC Contract 9AA20C
NS156476-06	PE	DRIVE,STORAGE,EXTERNAL	$	6,352.00	Jacobs SFOC Contract 9AA20C
NS156476-07	PE	EXTENDER, BUS	$	929.00	Jacobs SFOC Contract 9AA20C
NS156476-08	PE	EXTENDER, BUS	$	929.00	Jacobs SFOC Contract 9AA20C
NS158501-00	PE	LENS, 60 MM	$	559.00	Jacobs SFOC Contract 9AA20C
NS161060-00	PE	TRANSDUCER, PRESSURE	$	858.00	Jacobs SFOC Contract 9AA20C
NS161061-00	PE	TRANSDUCER, PRESSURE	$	858.00	Jacobs SFOC Contract 9AA20C
NS161062-00	PE	TRANSDUCER, PRESSURE	$	710.00	Jacobs SFOC Contract 9AA20C
NS162449-01	PE	DISPLAY	$	2,104.00	Jacobs SFOC Contract 9AA20C
NS162449-02	PE	LIGHT	$	1,726.00	Jacobs SFOC Contract 9AA20C
NS162449-03	PE	LIGHT	$	1,726.00	Jacobs SFOC Contract 9AA20C
NS164731-00	PE	COLD STORAGE UNIT	$	22,233.00	Jacobs SFOC Contract 9AA20C
NS166677-00	PE	110V , AIR CONDITIONER	$	724.00	Jacobs SFOC Contract 9AA20C

**Just fication of need is primary structure and identified secondary structure design, development, test and evaluation (DDT&E), fabrication,*

Attachment J-11.6 Propellant and Gases

Propellants and Gases	Quantity	Estimated Due Date
Fluids, Fuels and Gases	PER CEV-T-013	PER CEV-T-013

Attachment J-11.7.2 Government Furnished Property Aerojet (1)

Proposal Requester	Schedule A, B or C	SOW Ref.	NASA Part No.	Aerojet ID No.	Part Description	Justification of Need	Need Date	Qty (lbm)	RTN Date	RTN Status/ COND.	Current Property Location	Location of Property Use
Aerojet	A	6 2.7	N/A	N/A	Gimbal Actuator and Control Unit	Dev Unit	TBD	1	N/A	N/A	Unknown	Aerojet
Aerojet	A	6 2.7	N/A	N/A	Static Heat Shield	Altitude Dev Engine Testing	TBD	1	N/A	N/A	Unknown	Aerojet
Aerojet	A	6 2.7	N/A	N/A	Static Heat Shield	Qual 1 Testing	TBD	1	N/A	N/A	Unknown	Aerojet
Aerojet	A	6 2.7	N/A	N/A	Gimbal Actuators and Controllers	Qual 2	TBD	1	N/A	N/A	Unknown	Aerojet
Aerojet	A	6 2.7	N/A	N/A	Cables and Harnesses	Qual 2 EMI/EMC	TBD	1	N/A	N/A	Unknown	Aerojet
Aerojet	A	6 2.7	N/A	N/A	Gimbal Actuators with Modified Steps	OME ATP	TBD	2	N/A	N/A	Unknown	Aerojet

Address of Property
Aerojet
Aerojet
Aerojet
Aerojet
Aerojet
Aerojet

Attachment J-11.7.2 Government Furnished Property Aerojet (2)

Aerojet ID #	Deliverable	Need	Quantity	Need Date	Location of Property Use
CFE-HW-001	CRL TPS Assembly for Pod testing	DV Pod Testing	1	8/1/2011	Aerojet
CFE-HW-002	CRL TPS Assembly Boot Seal	DV Pod Testing	1	8/1/2011	Aerojet
CFE-HW-003	CRL TPS Assembly Thermal Barrier Compression Tool	DV Pod Testing	1	8/1/2011	Aerojet
CFE-HW-004	CRL TPS Assembly Protective Cover	DV Pod Testing	1	8/1/2011	Aerojet
CFE-HW-005	CRL TPS Assembly Handling and Installation Procedure (i.e. torque values)	DV Pod Testing	1	6/15/2011	Aerojet
CFE-HW-006	CPU-A TPS Assembly for DV Pod Testing	DV Pod Testing	1	8/1/2011	Aerojet
CFE-HW-007	CPU-A TPS Assembly Boot Seal	DV Pod Testing	1	8/1/2011	Aerojet
CFE-HW-008	CPU-A TPS Assembly Thermal Barrier Compression Tool	DV Pod Testing	1	8/1/2011	Aerojet
CFE-HW-009	CPU-A TPS Assembly Protective Cover	DV Pod Testing	1	8/1/2011	Aerojet
CFE-HW-010	CPU-A TPS Assembly Handling and Installation Procedure (i.e. torque values)	DV Pod Testing	1	6/15/2011	Aerojet
CFE-HW-051	CPD-A TPS Assembly for DV Pod Testing	DV Pod Testing	1	10/1/2011	Aerojet
CFE-HW-052	CPD-A Bracket for DV Pod Testing	DV Pod Testing	1	10/1/2011	Aerojet
CFE-HW-053	CPD-A Fasteners to connect TPS to Bracket for DV Pod testing	DV Pod Testing	1	8/1/2011	Aerojet
CFE-HW-054	CPD-A TPS Assembly Boot Seal Dev Pod testing	DV Pod Testing	1	10/1/2011	Aerojet
CFE-HW-055	CPD-A TPS Assembly Thermal Barrier Compression Tool Dev Pod testing	DV Pod Testing	1	10/1/2011	Aerojet
CFE-HW-056	CPD-A TPS Assembly Protective Cover Dev Pod testing	DV Pod Testing	1	10/1/2011	Aerojet
CFE-HW-057	CPD-A TPS Assembly Handling and Installation Procedure (i.e. torque values) Dev Pod testing	DV Pod Testing	1	6/15/2011	Aerojet
CFE-HW-058	CRL Mass Representation of Outer Thermal Barrier for DV Pod Testing	DV Pod Testing	1	10/1/2011	Aerojet
CFE-HW-059	CPU-A Mass Representation of Outer Thermal Barrier for DV Pod Testing	DV Pod Testing	1	10/1/2011	Aerojet
CFE-HW-060	CPU-A Mass Representation of Outer Thermal Barrier for DV Pod Testing	DV Pod Testing	1	10/1/2011	Aerojet

Aerojet ID #	Deliverable	Need	Quantity	Need Date	Location of Property Use
CFE-HW-011	CRL TPS Assembly for OFT-1	OFT-1	1	11/30/2011	Aerojet
CFE-HW-012	CRL TPS Assembly Boot Seal	OFT-1	1	11/30/2011	Aerojet
CFE-HW-013	CRL TPS Assembly Thermal Barrier Compression Tool (if changed or returned after Dev Pod installation)	OFT-1	1	11/30/2011	Aerojet
CFE-HW-014	CRL TPS Assembly Protective Cover	OFT-1	1	11/30/2011	Aerojet
CFE-HW-015	CRL TPS Assembly Handling and Installation Procedure (if revised after Dev Pod submittal)	OFT-1	1	10/15/2011	Aerojet
CFE-HW-016	CRR TPS Assembly for OFT-1	OFT-1	1	12/15/2011	Aerojet
CFE-HW-017	CRR TPS Assembly Boot Seal	OFT-1	1	12/15/2011	Aerojet
CFE-HW-018	CRR TPS Assembly Thermal Barrier Compression Tool	OFT-1	1	12/15/2011	Aerojet
CFE-HW-019	CRR TPS Assembly Protective Cover	OFT-1	1	12/15/2011	Aerojet
CFE-HW-020	CRR TPS Assembly Handling and Installation Procedure	OFT-1	1	11/1/2011	Aerojet
CFE-HW-021	CPU-A TPS Assembly for OFT-1	OFT-1	1	12/23/2011	Aerojet
CFE-HW-022	CPU-A TPS Assembly Boot Seal	OFT-1	1	12/23/2011	Aerojet
CFE-HW-023	CPU-A TPS Assembly Thermal Barrier Compression Tool	OFT-1	1	12/23/2011	Aerojet
CFE-HW-024	CPU-A TPS Assembly Protective Cover	OFT-1	1	12/23/2011	Aerojet
CFE-HW-025	CPU-A TPS Assembly Handling and Installation Procedure (If revised after Dev Pod submittal)	OFT-1	1	11/1/2011	Aerojet
CFE-HW-026	CPU-B TPS Assembly for OFT-1	OFT-1	1	1/15/2012	Aerojet
CFE-HW-027	CPU-B TPS Assembly Boot Seal	OFT-1	1	1/15/2012	Aerojet
CFE-HW-028	CPU-B TPS Assembly Thermal Barrier Compression Tool	OFT-1	1	1/15/2012	Aerojet
CFE-HW-029	CPU-B TPS Assembly Protective Cover	OFT-1	1	1/15/2012	Aerojet
CFE-HW-030	CPU-B TPS Assembly Handling and Installation Procedure	OFT-1	1	12/1/2011	Aerojet
CFE-HW-031	CYL TPS Assembly for OFT-1	OFT-1	1	2/15/2012	Aerojet
CFE-HW-032	CYL TPS Assembly Boot Seal	OFT-1	1	2/15/2012	Aerojet
CFE-HW-033	CYL TPS Assembly Thermal Barrier Compression Tool	OFT-1	1	2/15/2012	Aerojet

Aerojet ID #	Deliverable	Need	Quantity	Need Date	Location of Property Use
CFE-HW-034	CYL TPS Assembly Protective Cover	OFT-1	1	2/15/2012	Aerojet
CFE-HW-035	CYL TPS Assembly Handling and Installation Procedure	OFT-1	1	1/1/2012	Aerojet
CFE-HW-036	CYR TPS Assembly for OFT-1	OFT-1	1	1/30/2012	Aerojet
CFE-HW-037	CYR TPS Assembly Boot Seal	OFT-1	1	1/30/2012	Aerojet
CFE-HW-038	CYR TPS Assembly Thermal Barrier Compression Tool	OFT-1	1	1/30/2012	Aerojet
CFE-HW-039	CYR TPS Assembly Protective Cover	OFT-1	1	1/30/2012	Aerojet
CFE-HW-040	CYR TPS Assembly Handling and Installation Procedure	OFT-1	1	12/15/2011	Aerojet
CFE-HW-041	CPD-A TPS Assembly for OFT-1	OFT-1	1	2/28/2012	Aerojet
CFE-HW-042	CPD-A TPS Assembly Boot Seal	OFT-1	1	2/28/2012	Aerojet
CFE-HW-043	CPD-A TPS Assembly Thermal Barrier Compression Tool	OFT-1	1	2/28/2012	Aerojet
CFE-HW-044	CPD-A TPS Assembly Protective Cover	OFT-1	1	2/28/2012	Aerojet
CFE-HW-045	CPD-A TPS Assembly Handling and Installation Procedure	OFT-1	1	1/15/2012	Aerojet
CFE-HW-046	CPD-B TPS Assembly for OFT-1	OFT-1	1	3/15/2012	Aerojet
CFE-HW-047	CPD-B TPS Assembly Boot Seal	OFT-1	1	3/15/2012	Aerojet
CFE-HW-048	CPD-B TPS Assembly Thermal Barrier Compression Tool	OFT-1	1	3/15/2012	Aerojet
CFE-HW-049	CPD-B Assembly Protective Cover	OFT-1	1	3/15/2012	Aerojet
CFE-HW-050	CPD-B TPS Assembly Handling and Installation Procedure	OFT-1	1	2/1/2012	Aerojet
CFE-HW-061	CPD-A Bracket for DV Pod Testing	OFT-1	1	2/28/2012	Aerojet
CFE-HW-062	CPD-A Fasteners to connect TPS to Bracket for DV Pod testing	OFT-1	1	2/28/2012	Aerojet
CFE-HW-063	CPD-B Bracket for DV Pod Testing	OFT-1	1	3/15/2012	Aerojet
CFE-HW-064	CPD-B Fasteners to connect TPS to Bracket for DV Pod Testing	OFT-1	1	3/15/2012	Aerojet

Attachment J-11.7.2 Government Provided Material (Aerojet)

Aerojet Material (to be consumed in production)

Proposal Requester	Schedule A, B or C	SOW Ref.	NASA Part No.	Aerojet ID No.	Part Description	Justification of Need	Need Date	Qty (lbm)	RTN Date	RTN Status/ COND.	Property Owner	Current Property Location	Location of Property Use	Address of Property Use
Aerojet	A	10.1.2	TBD	N/A	OME (non-functional) or equivalent set of OME components*	Mass Simulator (STA)	4/7/2011	1	Consumed in deliverables	Consumed in deliverables	NASA	Aerojet	Aerojet	Aerojet
Aerojet	A	6.2.7.1	N/A	1233902-001	100 Lb Monopropellant Thruster	Risk Reduction Hot Fire Test (MR104D)	1/8/2011	8	Consumed in Test	Consumed in Test	NASA	Aerojet	Aerojet	Aerojet
Aerojet	A/B	10.1.2	TBD	N/A	OME (non-functional)	Mass Simulator	4/7/2011	2	Consumed in deliverables	Consumed in deliverables	NASA	Aerojet	Aerojet	Aerojet
Aerojet	A	ERB 605	TBD	N/A	BPV	Hydraulic Simulator	4/7/2011	2	Consumed in deliverables	Consumed in deliverables	NASA	Aerojet	Aerojet	Aerojet

*Equivalent Engine = non-functional BPV, pneumatic pack (PP), engine inlet propellant manifolds and BPV to chamber propellant manifolds

Aerojet Propellants and Gases

Proposal Requester	Schedule A, B or C	SOW Ref.	NASA Part	Aerojet ID No.	Part Description	Justification of Need	Need Date	Qty (lbm)	RTN Date	RTN Status/ COND.	Property Owner	Current Property Location	Location of Property Use	Address of Property Use
Aerojet	A	6.2.7	N/A	N/A	Oxidizer (N204)	Engine Test Operations	A/R	A/R	N/A	N/A	DESC	San Antonio	Aerojet	Aerojet
Aerojet	A	6.2.7	N/A	N/A	Hydrazine	Engine Test	A/R	A/R	N/A	N/A	DESC	San Antonio	Aerojet	Aerojet
Aerojet	A	6.2.7	N/A	N/A	Fuel (MMH)	Engine Test and Flight	A/R	A/R	N/A	N/A	DESC	San Antonio	Aerojet	Aerojet
Aerojet	A	6.2.7	N/A	N/A	Gaseous Nitrogen	Engine Test Operations	A/R	A/R	N/A	N/A	DESC	San Antonio	Aerojet	Aerojet
Aerojet	A	6.2.7	N/A	N/A	Gaseous Helium	Engine Test Operations	A/R	A/R	N/A	N/A	DESC	San Antonio	Aerojet	Aerojet
Aerojet	A	6.2.7	N/A	N/A	Liquid/Gaseous Methane	Engine Test	A/R	A/R	N/A	N/A	DESC	San Antonio	Aerojet	Aerojet
Aerojet	A	6.2.7	N/A	N/A	Liquid/Gaseous Oxygen	Engine Test	A/R	A/R	N/A	N/A	DESC	San Antonio	Aerojet	Aerojet

A/R As Required

Attachment J-11.7.4 Government Furnished Property (Hamilton Sundstrand)

Part/Model #	Serial # (if applicable)	Lot # (if applicable)	Nomenclature	Quantity	Unit of Measure	Cost	Extended cost	Government Furnished Property (GFP)	Justification
SVSK127815	N/A	N/A	Shuttle Freon Rig 111 (A&B) W th Trane Chiller System	1	ea	334K	334K	NNJ06VA01C PO 6000134612 This is the contract and PO that currently owns the rig.	HS needs the rig to test items with PGW. This rig is currently the property of USA for the use on the Shuttle program. The use of this rig wi l m tigate the risk of having a PGW rig ready for use.
7RG053600A	0003331 and 0003334	N/A	Portable Test Un t (PTU) Line Replaceable Unit (LRU) Test Adapter	2	ea	$892,000.00	$1,784,000.00	NNJ06VA01C PO 6000134612 This is the contract and PO that currently owns the rig.	Needed to support SPTU Orion testing
7RG053724A	0004675	N/A	PTU Self Test Box	1	ea	$50,000.00	$50,000.00	NNJ06VA01C PO 6000134612 This is the contract and PO that currently owns the rig.	Needed to support SPTU Orion testing
The part number refers to Applied Resources Corporations (ARC) part number. Preferred 192253 A t 192203	N/A	N/A	Shuttle mechanical switches *Description (Maintained /Maintained / Maintained) *Locking Feature Lock / Lock / Lock 3 Position switch	3	ea	$6,800.00	$20,400.00		HS needs the switches to populate the Auxiliary Bus Control Unit. The switches would be used for two ABCU assemblies and switch level testing. The use of the shuttle switches will mitigate the risk associated with the high environmental loads experienced by the ABCU, since the shuttle switch is the only currently available sw tch that can survive the environments.
The part number refers to Applied Resources Corporations (ARC) part number. Preferred 192255 A t 192205	N/A	N/A	Shuttle mechanical switches *Description Momentary /Maintained / Momentary *Locking Feature Lock Center 3 Position Switch	4	ea	$6,800.00	$27,200.00		HS needs the switches to populate the Auxiliary Bus Control Unit. The switches would be used for two ABCU assemblies and switch level testing. The use of the shuttle switches will mitigate the risk associated with the high environmental loads experienced by the ABCU, since the shuttle switch is the only currently available sw tch that can survive the environments.
The part number refers to Applied Resources Corporations (ARC) part number. Preferred 192251 A t 192201	N/A	N/A	Shuttle mechanical switches *Description Maintained / Momentary *Locking Feature Lock / Lock 2 Position Switch	8	ea	$6,800.00	$54,400.00		HS needs the switches to populate the Auxiliary Bus Control Unit. The switches would be used for two ABCU assemblies and switch level testing. The use of the shuttle switches will mitigate the risk associated with the high environmental loads experienced by the ABCU, since the shuttle switch is the only currently available sw tch that can survive the environments.
7RG053753A3	None	Property Number JO731864	Thermal Interface Plate	1	ea	$24,459.00	$24,459.00		Needed to support SPTU Orion testing.
TVAC-4	None	Property Number JO034140	TVAC-4	1	ea	$1,606,019.00	$1,606,019.00		Needed to support SPTU Orion testing
7RG025661	1401610	Property Number JO033922	Programmable Loads Remote Power Control Mechanism (RPCM)	1	ea	$64,788.00	$64,789.00		Needed to support SPTU Orion testing
7RG025661	1402044	Property Number JO033925	Programmable Loads RPCM	1	ea	$ 36 934.00	$ 36 934.00		Needed to support SPTU Orion testing
7RG025661	1440059	Property Number JO033927	Programmable Loads RPCM	1	ea	$ 70 833.00	$ 70 833.00		Needed to support SPTU Orion testing
7RG025661	1440060	Property NumberJO033928	Programmable Loads RPCM	1	ea	$ 73 435.00	$ 73 435.00		Needed to support SPTU Orion testing
7RG025661	1440058	Property NumberJO033929	Programmable Loads RPCM	1	ea	$ 67 501.00	$ 67 501.00		Needed to support SPTU Orion testing
7RG025661	1440210	Property NumberJO033932	Programmable Loads RPCM	1	ea	$ 68,331.00	$ 68,331.00		Needed to support SPTU Orion testing
7RG025661	1440208	Property NumberJO033933	Programmable Loads RPCM	1	ea	$ 56,010.00	$ 56,010.00		Needed to support SPTU Orion testing
7RG025661	1440271	Property Number JO033937	Programmable Loads RPCM	1	ea	$ 69,315.00	$ 69,315.00		Needed to support SPTU Orion testing
7RG025661	1440282	Property Number JO033940	Programmable Loads RPCM	1	ea	$ 68 895.00	$ 68 895.00		Needed to support SPTU Orion testing
7RG025661	1440391	Property Number JO034106	Programmable Loads RPCM	1	ea	$ 41 062.00	$ 41 062.00		Needed to support SPTU Orion testing
7RG025661	1449054	Property Number JO700761	Programmable Loads RPCM	1	ea	$ 130 967.00	$ 130 967.00		Needed to support SPTU Orion testing
7RG025661	1449612	Property Number JO723563	Programmable Loads RPCM	1	ea	$ 135 655.00	$ 135 655.00		Needed to support SPTU Orion testing
7RG025661	1449613	Property Number JO723564	Programmable Loads RPCM	1	ea	$ 135,800.00	$ 135,800.00		Needed to support SPTU Orion testing
7RG025661	1449614	Property Number JO723565	Programmable Loads RPCM	1	ea	$ 57,193.00	$ 57,193.00		Needed to support SPTU Orion testing
7RG025661	1449615	Property Number JO723566	Programmable Loads RPCM	1	ea	$ 57 193.00	$ 57 193.00		Needed to support SPTU Orion testing
7RG026915	1440253	Property Number JO033663	Tr lectron 40 KW Power Supply	1	ea	$ 67 046.00	$ 67 046.00		Needed to support SPTU Orion testing
7RG026915	1440258	Property Number JO033664	Tr lectron 40 KW Power Supply	1	ea	$ 67 046.00	$ 67 046.00		Needed to support SPTU Orion testing
7RG026915	1440254	Property Number JO033665	Tr lectron 40 KW Power Supply	1	ea	$ 67 046.00	$ 67 046.00		Needed to support SPTU Orion testing
7RG026915	1440256	Property Number JO033666	Tr lectron 40 KW Power Supply	1	ea	$ 67,046.00	$ 67,046.00		Needed to support SPTU Orion testing
7RG026915	1440250	Property Number JO033668	Tr lectron 40 KW Power Supply	1	ea	$ 67,046.00	$ 67,046.00		Needed to support SPTU Orion testing
7RG026915	1440252	Property NumberJO033669	Tr lectron 40 KW Power Supply	1	ea	$ 67 046.00	$ 67 046.00		Needed to support SPTU Orion testing
7RG026915	1440251	Property Number JO033671	Tr lectron 40 KW Power Supply	1	ea	$ 67 046.00	$ 67 046.00		Needed to support SPTU Orion testing
7RG026915	1440247	Property NumberJO033681	Tr lectron 40 KW Power Supply	1	ea	$ 67 046.00	$ 67 046.00		Needed to support SPTU Orion testing
7RG026915	1440255	Property Number JO033683	Tr lectron 40 KW Power Supply	1	ea	$ 66 558.00	$ 66 558.00		Needed to support SPTU Orion testing
7RG026915	1440261	Property Number JO033685	Tr lectron 40 KW Power Supply	1	ea	$ 66 558.00	$ 66 558.00		Needed to support SPTU Orion testing
7RG026915	1440248	Property Number JO033687	Tr lectron 40 KW Power Supply	1	ea	$ 66,558.00	$ 66,558.00		Needed to support SPTU Orion testing
7RG026915	1439993	Property Number JO700742	Tr lectron 40 KW Power Supply	1	ea	$ 66,558.00	$ 66,558.00		Needed to support SPTU Orion testing
7RG026915	1439994	Property NumberJO700743	Tr lectron 40 KW Power Supply	1	ea	$ 56 579.00	$ 56 579.00		Needed to support SPTU Orion testing
7RG026915	1439996	Property Number JO700745	Tr lectron 40 KW Power Supply	1	ea	$ 56 579.00	$ 56 579.00		Needed to support SPTU Orion testing
7RG026915-1	1440258	Property Number JO033644	Trilectron DC Power Supply	1	ea	$ 67 046.00	$ 67 046.00		Needed to support SPTU Orion testing
7RG025200-1	1305885	Property Number JO033915	VLDDCU	1	ea	$ 31 216.00	$ 31 216.00		Needed to support SPTU Orion testing
7RG025200-1	1400098	Property Number JO033917	VLDDCU	1	ea	$ 16,253.00	$ 16,253.00		Needed to support SPTU Orion testing
7RG025600-51	1400583	Property Number JO034104	PLDDCU	1	ea	$ 76,161.00	$ 76,161.00		Needed to support SPTU Orion testing
7RG025600-51	1400642	Property Number JO034105	PLDDCU	1	ea	$ 32 903.00	$ 32 903.00		Needed to support SPTU Orion testing
7RG025600-51	1440291	Property Number JO034109	PLDDCU	1	ea	$ 66 348.00	$ 66 348.00		Needed to support SPTU Orion testing
7RG025600-51	1449153	Property Number JO034113	PLDDCU	1	ea	$ 44 450.00	$ 44 450.00		Needed to support SPTU Orion testing
4R077420-1	X751272	Property Number JO731623	RPCM Type VI (Note Reported as APP)	1	ea	$ 159 375.00	$ 159 375.00		Needed to support SPTU Orion testing
AM503S	BO12573	Property Number SO143424	Current Amp ifier/Current Probe	1	ea	$ 3,044.00	$ 3,044.00		Needed to support SPTU Orion testing
AM503S	BO12572	Property Number SO143427	Current Amp ifier/Current Probe	1	ea	$ 3,044.00	$ 3,044.00		Needed to support SPTU Orion testing

Part/Model #	Serial # (if applicable)	Lot # (if applicable)	Nomenclature	Quantity	Unit of Measure	Cost	Extended cost	Government Furnished Property (GFP)	Justification
LISN	925008	Property Number SO148181	Solar 9238-10-TS-50-BNC	1	ea	$ 2,125.00	$ 2,125.00		Needed to support SPTU Orion testing
44203-1	24	Property Number SO148208	TWTA Model ASE 200X/KU; 200W (8-18 GHz)	1	ea	$ 37 472.00	$ 37 472.00		Needed to support SPTU Orion testing
44202-1	25	Property Number SO148209	TWTA Model ASE 200S; 200W (2-4 GHz)	1	ea	$ 37 472.00	$ 37 472.00		Needed to support SPTU Orion testing
None	1023	Property Number SO148963	Ridged Horn Antenna ARA DRG-2020/A	1	ea	$ 5 196.00	$ 5 196.00		Needed to support SPTU Orion testing
50905-1	44	Property Number SO148964	TWTA Model ASE 200L; 200W (1-2 GHz)	1	ea	$ 43 260.00	$ 43 260.00		Needed to support SPTU Orion testing
50902-1	43	Property Number SO148965	TWTA Model ASE 200C; 200W (4-8 GHz)	1	ea	$ 40,472.00	$ 40,472.00		Needed to support SPTU Orion testing
3980A	USCD014306	Property Number SO170278	Printer-HP LaserJet 6P	1	ea	$ 2,039.00	$ 2,039.00		Needed to support SPTU Orion testing
7RG025777-41	8828998	Property Number SO170340	RPCM Thermal Interface Plate	1	ea	$ 2 454.00	$ 2 454.00		Needed to support SPTU Orion testing
6030A	None	Property Number SO171151	HP6030A C Power Supply	1	ea	$ 4 927.00	$ 4 927.00		Needed to support SPTU Orion testing
None	None	Property Number SO184177	Power Ten DC Power Supply	1	ea	$ 15 586.00	$ 15 586.00		Needed to support SPTU Orion testing
TDS 7104	B053780	Property Number SO184378	Oscilloscope	1	ea	$ 27 436.00	$ 27 436.00		Needed to support SPTU Orion testing
None	None	Property Number JO034141	Thermal Vacuum And Cycling System 8 (TVACS-8)	1	ea	$ 2,043,924.00	$ 2,043,924.00		Needed to support OFT-1 and SPTU Orion testing
7RG025661-81	1449306	Property Number P002014	Programmable Load RPCM (PLRPC)	1	ea	$ 95,625.00	$ 95,625.00		Needed to support SPTU Orion testing
7RG025661-81	1441272	Property Number P002358	Programmable Load RPCM (PLRPC)	1	ea	$ 103 594.00	$ 103 594.00		Needed to support SPTU Orion testing
7RG025661-71	1449053	Property Number P002771	Programmable Load RPCM (PLRPC)	1	ea	$ 130 967.00	$ 130 967.00		Needed to support SPTU Orion testing
7RG025661-71	1440956	Property Number P002703	Programmable Load RPCM (PLRPC)	1	ea	$ 28 467.00	$ 28 467.00		Needed to support SPTU Orion testing
7RG025661-81	1441274	Property Number P002116	Programmable Load RPCM (PLRPC)	1	ea	$ 103 594.00	$ 103 594.00		Needed to support SPTU Orion testing
7RG096947A1	N/A	N/A	Assy, PTU Brassboard Discrete Telemetry & Control	1	ea				Needed to support SPTU Orion testing
7RG096948A1	N/A	N/A	Assy, PTU Analog Telemetry & Store Box	1	ea				Needed to support SPTU Orion testing
7RG096951A1	N/A	N/A	Cable Assy and Interconnect, PTU Test Boxes	1	ea				Needed to support SPTU Orion testing
7RG096994A1	N/A	N/A	Integration Test Fixture Assy, OPCU	1	ea				Needed to support SPTU Orion testing
7RG096997A1	N/A	N/A	Load box, OPCU Housekeeping PWA	1	ea				Needed to support SPTU Orion testing
7RG096998A1	N/A	N/A	Cable Assy, Adapter, OPCU Housekeeping PWA Input	1	ea				Needed to support SPTU Orion testing
7RG096999A1	N/A	N/A	Cable Assy, Adapter, OPCU J3 Input Power	1	ea				Needed to support SPTU Orion testing
7RG097052A1	N/A	N/A	FET Switch Assembly	1	ea				Needed to support SPTU Orion testing
7RG025661	N/A	N/A	Programmable Load, PLRPC	1	ea				Needed to support SPTU Orion testing
7RG097115A1	N/A	N/A	Damper Un t Test Assy	1	ea				Needed to support SPTU Orion testing
8R108300	N/A	N/A	Steering FET Driver OPCU PWA	1	ea				Needed to support SPTU Orion testing
8R108305	N/A	N/A	PWM FET Driver OPCU PWA	1	ea				Needed to support SPTU Orion testing
8R108310	N/A	N/A	Synchronous FET Driver OPCU PWA	1	ea				Needed to support SPTU Orion testing
8R108315	N/A	N/A	Input F lter OPCU PW	1	ea				Needed to support SPTU Orion testing
8R108320	N/A	N/A	Output Fi ter OPCU PWA	1	ea				Needed to support SPTU Orion testing
8R108325	N/A	N/A	Control and Telemetry OPCU PWA	1	ea				Needed to support SPTU Orion testing
8R109411	N/A	N/A	Housekeeping Power Supply OPCU PWA	1	ea				Needed to support SPTU Orion testing
TVACS-4 TVACS-8	N/A	N/A	Thermal Vacuum Chambers (Utilize 4 of 4)	1	ea				Needed to support OFT-1 and SPTU Orion testing
7RG053600A1	N/A	N/A	Console Assembly - PTU, LTA	1	ea				Needed to support SPTU Orion testing
7RG053602A1	N/A	N/A	LTA Test Cable Setup	1	ea				Needed to support SPTU Orion testing
7RE1897	N/A	N/A	Programmable Source	1	ea				Needed to support SPTU Orion testing
7RG025661	N/A	N/A	Programmable Load	1	ea				Needed to support SPTU Orion testing
7RG097024A1	N/A	N/A	Thermal Adapter Plate – OPCU	1	ea				Needed to support SPTU Orion testing
7RG053724A1	N/A	N/A	PTU-LTA Self Test Adapter	1	ea				Needed to support SPTU Orion testing
7R108230A1 EM01	N/A	N/A	Paralyne, Non-Flt-Like Control Card	1	ea				Needed to support SPTU Orion testing
7R108230A2 EM02	N/A	N/A	Paralyne, Flt-Like Control Card (Preferred)	1	ea				Needed to support SPTU Orion testing
7R108230A3 EM03	N/A	N/A	No Paralyne, Non-F t-Like Control Card	1	ea				Needed to support SPTU Orion testing
4R108230A1	N/A	N/A	QM01 Thermal and Vibe Unit	1	ea				Needed to support SPTU Orion testing
4R108230A2	N/A	N/A	QM02 EMI and PVT Unit (Preferred)	1	ea				Needed to support SPTU Orion testing
7RG053755A1	N/A	N/A	PTU Command and Telemetry Box	1	ea				Needed to support SPTU Orion testing
7R108230A2	9000459	Property Number JO731861	Assembly, Power Transfer Un t (EM02)	1	ea				Needed to support SPTU Orion testing
7R108230A3	9000460	Property Number JO7361862	Assembly Power Transfer Unit (EM03)	1	ea				Needed to support SPTU Orion testing
7R108230A3	9000460	Property Number JO731862	Assembly, Power Transfer Un t (EM03)	1	ea				Needed to support SPTU Orion testing
7RG096994A1	N/A	Property Number JO731662	OPC Test Fixture	1	ea				Needed to support SPTU Orion testing
7RG053600A1	3334	Property Number JO731570	PTU LRU Test Adapter	1	ea				Needed to support SPTU Orion testing
7RG053600A1	3331	Property Number JO731572	PTU LRU Test Adapter	1	ea				Needed to support SPTU Orion testing
7RG053724A1	4575	Property Number JO731865	PTU Self Test Box	1	ea				Needed to support SPTU Orion testing
7RG053755A1	4309	Property Number JO731723	CTU	1	ea				Needed to support SPTU Orion testing

Attachment J-11.7.4 HI Government Provided Data and Software

Center		Services / Other	Reference	Est. Beginning Use	Est. End Use
Johnson Space Center		FAST Acquisition Technology	6.2.12 Guidance Navigation and Control (GN&C)		through Schedule B
Johnson Space Center		algor thms, analysis including theory and validation results, algor thm implementation in Simulink models conforming to the established LM GN&C Simulink Computer Software Unit (CSU) Development Process and standards, Simulink Model Component Tests implemented in the MathWorks SystemTest tool, and support to the Honeywell Absolute Navigation Flight Software (FSW) team during the FSW development for the F ltered Navigation and Extended Kalman Fi ter CSUs.	6.2.12 GN&C	3/30/2011 ("functionally complete" Simulink model)	Through Schedule B
Johnson Space Center		algor thms, analysis including theory and validation results, algor thm implementation in Simulink models conforming to the established LM GN&C Simulink Computer Software Unit (CSU) Development Process and standards, Simulink Model Component Tests implemented in the MathWorks SystemTest tool, and support to the Honeywell Absolute Navigation Flight Software (FSW) team during the FSW development for the F ltered Navigation and Extended Kalman Fi ter CSUs.	6.2.12 GN&C	5/15/2011 ("design complete" Simulink model)	Through Schedule B
NASA provided Service		algor thms, analysis including theory and validation results, algor thm implementation in Simulink models conforming to the established LM GN&C Simulink Computer Software Unit (CSU) Development Process and standards, Simulink Model Component Tests implemented in the MathWorks SystemTest tool, and support to the Honeywell Absolute Navigation Flight Software (FSW) team during the FSW development for the F ltered Navigation and Extended Kalman Fi ter CSUs.	6.2.12 GN&C	9/1/2011 ("Model Component Test complete" Simulink Model)	Through Schedule B

Notes For reference use only

Name: Filtered Navigation and Extended Kalman Filter Algorithms and Simulink Model Implementation

Description:
NASA will provide the algorithms analysis including theory and validation results algorithm implementation in Simu ink models conforming to the established LM GN&C Simu ink Computer Software Unit (CSU) Development Process and standards Simu ink Model Component Tests implemented in the MathWorks SystemTest tool and support to the Honeywell Absolute Navigation Flight Software (FSW) team during the FSW development for the Filtered Navigation and Extended Kalman Filter CSUs.

Providing Organization:
Dr. Timothy P. Crain
EG6 Autonomous GN&C Systems
NASA Johnson Space Center

Program Applicabi ity: Orion Flight Test 1 and Orion-2 Programs

Need Dates:

- Initial Need Date: 3/30/11

The "Functionally complete" Simu ink model implementation integrated into the GN&C Empty Box Architecture (EBA) model contained in the LM Synergy GN&C Simu ink Model Baseline 3 of 3/30/11 is required to support the ANAV FSW development of the D6.3 baseline delivery. Functionally complete" is defined as the completion of:

1. the Simulink model implementation in accordance with the SRS requirements allocated to this CSU and
2. the initial CSU confidence tests developed in Simulink.

- Mid-term Need Date: 5/15/11

The “Design complete” Simu ink model implementation integrated into the GN&C Empty Box Architecture (EBA) model contained in the LM Synergy GN&C Simu ink Model Baseline 4 of 5/15/11 is required to support the completion of the ANAV FSW development for the D6.3 baseline delivery and to begin Simulink model component testing. “Design complete” is defined as the

1. the Simulink model implementation in accordance with the SRS requirements allocated to this CSU;
2. the CSU Memo sections documenting the algorithm theory model implementation and SRS requirements traceability to the CSU design components;
3. the completion of the exit criteria for the task Design Simulink Model Components (Production) [Task 3.1.1]” of the LM GN&C Simu ink CSU Development Process as defined in the CSU Development Process Checklist; and
4. the CSU Model Design Review and action item closure.

- Fin Need D e /1/ complete” Simulink model implementation integrated into the GN&C Empty Box Architecture (EBA) model contained in the LM Synergy GN&C Simu ink Model Baseline 5 of 9/1/11 is required to support the completion of the FSW unit testing activities for the D8 delivery. “Model Component Test complete” is defined as the completion of:

1. the algorithm validation testing and report;
2. the Simulink model component testing and its SystemTest test artifacts;
3. the CSU Memo sections documenting the model component tests and SRS requirements traceability to the CSU model component tests;
4. the completion of the exit criteria for the task “Test Simu ink Model Components (Production) [Task 3.1.2]” of the LM GN&C Simulink CSU Development Process defined in the CSU Development Process Checklist; and
5. the CSU Model Test Review and action item closure.

Period of Need: Duration of the OFT-1 and Orion-2 Program

Attachment J-11.8 - MAF Donated Assets

(b) (4)

[redacted]

(b) (4)

[redacted]

ATTACHMENT J-12

LIST OF GOVERNMENT FACILITIES

Guidance for Intallation-Accountable Government Property and Services (NFS 1852.245-77 Jul 1997) is included in Section G.11 of the Orion Contract.

The J-12 is a listing of facilities that the Government maintains records for and will be made available to LMSSC for performance of the Orion contract.
Associated "services" provided shall be listed in Attachment J-10.

Attachment J-12 Government Furnished Facilities

Government Facility	Description	Est. Beginning of Use	Est. End of Use
Ames Research Center	Arc Jet Test Building	4/1/2009	~~12/31/2014~~ 12/31/2020
Glenn Research Center	Seal Test Lab	4/1/2007	6/30/2009
Glenn Research Center	Bldg. 301 chamber VF-12	12/1/2007	4/30/2008
Glenn Research Center	Atomic Oxygen Beam Facility (AOBF)	4/1/2008	~~5/31/2009~~ 10/1/2019
Glenn Research Center	Solar Cell Evaluation Laboratory (SCEL)	4/1/2008	~~5/31/2009~~ 10/1/2019
Glenn Research Center	Plasma Interaction Facility (PIF)	~~4/1/2008~~ 1/1/2016	~~5/31/2009~~ 10/1/2019
Plum brook Space Power	Vibro acoustics Facility	~~7/30/2009~~ 5/1/2016	~~TBD~~ 12/31/2019
Plum brook Space Power	Thermal Vac Chamber	~~12/31/2011~~ 5/1/2016	~~TBD~~ 12/31/2020
Plum brook Space Power	EMI/EMC Test Facility - Antenna Facility	~~5/30/2011~~ 5/1/2016	~~TBD~~12/31/2020
Plum brook Space Power	Storage Facility w racks	~~6/30/2009~~ 5/1/2016	~~12/31/2014~~ 12/31/2020
Plum brook Space Power	Humidity Controlled Ordnance Storage	~~6/30/2009~~ 5/1/2016	~~12/31/2014~~ 12/31/2020
Plum brook Space Power	Maintenance Workshop	~~6/30/2009~~ 5/1/2016	~~12/31/2014~~ 12/31/2020
Plum brook Space Power	External Fenced Storage	~~6/30/2009~~ 5/1/2016	~~12/31/2014~~ 12/31/2020
Langley Research Facility	Drop Test Facility/Gantry Test Area/Water Egress Facility	~~7/30/2009~~ 9/1/2012	~~12/31/2014~~ 5/1/2020
Langley Research Facility	Storage Facility w racks	~~7/30/2009~~ 9/1/2012	~~12/31/2014~~ 5/1/2020
Langley Research Facility	Maintenance Workshop	~~7/30/2009~~ 9/1/2012	~~12/31/2014~~ 5/1/2020
Langley Research Facility	External Fenced Storage	~~7/30/2009~~ 9/1/2012	~~12/31/2014~~ 5/1/2020
~~Langley Research Facility~~	~~Ordnance Handling Facility~~	~~7/1/2009~~	~~12/31/2014~~
~~Johnson Space Center~~	~~CAIL Bldg. 29~~	~~TBD~~	~~12/31/2014~~
~~Johnson Space Center~~	~~Bldg. 361 Exploration ESP Test bed (EEST)~~	~~TBD~~	~~12/31/2014~~
~~Johnson Space Center~~	~~Rendezvous and Proximity Operations Docking Facility~~	~~1/1/2010~~	~~12/31/2014~~
~~Johnson Space Center~~	~~Bldg. 49 Acoustics Chamber~~	~~4/1/2008~~	~~12/31/2014~~
~~Johnson Space Center~~	~~Bldg. 32 Thermal Vacuum Lab~~	~~7/1/2008~~	~~12/31/2014~~
~~Johnson Space Center~~	~~Bldg. 49 / Bldg. 350 Vibration Laboratory~~	~~5/1/2008~~	~~12/31/2014~~
~~Johnson Space Center~~	~~Bldg. 14 EMI /EMC Test Facility and Antenna Facility~~	~~10/1/2008~~	~~12/31/2014~~
~~Johnson Space Center~~	~~Bldg. 14 6-Degree of Freedom (DOF) Laser Sensor Test Facility~~	~~1/1/2009~~	~~12/31/2014~~
~~Johnson Space Center~~	~~Bldg. 44 Electrical Systems Test Lab (ESTL)~~	~~7/1/2007~~	~~11/30/2012~~
~~Johnson Space Center~~	~~Building 7 Advanced Materials Test Lab~~	~~9/1/2008~~	~~12/31/2014~~
~~Johnson Space Center~~	~~Bldg. 13 Static/Dynamic Load Structural Test Lab~~	~~7/1/2008~~	~~12/31/2014~~
~~Johnson Space Center~~	~~Bldg. 13 Advanced Materials Testing Lab and Mass Properties Measurement Laboratory~~	~~12/1/2007~~	~~12/31/2014~~
~~Johnson Space Center~~	~~Bldg. 15 Receiving Inspection Test Facility (RITF)~~	~~7/1/2008~~	~~12/31/2014~~
~~Johnson Space Center~~	~~Bldg. 15 Graphics Research Analysis Facility~~	~~8/1/2007~~	~~9/30/2012~~
Johnson Space Center	Bldg. 15 Anthropometry & Biomechanics Facility	4/1/2008	~~8/31/2012~~ 12/31/2020
Johnson Space Center	Bldg. 15 Usability Test & Analysis Facility	4/1/2008	~~5/30/2009~~ 12/31/2020
Johnson Space Center	Bldg. 16 High Bay Reconfigurable Operational Cockpit	10/1/2007	~~5/31/2011~~ 12/31/2020
~~Johnson Space Center~~	~~Building 16 R&I Laboratory~~	~~8/1/2011~~	~~12/31/2011~~
Johnson Space Center	Lighting Environment Test Facility (LETF)	1/1/2010	~~12/31/2011~~ 12/31/2020
~~Johnson Space Center~~	~~Neutral Buoyancy Laboratory (NBL)~~	~~5/1/2007~~	~~12/31/2014~~
~~Johnson Space Center~~	~~Integrated Power Lab (IBL)~~	~~10/1/2008~~	~~12/31/2014~~
Johnson Space Center	Bldg. 222 Arc Jet Testing Facility	8/1/2007	12/31/2012
~~Johnson Space Center~~	~~Bldg. 260 Radiant Test Facility~~	~~8/1/2007~~	~~12/31/2014~~
~~Johnson Space Center~~	~~Bldg. 33 Supporting Thermal Vacuum Chambers~~	~~10/1/2008~~	~~12/31/2011~~
Johnson Space Center	Bldg. 9 CEV Mockups, 6 DOF Stewart Motion Platform, Precision Air Bearing Floor, Precision Cleaning Facility	~~2Q11~~ 4/1/2016	~~4Q12~~ 12/31/2020
Johnson Space Center	Bldg. 37 Toxicology Lab	~~12/31/2007~~ 4/1/16	~~10/31/2010~~ 12/31/2020
~~Johnson Space Center~~	~~Bldg. 7 Glove Box Suit Interface Lab~~	~~12/1/2007~~	~~10/31/2010~~
~~Johnson Space Center~~	~~White Sands Test Facility - Materials Lab~~	~~1/1/2008~~	~~12/31/2013~~
Johnson Space Center	White Sands Space Launch Complex	4/1/2008	6/30/2011
~~Johnson Space Center Bldg. 354~~	~~Cold Storage for Batteries~~	~~DD250~~	~~12/31/2014~~
~~Johnson Space Center~~	~~Bldg. 361 EEST External Data Repository~~	~~TBD~~	~~12/31/2014~~
~~Johnson Space Center~~	~~Bldg. 361 EEST Conference, Build-Up, Lab Test bed, Storage~~	~~TBD~~	~~12/31/2011~~
~~Johnson Space Center~~	~~Crew Systems Avionics Lab (CAIL) Conference~~	~~TBD~~	~~12/31/2014~~
~~Johnson Space Center~~	~~CAIL Control Rooms~~	~~TBD~~	~~12/31/2014~~

Government Facility	Description	Est. Beginning of Use	Est. End of Use
Kennedy Space Center	~~Canister Rotation Facility (CRF)~~ LAS Facility (LASF) Production Zone. This is considered an Industrial Operating Zone (IOZ) (M7-0777). Includes both Phase 1 and Phase 2 LASF Modifications.	5/1/2011	~~12/31/2014~~ 12/31/2020
Kennedy Space Center	LASF POL (M7-0776A). Considered an IOZ.	5/1/2011	12/31/2020
Kennedy Space Center	~~CRF~~ ~~LPF~~ LASF Support/Storage Building (M7-0776B). Considered an IOZ. Includes rooms 100, 102, 104, 106, 108.	5/1/2011	~~12/31/2014~~ 12/31/2020
Kennedy Space Center	Operations & Checkout (O&C) Administrative Floor Space (M7-0355). Non IOZ. Includes rooms 2243, 3259, 4217, 4231, 4234, 4236, 4255, 4265, 4267, 5200, 5201, 5204, 5205, 5206, 5207, 5208, 5210, 5211, 5212, 5213, 5214, 5218, 5219, 5221.	1/1/2007	~~12/31/2014~~ 12/31/2020
Kennedy Space Center	O&C IOZ (M7-0355). Includes High Bay, Low Bay, rooms 1238, 1239, 1245, 1246, 1247, 1249, 1251, 1253, 1255, 1263, 1275, 1278, 1281, 1287, 1600, 1610, 1612, 1631, 1633, 1635, 1637, 1639, 1641, 1643, 1645, 1646, 1647, 1648, 1649, 1650, 1651, 1652, 1653, 1655, 1657, 1659, 1661, 1667, 1669, 1671, 1673, 1675, 1677, 1679, 1680, 1681, 1683, 1684, 1685, 1687, 1688, 1689, 1690, 1691, 1692, 1693, 1694, 1695, 1696, 1697, 1698, 1600A, 1600B, 1635A, 1669A, 1669B, 1669C, 1699A, 1699B, B612, B620, B622, B634, B638, B650, B680, B687, B696A and all supporting systems required to perform spacecraft mfg.	1/1/2007	~~12/31/2014~~ 12/31/2020
Kennedy Space Center	Operation & Checkout Facility POL (M7-0355F). Considered an IOZ. Includes room 100.	1/1/2007	~~12/31/2014~~ 12/31/2020
~~Kennedy Space Center~~	~~Operation & Checkout Storage Building (M7 0355F)~~	~~1/1/2007~~	~~12/31/2014 12/31/2020~~
~~Kennedy Space Center~~	Water Test Facility	12/1/2007	12/31/2008
Kennedy Space Center	Cal bration Laboratory (K6-1298)	1/1/2011	~~12/31/2014~~ 12/31/2020
~~Kennedy Space Center~~	~~Parachute Refurbishment Facility~~	~~1/1/2012~~	~~12/31/2014~~
Kennedy Space Center	SSPF Butler Bldg. (M7-0362). Non-IOZ, Includes rooms 1000, 1010, 1012, 1020.	3/1/2011	~~12/31/2014~~ 12/31/2020
~~Kennedy Space Center~~	Vertical Assembly Building (VAB) (for EGSE fabrication)	6/1/2012	12/31/2012
Kennedy Space Center	Logistics Warehouse	1/1/2012	12/31/2020
Kennedy Space Center	TPSF	1/1/2012	12/31/2020
Kennedy Space Center/Cape Canaveral Air Force Station (CCAFS)	Ordnance Storage Facility (Ordnance Lab) Note: Government furnished service for EFT-1. LM contracted for service after EFT-1.	1/1/2007	~~12/31/2014~~ 12/31/2020
Kennedy Space Center/CCAFS	Materials & Processing (M&P) Labs in Hanger N	1/1/2007	~~1/31/2013~~ 12/21/2020
Kennedy Space Center	Bldg. K6-0848 M&P Lab	1/1/2007	~~12/31/2014~~ 12/31/2020
Kennedy Space Center	LETF	1/1/2012	**12/30/2019**
~~Marshall Space Flight Center Huntsville, AL~~	~~Material Environment Test Complex (METCO)~~	~~6/1/2011~~	~~12/31/2012~~
~~Marshall Space Flight Center Huntsville, AL~~	~~Bldg. 4623 Room 100 Material Combustion Research Facility~~	~~1/1/2010~~	~~12/31/2014~~
~~Marshall Space Flight Center Huntsville, AL~~	~~Bldg. 4619 (West End) Environmental Test Facility ET20 Sunspot Thermal/Vacuum Chamber~~	~~5/1/2008~~	~~12/31/2014~~
~~Marshall Space Flight Center Huntsville, AL~~	~~Bldg. 4619 (east end) Structural Dynamics Test Branch ET40 Acoustics Chamber~~	~~5/1/2008~~	~~12/31/2014~~
~~Marshall Space Flight Center Huntsville, AL~~	~~300m x 2 x Vacuum Facility~~	~~4/1/2008~~	~~8/31/2009~~
~~Marshall Space Flight Center Huntsville, AL~~	~~Bldg. 4705, Bldg. 4711 (700sq ft. mfg.)~~	~~10/1/2007~~	~~10/31/2008~~
~~Marshall Space Flight Center Huntsville, AL~~	~~Bldg. 4707, Bldg. 4711 (900 sq. ft. mfg.)~~	~~10/1/2007~~	~~10/31/2008~~
~~Marshall Space Flight Center Huntsville, AL~~	~~Bldg. 4702 (750 sq. ft. mfg.)~~	~~10/1/2007~~	~~10/31/2008~~
~~Marshall Space Flight Center Huntsville, AL~~	~~Bldg. 4711 (2eng), Bldg. 4702 (1 eng) [450 sq. ft. office]~~	~~10/1/2007~~	~~10/31/2008~~
~~Marshall Space Flight Center Huntsville, AL~~	~~400 sq. ft. Office to support Material Process Development~~	~~10/1/2007~~	~~10/31/2008~~
~~Marshall Space Flight Center Huntsville, AL~~	~~330 sq. ft. Office to support Heat Treat & Specimen Prep~~	~~10/1/2007~~	~~10/31/2008~~

Government Facility	**Description**	**Est. Beginning of Use**	**Est. End of Use**
~~Marshall Space Flight Center Huntsville, AL~~	~~500 sq. ft. Office to support Composite Specimen Fab & Development~~	~~10/1/2007~~	~~10/31/2008~~
~~Marshall Space Flight Center Huntsville, AL~~	~~500 sq. ft. Office to support TPS Specimen Fab & Development~~	~~10/1/2007~~	~~10/31/2008~~
Marshall Space Flight Center - Michoud Assembly Facility	Michoud Assembly Facility - Office Space	ATP	Schedule B
Marshall Space Flight Center - Michoud Assembly Facility		ATP	Schedule B
Marshall Space Flight Center - Michoud Assembly Facility	Michoud Assembly Facility - Shared Manufacturing Space	ATP	Schedule B
Marshall Space Flight Center - Michoud Assembly Facility	Bldg. 103 Manufacturing Space - Orion Main Assembly Area (46,600 sq. ft.) at Michoud	7/1/2008	~~12/31/2014~~ 12/31/2020
Marshall Space Flight Center - Michoud Assembly Facility	Bldg. 103 Manufacturing Space - Orion Composites Fabrication at Michoud (10,400 sq. ft.)	7/1/2008	~~12/31/2014~~ 12/31/2020
Marshall Space Flight Center - Michoud Assembly Facility	Adjacent to Bldg. 103 - Office Space (150 people)	12/1/2007	~~12/31/2014~~ 12/31/2020
Marshall Space Flight Center - Michoud Assembly Facility	Bldg. 103 - Shared Space - aisles, machine shops, etc.	12/1/2007	~~12/31/2014~~ 12/31/2020
Marshall Space Flight Center - Michoud Assembly Facility	Bldg. 404, 2,736 sq. ft.	7/1/2009	~~12/31/2014~~ 12/31/2020
Marshall Space Flight Center - Michoud Assembly Facility	Bldg. 404A, 4,424 sq. ft.	1/1/2008	~~12/31/2014~~ 12/31/2020
Marshall Space Flight Center - Michoud Assembly Facility	Bldg. 220, 7,500sq ft. warehouse space	1/1/2008	~~12/31/2014~~ 12/31/2020
~~Dryden Flight Research Center~~	~~Dynamics Facility~~	~~4/1/2008~~	~~8/31/2008~~
~~Dryden Flight Research Center and White Sands Missile Range~~	~~Custom 14 Foot Trailer to house Special Test Equipment (STE) during the integration and checkout activities of the Abort Flight Test (AFT) Crew Module (CM). The trailer will be used to protect the STE from the outside environment at Dryden Flight Research Center (DFRC) and White Sands Missile Range (WSMR). STE includes Article In the Loop (AIL) simulator, Pyro Test Set (PTS), LAS Interface Emulator (LAS IFE Details in Memo: STE Trailer Requirements, April 7, 2008, Rev C~~	~~10/31/2008~~	~~Schedule B~~
~~Dryden Flight Research Center and White Sands Missile Range~~	~~Lifting Devices (Hydrasets, Crane hooks, and up) O&C Bridge Crane, Hydrasets~~	~~8 months prior to PA 2~~	~~Schedule B~~
~~Dryden Flight Research Center and White Sands Missile Range~~	~~Lifting Devices (Hydrasets, Crane hooks, and up) SSPF Bridge Crane, Hydrasets~~	~~8 months prior to Ares-2~~	~~Schedule B~~
~~Dryden Flight Research Center and White Sands Missile Range~~	~~Integrated Stack Command, Control and Monitoring System~~	~~6 months prior to Ares-2~~	~~Schedule B~~
~~Dryden Flight Research Center and White Sands Missile Range~~	~~Facility Infrastructure Systems [Facility power (120 VAC, 480 VAC), Facility Data (internet access, phones, etc.)]O&C~~	~~8 months prior to PA 2~~	~~Schedule B~~
~~Dryden Flight Research Center and White Sands Missile Range~~	~~Facility Infrastructure Systems [Facility power (120 VAC, 480 VAC), Facility Data (internet access, phones, etc.)] SSPF~~	~~6 months prior to Ares 2~~	~~Schedule B~~
~~Dryden Flight Research Center and White Sands Missile Range~~	~~K Mag Transporter A/R~~	~~6 months prior to Ares 2~~	~~Thru Sch B~~

ATTACHMENT J-13

ACRONYM LIST

Crew Exploration Vehicle – (CEV)

Acronym List

ABCU	Auxiliary Bus Control Unit
ABHX	Ammonia Boiler Heat Exchanger
AC	Alternating Current
ACC	Battery Control Card
ACI	Administratively Controlled Information
ACO	Administrative Contracting Officer
ACWP	Actual Cost of Work Performed
ADD	Architectural Design Document
ADIO	Analog & Digital Input Output
ADP	Acceptance Data Package
AF	Automation Framework
AFFARS	Air Force Federal Acquisition Regulation Supplement
AFLC	Air Force Logistics Command
AFMC	Air Force Material Command
AFMCFARS	Air Force Material Command Federal Acquisition Regulation Supplement
AI	Affordability Initiative
AIAA	American Institute of Aeronautics and Astronautics
AIS	Automated Information Systems
ALARA	As Low As Reasonably Achievable
AM	Ames
AML	Approved Materials List
AMT	Architectural Modeling Tool
ANAV	Absolute Navigation
ANSI	American National Standards Institute
AOE	Areas of Emphasis
APAS	Androgynous Peripheral Assembly System
APL	Approved Processes List
APW	Avionics Power Wiring / Product Team
AR	Acceptance Review
AS	Aerospace Standards
ASAP	Aerospace Safety Advisory Panel
ASCII	American Standard Code for Information Interchange
ASIC	Application-Specific Integrated Circuit
ASMAT	Aries 1 Scale Model Test

ASRS	Automated Support Requirements System
ASRS	Avionics System Resource Schedule
ATB	Abort Test Booster
ATCS	Active Thermal Control Systems
ATP	Authority To Proceed
ATP	Acceptance Test Procedure
AWG	American Wire Gauge
BAFO	Best And Final Offer
BALT	Bara metric Altimeter
BCWP	Budgeted Cost for Work Performed
BCWS	Budgeted Cost for Work Scheduled
BIS	Bureau of Industry and Security
BIT	Built-In Test
BITE	Built-In Test Equipment
BTA	Boilerplate Test Article
BOE	Basis Of Estimate
C&DH	Command & Data Handling
C&T	Communications & Tracking
CAD	Computer Aided Design
CAGE	Commercial And Government Entity
CAIL	CEV Avionics Integration Laboratory
CAIV	Cost As an Independent Variable
CAOT	Cognizant Audit Office Template
CAP	Corrective Action Plan
CARD	Cost Analysis Requirements Description
CARD	Constellation Architecture Requirements Document
CAS	Cost Accounting Standards
CASB	Cost Accounting Standards Board
CBI	Confidential Business Information
CBL	Commercial Bill of Lading
CBT	Computer Based Training
CCAFS	Cape Canaveral Air Force Station
CCAS	Cape Canaveral Air Station
CCCI or C3I	Command, Control, Communications and Information
CCDR	Contractor Cost Data Reporting
CCF	Common Cause Failure

CCIP	Contamination Control and Implementation Plan
CCMS	Command Control Monitoring System
CCP	Contamination Control Plan
CCRM	Continuous Cost Risk Management
CCS	Center Chief of Security
CCSDS	Consultative Committee on Space Data Standards
CD	Compact Disk
CDF	Cumulative Distribution Function
CDM	Configuration and Data Management
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CDS	Cargo Delivery System
CECSR	Contractor’s Employee Compensation System Review
CESR	Contractor’s Estimating System Review
CEV	Crew Exploration Vehicle
CEVLV	CEV Launch Vehicle
CEVPO	Crew Exploration Vehicle Project Office
CEWL	Critical Environment Watch List
CFD	Computational Fluid Dynamics
CFR	Code of Federal Regulations
CFSR	Contract Fund Status Report
CG	Center of Gravity
CIAS	Crew Impact Attenuation System
CIL	Critical Items List
CIO	Chief Information Officer
CIS	CEV Instrumentation System
CLIN	Contract Line Item Number
CLV	Crew Launch Vehicle
CM	Configuration Management
CM	Crew Module
CMB	Crew Module Battery
CMF	Command & Data Handling Management Function
CMG	Control Moment Gyro
CMM	Capability Maturity Model
CMMI	Capability Maturity Model – Integrated
CMP	Configuration Management Plan

CO	Contracting Officer
CoFR	Certificate of Flight Readiness
COMSEC	Communications Security
CONOPS	Concept of Operations
COTR	Contracting Officers Technical Representative
COTS	Commercial-Off-The-Shelf
CPAF	Cost Plus Award Fee
CPARS	Contractor Performance Assessment Reporting Systems
CPAS	Crew Exploration System Parachute Assembly System
CPD	Crew Module Propulsion Drive Electronics
CPI	Cost Performance Index
CPIA	Chemical Propulsion Information Agency
CPIC	Capitol Planning & Investment Control
CPIF	Cost Plus Incentive Fee
CPR	Cost Performance Report
CPSR	Contractor's Procurement System Review
CPU	Central Processing Unit
CSC	Computer Software Component
CSCI	Computer Software Configuration Item
CSP	Cryptographic Security Plan
CSS	Common Support Services
CST	Central Standard Time
CST	Cost/Price Summary Template
CST WBS	Cost/Price Summary Template Work Breakdown Structure
CSU	Computer Software Unit
CTA	Conceptual Test Article
CTAG	Communication Timing Archive Group
CTU	Command Telemetry Unit
CUI	Compact Unique Identifier
CWBS	Contractor Work Breakdown Structure
CWS	CCMS Work Stations
CXP	Constellation Program
CY	Contract Year
D&C	Displays & Controls
D. C.	District of Columbia
DAL	Data Accession List

DAU	Data Acquisition Unit
DC	Direct Current
DCAA	Defense Contract Audit Agency
DCD	Data Command Dictionary
DCMC	Defense Contract Management Command
DCR	Data Change Request, Design Certification Review
DDT&E	Design, Development, Test & Evaluation
DFAR	Defense Federal Acquisition Regulation Supplement
DFAT	Direct Field Acoustics Test
DFRC	Dryden Flight Research Center
DID	Data Item Description
DIEP	Display and Interface Evaluation Plan
DIIR	Development and Integration Item Report
DIM	Design Integration Meeting
DL	Direct Labor
DM	Data Management
DoD	Department of Defense
DOE	Department of Energy
DOORS	Dynamic Object Oriented Requirements System
DPD	Data Procurement Document
DR	Dryden
DRD	Data Requirements Document
DRM	Design Reference Mission
DSI	Data Source Information
DSN	Deep Space Network
DSNE	Design Specification for Natural Environments
DTA	Development Test Article
DUNS	Dun and Bradstreet Number
EAC	Estimate at Completion
EAR	Export Administration Regulations
ECD	Estimated Completion Date
ECD	Engineering Change Directive
ECLSS	Environmental Control and Life Support System
ECO	Engineering Change Order
ECP	Engineering Change Proposal
EDA	Electronic Data Access

EDCG	Externally Driven Cost Growth
EDD	Environment Definition Document
EDI	Electronic Data Interchange
EDL	Exploration Development Lab
EDL	Engineering Drawing List
EDS	Earth Departure Stage
EDSG	Externally Driven Schedule Growth
EDU	Engineering Development Unit
EEE	Electrical, Electronic and Electromechanical
EEST	Exploration Electrical power System Testbed
EF	Early Finish
EFFBD	Extended Functional Flow Block Diagrams
EIA	Electronic Industry Alliance
EICD	External Interface Control Document
EIRD	External Interface Requirements Document
ELAB EGSE	Electronic Laboratory Electronic Ground Support Equipment
ELV	Expendable Launch Vehicle
EMC	Electromagnetic Compatibility
EME	Electromagnetic Effects
EMI	Electromagnetic Interference
EN	Evaluation Notice
EP	Equivalent Personnel
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPDC	Electrical Power Distribution and Control
EPM	Excel Pricing Model
EPS	Electrical Power System
EPSync	Software Tool
ES	Early Start
ESD	Electrostatic Discharge
ESMD	Exploration Systems Mission Directorate
eSRS	Electronic Subcontracting Reporting Systems
EVA	Extra Vehicular Activity
EVM	Earned Value Management
EVMS	Earned Value Management System
EWR	Eastern-Western Range

F.O.B.	Free On Board
FA	Failure Analysis
FAA	Federal Aviation Administration
FAR	Federal Acquisition Regulation
FAR	Federal Aviation Regulation
FAS	Financial Accounting Standard
FB	Forward Bay
FBC	Forward Bay Cover
FC	Fingerprint Card
FCA	Functional Configuration Audit
FCE	Flight Crew Equipment
FCT	Flight Control Teams
FCT	Flight Control Team
FDIR	Fault Detection, Isolation and Recovery
FDO	Fee Determination Official
FEM	Finite Element Model
FET	Field Effect Transistor
FF	Finish to Finish
FFA	Functional Fault Analysis
FFBD	Functional Flow Block Diagrams
FIPS	Federal Information Processing Standard
FIT	Functional Integration Team
FM	Fault Management
FMDD	Fault Management Design Document
FMEA	Failure Modes Effects Analyses
FMEA/CIL	Failure Modes Effects Analyses and Critical Items List
FOD	Foreign Object Debris
FODR	FSW OFT-1 Design Review
FOIA	Freedom of Information Act
FOM	Figure of Merit
FOUO	For Official Use Only
FPGA	Field Programmable Gate Array
FPR	Final Proposal Revision
FQT	Formal Qualification Test
FRR	Flight Readiness Review
FS	Finish to Start

FSPT	Flight Software Production Team
FSW	Flight Software
FSW	Friction Stir Weld
FTA	Fault Tree Analysis
FTA	Free Trade Agreement
FTA	Flight Test Article
FTE	Full Time Equivalent
FTMO	Flight Test Management Office
FTS	Flight Termination System
FY	Fiscal Year
G&A	General & Administrative
GAO	General Accounting Office
GBL	Government Bill of Lading
GFE	Government Furnished Equipment
GFI	Government Furnished Information
GFP	Government Furnished Property
GFY	Government Fiscal Year
GIDEP	Government Industry Data Exchange Program
GRC	Glenn Research Center
GLOW	Gross Lift Off Weight
GN&C	Guidance, Navigation & Control
GNUG	Ground Network Users' Guide
GO	Goddard Space Flight Center
GOP	NASA Ground Operations Program
GOTS	Government-Off-The-Shelf
GPS	Global Positioning System
GPSR	Global Position System Receiver
GPU	Ground Power Unit
GSA	General Services Administration
GSE	Ground Support Equipment
GSU	GPS Simulator Unit ?(Kemp)
GTA	Government Task Agreement
GTI	Ground Test Instrumentation
HBCU	Historically Black Colleges and Universities
HCC	Heater Control Card
HDBK	Handbook

HDTV	High Definition Television
HEMAP	Human Engineering Motion and Performance
HFTA	Hot Fire Test Article
HNIC	High Integrity Network Interface Card
HOTH	Houston Orion Test Hardware
HQ	Headquarters
HR	Human Resources
HRA	Human Reliability Analysis
HS	Hamilton Sundstrand
HS	Heat shield
HSIR	Human System Integration Requirements
HSIS	Human Systems Integration Standards
HSSIT	Hardware S/W System Integration Team
HUBZone	Historically Underutilized Business Zone
HW CUI	Compact Unique Identifier
HWCI	Hardware Configuration Items
HWIL	Hardware-in-the-Loop
IA	Information Assurance
IBR	Integrated Baseline Review
IC	Integrated Circuit
ICA	Interface Compatibility Analysis
ICAR	Interface Compatibility Requirements
ICD	Interface Control Document
ICE	Integrated Collaborative Environment
ID	Identification
IDD	Interface Definition Document
IDEFO	Integrated Definition for Function Modeling
IDIQ	Indefinite Delivery, Indefinite Quantity
IE&RS	Industrial, Environmental, and Range Safety
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IG	Inspector General
ILS	Integrated Logistics Support
ILSP	Integrated Logistics Support Plan
IM&S	Integrated Modeling & Simulation
IMP	Integrated Master Plan

IMS	Integrated Master Schedule
IMT	Implementation Task
IMU	Inertial Measurement Unit
INA	Iranian Nonproliferation Act
IOC	In-Orbit Checkout
IP	Internet Protocol
IPPD	Integrated Product & Process Development
IPT	Integrated Product Team
IRD	Interface Requirements Document
IRS	Internal Revenue Service
IRS	Interface Requirements Specification
IRT	Indirect Rate Template
ISO	International Organization for Standardization
ISP	Information Sharing Protocol
ISP	Integrated Sync Point
ISR	Internal Surveillance Review
ISS	International Space Station
IT	Information Technology
ITAR	International Traffic in Arms Regulation
ITD	Inception To Date
ITL	Integrated Test Labs
ITO	Information Technology Office
ITS	Information Technology System
IV&V	Independent Verification & Validation
IVHM	Integrated Vehicle Health Management
JBOSC	Joint Base Operations Support Contractor
JO	Johnson Space Center
JSC	Johnson Space Center
KE	Kennedy Space Center
KOZ	Keep Out Zone
KPP	Key Performance Parameters
KSC	Kennedy Space Center
LA	Langley
LAS	Launch Abort System
LASF	Launch Abort System Facility
LCC	Life Cycle Cost

LCCE	Life Cycle Cost Estimate
LCG	Liquid Cooling Garment
LEO	Low Earth Orbit
LET	Linear Energy Transfer
LF	Late Finish
LIDS	Low Impact Docking System
LMS	Logistics Management System
LOC	Loss of Crew
LOE	Level of Effort
LPP	Lightning Protection Plan
LPU	Life Preserver Unit
LRR	Launch Readiness Review
LRRF	Lunar Risk Reduction Flight
LRU	Line Replaceable Unit
LS	Late Start
LSA	Logistics Support Analysis
LSAM	Lunar Surface Access Module
LSAR	Logistics Support Analysis Records
LSU	Life Support Umbilical
LV	Launch Vehicle
M&P	Materials & Processes
M&S	Modeling & Simulation
MAC	Manual Abort Controller
MAPTIS	Materials and Processes Technical Information System
MATA	Motor Adapter Truss Assembly
MCDAU	Miniature Controller Data Acquisition Unit
MCPR	Modified Cost Performance Report
MCT	Material Cost Template
MDA	Manufacturing Development Article
MDC	Mild Detonation Cord
MDD	Mission Design Data Book
MDP	Maximum Design Pressure
MDT	Mean Down Time
MEL	Master Equipment List
MEOP	Maximum Expected Operating Pressure
MES	Mission Event Sequence

MI	Minority Institutions
MIL	Military
MIL-STD	Military Standard
MIUL	Materials Identification and Usage List
MLD	Master Logic Diagrams
MML	Master Measurement List
MMOD	Micrometeoroid and Orbital Debris
MMP	Margins Management Plan
MOI	Moment Of Inertia
MPL	Master Parts List
MR	Management Reserve
MRB	Material Review Board
MS	Microsoft
MSA	MPCV Stage Adapter
MSCSR	Mission Success Critical System Review
MSFC	Marshall Space Flight Center
MSIS	Man Systems Integration Standards
MSPS	Mega Symbol Per Second
MTBF	Mean Time between Failure
MTBME	Mean Time between Maintenance Events
MTTF	Mean Time to Failure
MUA	Materials Usage Agreements
MVP	Master Verification Plan
MWDAU	Miniature Wide-band Data Acquisition Unit
MWI	Manufacturing Work Instruction
NAC	National Agency Check
NAICS	North American Industry Classification System
NASA	National Aeronautics and Space Administration
NDE	Non Destructive Evaluation
NDT	Nondestructive Test
NEAT	Non Employee Access Tracking
NEPA	National Environmental Policy Act
NExIOM	NASA Exploration Information Ontology Model
NFNMS	NASA Foreign National Management System
NFPA	National Fire Protection Act
NFS	NASA FAR Supplement

NIC	Network Interface Card
NIL	Network Integration Lab
NITR	NASA Information Technology Requirement
NLR	Non Labor Resources
NODIS	NASA Online Directives Information System
NOI	Notice of Interest
NPD	NASA Policy Directive
NPR	NASA Policy Requirements
NRC	Network Routing Card
NSC	Network Switch card
NSN	National Stock Number
NSPD	National Security Presidential Directive
NSTS	National Space Transportation System
NSTS	Navigation Systems Test Set
NTIA	National Telecommunications and Information Administration
NUND	Next User Need Date
NWODB	New Ways Of Doing Business
O&C	Operation and Checkout Building
O&M	Operations and Maintenance
OASIS	Orion Aft Stowage IVA System
OASIS	Orion Aft Stowage IVA System
ODCIDP	Onboard Displays and Crew Interface Design Plan
ODCT	Other Direct Costs Template
ODN	Orion Data Network
ODS	Orion Data Service
OFT	Orion Flight Test
OIMU	Orion Inertia Measurement Unit
OMB	Office of Management and Budget
OME	Orion Man Engine
OMDP	Operations and Maintenance Documentation
OML	Outer Mold Line
OMS-E	Orbital Maneuvering System Engine
OP	Operating Plan
OPSR	Orion Program Schedule Review
ORU	Orbital Replacement Unit
OSH	Occupational Safety and Health

OSHA	Occupational Safety & Health Act
OTL	Orion Test Labs
OTTER	Orion Timeline Tracking Event and Relationships Group
PAA	Phased Array Antenna
PAS	Pre-award Survey
PAUT	Phased Array Ultrasonic Testing
PAUT	Phased Array Ultrasonic Testing
PBA	Printed Board Assembly
PC	Pressurized Cargo
PC	Personal Computer
PCA	Physical Configuration Audit
PCF	Power Configuration File
PDA	Probabilistic Design Analysis
PDF	Portable Document Format
PDK	Product Development Kaizen
PDR	Preliminary Design Review
PDU	Power and Data Unit
PEB	Performance Evaluation Board
PEB-IT	Performance Evaluation Board Integration Team
PEBR	PEB-IT Report
PEC	Pyro Event Controller
PEL	Power Equipment List
PHA	Preliminary Hazards Analysis
PHS&T	Packaging, Handling, Storage and Transportation
PM	Program Manager
PMB	Performance Measurement Baseline
PMP	Project Management Plan
PMR	Performance Management Review
PO	Purchase Order
POP	Program Operating Plan
POST	Power On System Test
PPA	Pollution Prevention Act
PPE	Personnel Protective Equipment
PPRA	Positive Pressure Relief Assembly
PPRV	Positive Pressure Relief Valve
PPRV	Positive Pressure Relief Valve

PPT1	Precision Pressure Transducer 1
PPT2	Precision Pressure Transducer 2
PPTF	Proof Pressure Test Facility
PQIT	PTE Impedance Tester
PQS	Power Quality Specification
PR	Peer Review
PR	Problem Report
PR	Purchase Requisition
PRA	Probabilistic Risk Assessment
PRACA	Problem Reporting And Corrective Action
PRAG	Performance Risk Assessment Group
PRD	Program Requirements Document
PROTAP	Project Tasks Planning
PSTS	Pyro Signal Test Set
PTC	Power and Thermal Control (Software Portion)
PTCDDB	Passive Thermal Control Design and Data Book
PTPU	Power Transient Protection Unit
PV	Procedure Validation
QA	Quality Assurance
QTP	Qualification Test Procedure
R	Resources
R&M	Reliability & Maintainability
RAL	Reverberant Acoustics Facility
RBDA	Reliability Block Diagram Analysis
RC	Reporting Category
RCM	Reliability Centered Maintenance
RCN	Requirement Change Notice
RCS	Reaction Control System
RDCG	Risk-Driven Cost Growth
RDSG	Risk-Driven Schedule Growth
RF	Radio Frequency
RFCT	Radio Frequency Communications Test Set
RFP	Request For Proposal
RFTS	Radio Frequency Test Set
RFV	Request for Visit
RID	Review Item Discrepancy

RMO	Requirements Management Office
RMRA	(Honeywell Advanced Procurement Process)
RMS	Reliability, Maintainability, and Supportability
RQ	Requirements
RRF	Risk Reduction Flight
RSPL	Recommended Spares Parts List
RSS	Range Safety System
RVTM	Requirements Verification Traceability Matrix
S&MA	Safety & Mission Assurance
SA	Software Assurance
SA	Spacecraft Adapter
SA	Systems Analysis
SAA	Space Act Agreements
SAE	Society of Automotive Engineers
SAM	System Architecture Model
SAR	System Acceptance Review
SAS	Planning/Reporting Requirement Actually a company name
SASM	Solar Array Shunt Module
SB	Small Business
SBA	Simulation Based Acquisition
SC	Subcontractor
SCCT	Subcontractor Cost Template
SCD	Spec Control Drawings
SCM	Software Configuration Management
SCT	Supply Cost Template
SDB	Small Disadvantaged Business
SDD	Software Design Description
SDI	Software Data Integration
SDO	Solenoid Drive Card
SDR	System Definition Review
SE	System Engineering
SE&I	System Engineering & Integration
SEA	Sensor Enclosure Assembly
SEMO	Supply and Equipment Management Officer
SEMP	Systems Engineering Management Plan
SET	Space Environment Test Facility

SEU	Single Event Upset
SF	Standard Form
SFAC	Space Flight Advisory Committee
SHA	System Hazard Analysis
SHIOP	Sim Host Input/Output Pump
SI	Systems Integration
SIC	Standard Industrial Code
SIL	Software-in-the-Loop
SIU	Spacecraft I/F Unit
SLDB	Separately Loaded Data Base
SLOC	Source Lines Of Code
SM	Service Module
SMMC	Smart Mass Memory Card
SMU	SM Umbilical
SUM	Software User Manual
SNIC	Standard Network Interface Card
SNUG	Space Network Users' Guide
SOCRRATES	Software Only CEV Risk Reduction Analysis and Test Engineering Simulation
SOO	Statement Of Objectives
SOW	Statement Of Work
SPD	Service Module Propulsion Drive Electronics
SPEC	Specification
SPI	Schedule Performance Index
SQA	Software Quality Assurance
SR	Software Request
SRCP	S/W change panel
SRD	System Requirements Document
SRR	Systems Requirements Review
SRS	Software Requirements Specification
SRU	Shop Replaceable Unit
SS CDR	Subsystem Critical Design Review
SS PDR	Subsystem Preliminary Design Review
SSA	Source Selection Authority
SSAC	Source Selection Advisory Committee
SSDL	Simulation Software Development Lab

SSET	Source Selection Evaluation Team
SSHA	Subsystem Hazard Analysis
SSP	Space Shuttle Program
ST	Stennis Space Center
STD	Standard
STE	Special Test Equipment
STR	Software Trouble Report
SVMF	Space Vehicle Mockup Facility
SVVIT	Spacecraft Verification Validation Integration Team
SW	Software
SWG	Structures Working Group
SwRR	Software Requirements Review
T&V	Test & Verification
TA	Technical Approach
TAMU	Texas A & M University
TARRT	Telemetry tool
TAS	Thermal Protection System Attach Structure
TBD	To Be Determined
TBR	To Be Resolved
TBS	To Be Supplied
TCT	Travel Cost Template
TDDB	Thermal Design and Data Book
TDRSS	Tracking and Data Relay Satellite System
TIN	Taxpayer Identification Number
TIS	Test Information Sheet
TM	Timeline Manager (Software Portion)
TMF	Tool Manufacturing Facility
TMG	Timeline Management
TPM	Technical Performance Measures
TPP	Technical Performance Parameters
TPS	Thermal Protection System
TPSDDB	Thermal Protection System Design and Data Book
TPSF	Thermal Protection System Facility
TRL	Technology Readiness Level
TRR	Test Readiness Review
TSC	Technical SubCommittee

TT&E	Test, Teardown, & Evaluation
TTC	Teletronic Technology Corp.
TVM	Timeline Vehicle Manager
U.S.C.	United States Code
UB	Undistributed Budget
UML	Unified Modeling Language
UN/EDIFACT	United Nations Electronic Data Interchange for Administration, Commerce and Transport
US	United States
USAF	United States Air Force
USPS	United States Postal Service
UWS	Universal Weld System
V&V	Verification & Validation
VAFB	Vandenberg Air Force Base
VEU	VTB EGSE Unit
VM	Vehicle Manager (Software Portion)
VMC	Vehicle Management Computer
VNS	Vision Navigation Sensor
VPAT	VMC Performance Analysis Tool
VPU	Video Processor Unit
VTB	Vehicle Test Bed
VV&A	Verification, Validation & Accreditation
WBS	Work Breakdown Structure
WD	Western Digital
WIT	Water Impact Test
WYE	Work Year Equivalent

ATTACHMENT J-15

Feb 2014

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ATTACHMENT J-16

INTEGRATED PROJECT SCHEDULE

J-16 Integrated Project Schedule

This attachment shall be used by the Contractor to develop an integrated project schedule that reflects any efficiency gained as a result of the Contractor's streamlining plan in Attachment J-2, **DRD CEV-M-001,** *CEV Prime Project Management Plan.*

* - contractor should consider these dates as "no later than"

Table J-16-1, MPCV Program Schedule A Milestones

Phase 2 Milestones	Date
CEV Phase 2 Contract Award	9/8/2006 (actual)
System Requirements Review (SRR) Board	3/1/2007 (actual)
Integrated Baseline Review (IBR)	6/25/2007 (actual)
System Definition Review (SDR)	8/24/2007 (actual)
Software Requirements Review (SwRR)	4/23/2008 (actual)
Preliminary Design Review (PDR)	8/31/2009 (actual)
EM-1/EM-2 Delta Preliminary Design Review (PDR)	08/29/2014
EM-1 Critical Design Review (CDR) [1]	4/01/2015
EM-1 System Acceptance Review (SAR)/Design Certification Review(DCR)[2]	Attachment J-9 EM-1 CM DD250 Date2/15/2017
EM-1 Flight Readiness Review (FRR)	10/15/2017
AA-2 SAR/DCR[2]	Attachment J-9 AA-2 CM DD250 Date 9/1/2018
EM-2 CDR	9/30/2018
AA-2 FRR	10/01/2018
EM-2 SAR/DCR[2]	Attachment J-9 EM-2 CM DD250 Date 2/15/2020
EM-2 FRR	7/15/2020
Schedule A	**Launch Date***
PA-1 Test Flight	5/6/2010 (actual)
EFT-1	No later than 12/30/2014
EM-1	12/1/2017
AA-2 Test Flight	12/15/2018
EM-2	9/1/2020

Notes

1. A combined System Acceptance Review (SAR) and Design Certification Review (DCR) will be held for each delivered vehicle (e.g., AA-2, EM1 and EM2). Additionally, lower level (e.g., component) certifications and acceptance reviews will occur incrementally.

Acceptance Data Packages (ADPs) or Certification Data Packages (CDPs) will be delivered with the applicable deliverable items.

ATTACHMENT J-26

Feb 2014

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