AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE

PAGE 1 OF 3 PAGES

2. AMENDMENT/MODIFICATION NO.: 000013

3. EFFECTIVE DATE: See Block 16C

4. REQUISITION/PURCHASE REQ. NO.: N/A

5. PROJECT NO. (If applicable): N/A

6. ISSUED BY CODE MSFC

NASA/Marshall Space Flight Center
Office of Procurement
Marshall Space Flight Center AL 35812

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

NASA/Marshall Space Flight Center
Stacey E, Hadavi
T: 256-544-3506
F: 256-544-5028
stacey.e.hadavi@nasa.gov
Marshall Space Flight Center AL 35812

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

JACOBS
600 WILLIAM NORTHERN BLVD
TULLAHOMA TN 37388-4729

CODE 07486 FACILITY CODE

(x) 9A. AMENDMENT OF SOLICITATION NO.

9B. DATED (SEE ITEM 11)

x 10A. MODIFICATION OF CONTRACT/ORDER NO. NNM12AA41C

10B. DATED (SEE ITEM 13) 05/29/2012

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 ACKNOWLEDGEMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

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

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

CHECK ONE	
	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).
	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
	D. OTHER (Specify type of modification and authority)
X	Bilateral Modification/FAR 43.103(a) Supplemental agreement

E. IMPORTANT: Contractor ☐ is not, ☒ is required to sign this document and return 2 copies to the issuing office.

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

1. The purpose of this modification is to change the following:

a) Update the funded through date in Clause B.3 1852.232-81 Contract Funding (Jun 1990), from July 26, 2013 to August 14, 2013, to correctly reflect the current funding amount obligated by modification 000012 to the contract in the amount of $94,271,087.

b) Update Section I.1 52.252.2 Clauses Incorporated by Reference (Feb 1998), Clause 52.223-2, entitled Affirmative Procurement of Biobased Products Under Service and Construction Contracts from an effective date of (Dec 2007) to (May 2012).

Continued ...

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): Randal W. Lycans, V.P. & General Mgr

16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print): Lizette M Kummer

15B. CONTRACTOR/OFFEROR: RW Lycans (Signature of person authorized to sign)

15C. DATE SIGNED: 2-1-13

16B. UNITED STATES OF AMERICA: Lizette M. Kummer (Signature of Contracting Officer)

16C. DATE SIGNED: 2-1-13

NAME OF OFFEROR OR CONTRACTOR
JACOBS

ITEM NO. (A)	SUPPLIES/SERVICES (B)	QUANTITY (C)	UNIT (D)	UNIT PRICE (E)	AMOUNT (F)
	c) Separate Appendix A, entitled Contractor Innovations, Corporate Capital Investments, Approaches, and Advance Agreements, from Attachment J-1 entitled Performance Work Statement (PWS), by repaginating J-1-24 through J-1-27 with J-1-A1 through J-1-A4. d) Incorporate the repaginated Appendix A, Contractor Innovations, Corporate Capital Investments, Approaches, and Advance Agreements, into Part III - List of Documents, Exhibits and Other Attachments, Section J. e) Update and replace Attachment J-1, entitled Performance Work Statement (PWS) in its entirety to incorporate the new contract major skill category descriptions numbered 3.19 through 3.28 and 3.50 through 3.81, and to add the new contract major skill categories to the PWS Table of Contents numbered 3.19 through 3.28 and 3.50 through 3.81. 2. The following clauses and attachments have been modified. Changes are distinguished by a vertical line on the outside margin of each replacement page. A tabular description of the change pages incorporated by this modification follows. - B.3 1852.232-81 Contract Funding - Clause 52.223-2 entitled Affirmative Procurement of Biobased Products Under Service and Construction Contracts - Attachment J-i List of Attachments - Attachment J-1 Performance Work Statement (PWS) and PWS Table of Contents - Attachment J-1-A PWS Appendix A Payment Terms: Net 30 days				

A tabular description of the change pages incorporated by modification 13:

Section	Current Page(s)	Revised Page(s)
B.3 1852.232-81 Contract Funding	B-3 (Mod 12)	B-3 (Mod 13)
I.1 Clause 52.223-2 entitled Affirmative Procurement of Biobased Products Under Service and Construction Contracts	I-3 (Basic)	I-3 (Mod 13)
Attachment J-i List of Attachments	J-i (Basic)	J-i (Mod 13)
Attachment J-1 Performance Work Statement (PWS)	J-1-2 through J-1-27 (Basic)	J-1-2 through J-1-41 (Mod 13)
Attachment J-1-A PWS Appendix A	J-1-24 through J-1-27 (Basic)	J-1-A1 through J-1-A4 (Mod 13)

3. All other terms and conditions remain unchanged.

4. 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 and all 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 Identification: Modification 13

B.3 1852.232-81 CONTRACT FUNDING. (JUN 1990)

(a) For purposes of payment of cost, exclusive of fee, in accordance with the Limitation of Funds clause, the total amount allotted by the Government to this contract is (b)(4) This allotment is for Engineering and Science Services and Skills Augmentation (ESSSA) and covers the following estimated period of performance: **August 1, 2012** through **August 14, 2013**.
(b) An additional amount of (b)(4) is obligated under this contract for payment of fee.
(c) Recapitulation of funding is as follows:

	Previous	This Action	Total *
Estimated Cost	(b)(4)		
Earned Fixed Fee	$0	$0	$0
Provisional Fee (50%)	(b)(4)		
Total Sum Allotted	**$87,863,054**	**$6,408,033**	**$94,271,087**

(End of clause)

B.4 MSFC 52.222-90 PREMIUMS FOR SCHEDULED OVERTIME. (FEB 2001)

(a) Pursuant to the clause entitled "Payment for Overtime Premiums," the amount of overtime premium authorized shall not exceed the amount specified below for the indicated period.

Period	Amount*
Base (Year 1)	$ TBD
Base (Year 2)	$ TBD
Option 1 (Year 3)	$ TBD
Option 2 (Year 4)	$ TBD
Option 3 (Year 5)	$ TBD

*To Be Completed After Award.

(b) Any overtime premium shall be specified in individual Task Orders. The amounts above reflect a summation of the amounts specified in the Task Orders and will be updated by modification periodically.

(End of clause)

B.5 EVALUATION OF FEE DEDUCTIONS.

(a) This contract is performance-based and provides for deduction from the fixed fee based upon defined performance levels in Attachment J-3, *Surveillance and Fee Evaluation Plan* and Attachment J-5, *Performance Standards*. The Contractor's *Financial Management Report (533M)* (DRD 1390MA-007), *Task Order Activity Reports* (DRD 1390MA-005), *Contractor's Self-Assessment Report* (DRD 1390MA-006), and Attachment J-4, *Quality Performance Quarterly Survey*, will be used to assess the Contractor's performance and determine any fee deductions.
(b)(1) Provisional fixed fee payments will be made under this contract pending the determination of the amount of fee deductions for an evaluation period. If applicable, provisional fixed fee payments will be made to the Contractor on a monthly basis. The total amount of fixed fee

52-217-9	Option to Extend the Term of the Contract. (Mar 2000) (a) FILL-IN "**30 day**"(c) FILL-IN "**5 years**"
52.219-4	Notice of Price Evaluation Preference for Hubzone Small Business Concerns. (Jan 2011) N/A ☐ Offeror Elects To Waive The Evaluation Preference.
52.219-8	Utilization of Small Business Concerns. (Jan 2011)
52.219-9	Small Business Subcontracting Plan. (Jan 2011) – Alternate II (Oct 2001)
52.219-16	Liquidated Damages — Subcontracting Plan. (Jan 1999)
52.219-25	Small Disadvantaged Business Participation Program-Disadvantaged Status And Reporting. (Dec 2010)
52.219-28	Post-Award Small Business Program Representation. (Apr 2009)
52.222-1	Notice to the Government of Labor Disputes. (Feb 1997)
52.222-2	Payment for Overtime Premiums. (Jul 1990) (a) The use of overtime is authorized under this contract if the overtime premium does not exceed "See Section B, Premium for Scheduled Overtime clause" or the overtime premium is paid for work -
52.222-3	Convict Labor. (Jun 2003)
52.222-4	Contract Work Hours and Safety Standards Act – Overtime Compensation. (Jul 2005)
52.222-21	Prohibition of Segregated Facilities. (Feb 1999)
52.222-26	Equal Opportunity. (Mar 2007)
52.222-35	Equal Opportunity for Veterans. (Sep 2010)
52.222-36	Affirmative Action for Workers with Disabilities. (Oct 2010)
52.222-37	Employment Reports on Veterans. (Sep 2010)
52.222-40	Notification of Employee Rights Under the National Labor Relations Act. (Dec 2010)
52.222-41	Service Contract Act of 1965. (Nov 2007)
52.222-50	Combating Trafficking in Persons. (Feb 2009)
52.222.54	Employment Eligibility Verification. (Jan 2009)
52.223-2	**Affirmative Procurement of Biobased Products Under Service and Construction Contracts. (May 2012)**
52.223-3	Hazardous Material Identification and Material Safety Data. (Jan 1997) – Alternate I (Jul 1995) FILL-IN "**None**"
52.223-5	Pollution Prevention and Right-To-Know Information. (May 2011) – Alternate I (May 2011) and Alternate II (May 2011)

PART III – LIST OF DOCUMENTS, EXHIBITS AND OTHER ATTACHMENTS
SECTION J

LIST OF ATTACHMENTS

Attachment	Title
J-I	Performance Work Statement
J-1-A	**Performance Work Statement Appendix A**
J-2	Data Procurement Document (DPD)
J-3	Surveillance and Fee Evaluation Plan
J-4	Quality Performance Quarterly Survey
J-5*	Performance Standards
J-6*	Small Business Subcontracting Plan
J-7	Installation-Provided Property and Services
J-8	Applicable Regulations and Procedures
J-9*	Schedule of Fully Burdened/Composite Not-To-Exceed (NTE) Labor Rates ($/Hr), Engineering Technician Overtime Rates, and Indirect and Fee Rate Matrix
J-10	Task Flow Process
J-11	Work Breakdown Structure (WBS)
J-12	DD254 – Department of Defense Contract Security Classification Specification
J-13*	Safety, Health and Environmental (SHE) Plan
J-14	Safety Health Management Implementation Guide and Assessment Matrix
J-15*	Organizational Conflict of Interest (OCI) Plan
J-16	Personal Identity Verification (PIV) Procedures
J-17	Wage Determination
J-18	Acronym List

* TO BE COMPLETED BY OFFEROR

National Aeronautics and Space Administration (NASA) Engineering and Science Services and Skills Augmentation (ESSSA)

Attachment J-1

Performance Work Statement (PWS)

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ATTACHMENT J-1

PERFORMANCE WORK STATEMENT (PWS)

This *Performance Work Statement* (PWS) broadly defines the requirements for Engineering and Science Services and Skills Augmentation (ESSSA) provided to the Marshall Space Flight Center (MSFC) by the Contractor in support of NASA led activities. These services cover a wide range of engineering and science disciplines deployed among a large number and variety of MSFC activities (including support for NASA activities and other reimbursable work for which MSFC has responsibility including in support of DoD, other Government, commercial, or educational activities). The Contractor's work on these activities is controlled by means of Task Orders (TOs) and TO sub-elements (all mention of TOs throughout the PWS includes the TO sub-elements). The TOs range from general support for an organization to specific product oriented tasks. These TOs and TO sub-elements require the Contractor to coordinate with the MSFC Departments, Laboratories, and Offices that exercise MSFC responsibility for the activities. The dynamic nature of the work required by this PWS demands significant flexibility in the allocation of engineering, science, and technical resources among a changing population of TOs. Since MSFC Civil Service engineering and science resources will lead the implementation of work, frequent coordination between Contractor personnel and Civil Service personnel is likely. This PWS is constructed in accordance with the *Work Breakdown Structure* (WBS) provided in Attachment J-11.

1.0 SCOPE

The Contractor shall provide all the necessary management, personnel, and equipment/supplies (not otherwise provided by the Government) required to perform the engineering and science (also referred to throughout the PWS as technical) tasks broadly defined in this PWS and more specifically described in TOs issued by the Government in accordance with Clauses H.5, *1852.216-80 Task Ordering Procedure* and H.6, *Supplemental Task Ordering Procedure* of this solicitation. A graphical depiction of the *Task Flow Process* can be found in Attachment J-10. The list of equipment, supplies, and intellectual property that will be provided by the Government is presented in Attachment J-7, *Installation-Provided Property and Services*. The Contractor shall comply with National Aeronautics and Space Administration (NASA) and MSFC regulations, policies, directives, procedures, and standards when performing all work under this PWS.

2.0 CONTRACT MANAGEMENT AND CONTROL

The Contractor shall provide the planning, coordination, technical direction, and surveillance of the activities necessary to assure disciplined performance of work and timely application of resources for the accomplishment of all TOs and TO sub-elements issued under the contract. The Contractor shall be responsible for maintaining communication with each supported organization and alerting the Contracting Officer Technical Representative (COTR) and Contracting Officer (CO) immediately of any problems that would prevent meeting established objectives. The Contractor shall report and document this work and fulfill the requirements of associated Data Requirement Descriptions (DRDs) as outlined in *Data Procurement Document*

(DPD) 1390 (Attachment J-2). The Contractor shall determine the data restriction that applies to each data deliverable and mark or transmit the data restriction in accordance with section 2.3.3 of the DPD.

2.1 Planning and Control

2.1.1 The Contractor shall establish, implement, and maintain technical management and oversight of all work performed under this PWS. The Contractor shall assure the technical excellence, cost effectiveness, and timeliness of all required work and deliverable products. The Contractor shall provide necessary Human Resources (HR) such as recruiting, hiring, compensation administration, and other HR required activities to provide a highly qualified workforce to perform the requirements of the Task Orders.

2.1.2 The Contractor shall provide the overall management effort required to integrate technical and programmatic functions necessary for achievement of the objectives of the contract. The Contractor shall prepare, implement and maintain a *Management Plan* in accordance with DRD 1390MA-001. In the *Management Plan*, the Contractor shall describe their approach to developing, implementing, and maintaining *Information Technology (IT) Security* in accordance with NFS Clause 1852.204-76 of the contract. This section shall describe the processes and procedures that will be followed to ensure the appropriate security of IT resources that are developed, processed, or used under this contract.

2.1.3 The Contractor shall provide support necessary to effectively administer the Prime contract and any subcontracts issued under it. The Contractor shall ensure that all subcontracts are awarded in accordance with the applicable Federal Acquisition Regulation (FAR) and NASA FAR Supplement (NFS) clauses. Subcontracts shall be closely monitored by the Contractor to ensure effective and efficient performance. The Contractor shall ensure the subcontractor submits invoices to the Contractor in a timely manner (within thirty (30) calendar days of providing services).

2.1.4 The Contractor shall provide, implement, and maintain an *Organizational Conflict of Interest (OCI) Plan*, prepared in accordance with DRD 1390MA-003.

2.1.5 The Contractor shall prepare, submit, implement, and maintain a report identifying and listing all equipment and tools provided by the Government for use by the Contractor in the performance of the contracted effort, and for which the Contractor has been given physical custody. The Contractor shall prepare, submit, implement and maintain a *Government Property Management Plan* in accordance with DRD 1390LS-001.

2.1.6 The Contractor shall establish and implement an industrial safety, occupational health, and environmental program that will (1) provide a workplace that is incident and injury free by (a) preventing employee fatalities, (b) reducing the number of incidents, and (c) reducing the severity of employee injuries and illnesses, (2) protect the environment through the ongoing planning, implementation, integration and management control of these programs, and (3) be compliant with the MSFC SHE Core Program Requirements (CPRs), including their sub-elements, as required by the *Safety, Health, and Environmental (SHE) Plan*, DRD 1390SA-001. The Contractor's SHE Plan shall address each MSFC SHE CPR, including their sub-elements identified as applicable to the contracted effort in sufficient detail to confirm the Contractor has a clear understanding of the MSFC SHE CPRs. Include a matrix that identifies where each MSFC SHE CPR,

including their sub-elements, is addressed in the Contractor's SHE Plan:

a. CPR 1 - Management Leadership and Employee Involvement.
b. CPR 2 - Worksite Analysis.
c. CPR 3 - Hazard Prevention and Control.
d. CPR 4 - Safety, Health and Environmental Training.
e. CPR 5 - Environmental Compliance.

2.1.7 The Contractor shall report mishaps and safety statistics to the MSFC Industrial Safety Branch in accordance with the *Mishap and Safety Statistics Report*, DRD 1390SA-003. The Contractor shall submit directly into the NASA Incident Reporting Information System (IRIS) or shall use the forms listed in section 15.4 of DRD 1390SA-003 or an electronic equivalent to report mishaps and related information required to produce the safety metrics.

2.1.8 The Contractor shall submit the *Environmental and Energy Consuming Product Compliance Report* that includes the *Annual Green Purchasing Report, Waste Reduction Activity Report, Energy Efficiency Product Procurement Report, Ozone Depleting Substances (ODS) Notification*, and *Equipment Notifications* in accordance with DRD 1390EE-001.

2.1.9 Critical processes or potentially hazardous operations identified by a NASA program/project can require specific training and/or certification (i.e., buildup, fabrication, operation, and maintenance of research, development or test facilities and ancillary equipment and processes). Personnel performing these critical processes or potentially hazardous operations shall be trained and certified when required by a NASA program/project. The Contractor shall ensure that required training is accomplished. The Contractor shall track and maintain certifications and make them available to the Government upon request or in accordance with the requirements of MWI 3410.1, *Personnel Certification Program* for those critical skills and potentially hazardous operations identified in the MWI. A *Contractor Personnel Certification Plan* shall be prepared and submitted in accordance with DRD 1390SA-002.

2.1.10 The Contractor shall provide technical information concerning any invention, discovery, improvement, or innovation made by the Contractor in the performance of work under this contract. This information will be reported in Technology Reports which shall be prepared in accordance with DRD 1390CD-003.

2.2 Facilities

2.2.1 Work delineated in this PWS shall be performed on-site in MSFC provided facilities and/or in other locations as directed by the Contracting Officer. Adequate Government provided property and services, as identified in Attachment J-7, *Installation-Provided Property and Services,* will be made available to all on-site personnel necessary to accomplish this contract. Contract management shall be at an off-site Contractor's facility. On an exception basis, the CO may authorize short-term or highly specialized tasks to be performed off-site in Contractor provided facilities across the country if deemed advantageous to the Government.

2.2.2 The Contractor shall prepare and submit an *On-Site Employee Location Listing* of all Contractor and subcontractor personnel working on-site at MSFC in accordance with DRD 1390CD-002.

2.3 Financial Reporting

The Contractor shall establish, implement, and maintain a financial reporting system in accordance with the NFS 1852.242-73, *NASA Contractor Financial Management Reporting* and NASA Handbook (NHB) 9501.2. The Contractor shall submit *Financial Management Reports (533M)* in accordance with DRD 1390MA-007 and the *Funding Projection Reports* in accordance with DRD 1390MA-008.

2.4 Task Management

2.4.1 The Contractor shall establish, implement, and maintain an electronic automated task order management system (ATOMS) required to plan, organize, direct, and control contract activities. To this end, the Contractor shall provide the Government with access to the ATOMS, in accordance with the procedures in Clause H.5, *1852.216-80 Task Ordering Procedure,* and Clause H.6, *Supplemental Task Ordering Procedures*, and the process depicted in Attachment J-10, *Task Flow Process.* The Contractor shall provide ATOMS in a manner that is consistent and compatible with Center Information Technology Standards and be 508 compliant, pursuant to The Rehabilitation Act Amendment of 1973, as amended in 1998, Section 508, 29 U.S.C. 794(d) (http://www.section508.gov/). The Contractor's system shall comply with NASA standards for desktop computing, per NASA-STD-2804, *Minimum Interoperability Software Suite,* and NASA-STD-2805, *Minimum Hardware Configuration.* The Contractor shall include an *IT Security Plan* for the ATOMS as part of the *Management Plan* in accordance with DRD1390MA-001. At no direct cost to the Government, the Contractor shall provide a user's guide to the system and Government training on the ATOMS as requested. The ATOMS shall be an interactive system to be used by the Government and the Contractor. The ATOMS shall be hosted on the Contractor's server computer at the Contractor off-site location. ATOMS shall be designed to provide a fast response to 100 concurrent users. The ATOMS shall be ready for Government use thirty (30) calendar days prior to contract commencement.

2.4.2 The ATOMS shall be an integrated system that allows insight and management of the day-to-day requirements described in Clause H.5, *1852.216-80 Task Ordering Procedure* and Clause H.6, *Supplemental Task Ordering Procedure*. This includes development and management of Task Orders (TO), Task Order Requests (TORs), Task Order Change Requests (TOCRs), Task Order Plans (TOPs), Task Order Change Plans (TOCPs), modified Task Orders, Emergency Task Orders and Task Order sub-elements in accordance with DRD 1390MA-002. A TOCR is the same as a TOR except that it describes changes to an existing TO instead of describing a new TO. All TOR requirements shall apply to TOCRs. A TOCP is the same as a TOP except that it describes planned changes to an existing TO instead of describing plans for a new TO. All TOP requirements shall apply to TOCPs. The *Task Order Activity Report*s developed in accordance with DRD 1390MA-005 and the *Funding Projection Report* in accordance with DRD 1390MA-008 shall be standard outputs of the ATOMS.

2.4.2 The ATOMS shall provide a numbering system that provides traceability of TOs throughout their lifetime and shall track the status of TOs/Sub-elements from planning

through closure. The ATOMS shall provide TO status notification to the CO, COTR, TO and sub-element initiators; approval tracking; modification tracking; traceability to Contract WBS Level 4 or lower; delineation of inactive and active TOs; period of performance for the TO/Sub-element; and negotiated estimated cost and fixed fee per TO and by evaluation period.

2.4.4 Specific information to be contained in the ATOMS for the TORs shall include the following: a TOR number allowing traceability to a Contract WBS Level 4 or lower; TO Initiator and Resource Analyst; Project WBS, Cost Center and Fund; TO description and objectives; travel requirements; materials; equipment; Government furnished equipment and information; proposed performance standards, deliverables and milestone dates; and special instructions.

2.4.5 The ATOMS shall allow for the electronic routing and approval of TOs and maintain a history of the approval process. The routing and approval process shall include the COTR and the CO, respectively, as the final approvers prior to beginning work on a TO. The Government shall specify any other reviewers to be included in the routing process. The ATOMS shall have the capability for the Government to add or edit the funding information (project WBS, Cost Center, and Fund) for each sub-element within the TO during the routing and approval process.

2.4.6 The ATOMS shall report the TO and sub-element data by the Contract WBS for each sub-element as developed by the Contractor and provided in their *Work Breakdown Structure and WBS Dictionary*. This *WBS and WBS Dictionary* shall be developed in accordance with DRD 1390MA-004 using Attachment J-11, *Work Breakdown Structure*. This data is required by the *Task Order Activity Reports* that status each TO and sub-element on a monthly basis in accordance with DRD 1390MA-005.

2.4.7 The ATOMS shall interface with the Contractor's Financial System to provide Financial Reporting, in a formatable/sortable Excel spreadsheet format, containing the financial reporting requirements outlined in DRD 1390MA-007, *Financial Management Report (533M)*, DRD 1390MA-008 *Funding Projection Report* and DRD 1390MA-005, *Task Order Activity Reports*. The ATOMS shall provide the *Active Task Order Summary Report* and *Contract Year Task Order Value Summary Report* as specified in DRD 1390MA-009, *Weekly Contract Status Briefing*.

2.4.8 The ATOMS shall allow the Government to input and collect anticipated funding information [Project Work Breakdown Structure (WBS), Cost Center, Fund and amount of funding] cross-walked to individual TO sub-elements. The information collected represents planning data for incremental funding modifications. The Contractor shall not construe the preliminary collection of this data as actual funding applied to the contract until receipt of a formal modification signed by the CO. After receipt of the modification, the Contractor shall use the data for tracking and reporting purposes.

2.4.9 The ATOMS shall have the capability of tracking actual cost back to the Contractor's *Financial Management Reporting* (DRD 1390MA-007) at all levels down to the TO sub-element level. The ATOMS shall record projected and actual resources data for each TO/Sub-element.

2.4.10 The ATOMS shall track funding (to include Project WBS, Cost Center and Fund), cost, and Work-Year Equivalents (WYEs) at the TO/Sub-element level. In cases where the

Task Order specifies tracking at a lower level on a TO sub-element, cost detail shall be delineated to a level lower than TO sub-element. An example where this may be needed is for individual tests within a project or sub-system. The ATOMS shall provide visibility to funding provided by the customer and track the associated cost by the Contractor developed *WBS*.

2.5 Contractor Procurements

2.5.1 With the exception of the property listed in the *Installation-Accountable Government Property* Clause (NFS 1852.245-71), the Contractor shall procure non-quality sensitive materials, supplies, tools, and equipment necessary for the accomplishment of this PWS. Total acquisition cost of an individual procurement shall not exceed $150,000 unless approved by the CO. The Contractor shall not purchase the IT products specified in Attachment J-7, *Installation Provided Property and Services* as Desktop Services and Software. The Contractor shall only purchase items needed to meet the requirements of the TOs. The Contractor shall not purchase quality sensitive items such as raw materials or supplies that will become part of a quality sensitive product, or lifting and handling fixtures that deal with quality sensitive hardware.

2.5.2 In accordance with the NFS Clause 1852.245-71, *Installation-Accountable Government Property*, accountability for property which is acquired for the Government shall be transferred to the Government using the following procedure:

The transfer of accountability shall be initiated by the Contractor submitting a MSFC Form 4554, *Transfer and Shipping Document* (or equivalent DD Form 1149), accompanied by a copy of the Contractor's applicable purchasing and receipt document for the property. The Contractor shall reference both the Contractor's Subcontract/Purchase order number and the Government contract number on the Form 4554. For purchases of supplies and materials (exception only material items purchased to repair equipment), this document shall be submitted within thirty (30) calendar days after the end of each calendar-year quarter (that is, not later than January 30, April 30, July 30, and October 30). For equipment purchases, the Form 4554 shall be submitted within ten (10) working days after acceptance of each item of equipment by the Contractor.

2.6 Evaluation

2.6.1 The Government will evaluate the Contractor's performance in accordance with Attachment J-3, *Surveillance and Fee Evaluation Plan*. To aid in this evaluation, the Contractor shall prepare and submit a *Contractor Self-Assessment Report* in accordance with DRD 1390MA-006 that assesses the performance of the contract tasks.

2.6.2 The Contractor shall provide performance information to aid in the Government's decision to exercise options for renewal of the contract. This information shall be provided in an *Option Decision Package* prepared in accordance with DRD 1390CD-001.

2.7 Technical Reporting

The Contractor shall prepare and submit a *Final Scientific and Technical Report* that complies with the requirements of NFS 1852.235-73, *Final Scientific and Technical*

Reports as required by a specific Task Order and/or sub-element. A final report that summarizes the results of the entire contract is not required. If a final report is required by a TO, the final report shall summarize the results of the TO.

3.0 CONTRACT MAJOR SKILL CATEGORIES

The Contractor shall provide and manage the services described in this section as required by TOs. The services are organized into major skill categories. Each major skill type as described will envelope various skills that may be required to produce deliverables and products per TO/Sub-elements in this contract. The description is not intended to cover all skills or products required in this contract, instead it is intended to give an idea of what types of skills and products may be required over the life of the contract. The actual skills required for this contract are dependent upon the content of TOs and may not include all skills listed in this PWS. There also may be additional skills or products required in these topic areas that are not listed. These skills may range from entry level to journeyman to Subject Matter Experts, depending on the varied requirements to produce products and deliverables defined in individual TO/Sub-elements. Skills may also be classified as highly-specialized or mission critical. Highly-specialized skills require personnel with very unique skills as a result of years of specialized training and/or experience. Mission critical skills are skills required at the start of the contract and require extensive specialized training or experience to support the development or operation of specific flight hardware, laboratory, and/or analysis related activities. The skills themselves are not necessarily "highly-specialized" but the individual's knowledge/experience is critical to the hardware or program/project being supported.

3.1 Aerodynamics Design, Analysis and Test

The Contractor shall provide aerodynamics skills to support the design, development, analysis, integration, simulation, modeling, and testing of space systems, propulsion systems, space transportation systems, scientific research equipment, ground support equipment, and special equipment for current and future programs or projects. The Contractor shall deliver products associated with areas of aeroacoustics, aerodynamic flight control surfaces, venting, aerodynamic heating, plume induced pressure, forces and heating, Guidance, Navigation and Control (GN&C) flight systems, thermal analysis and controls, flight mechanics, fault management, dynamics, loads, strengths, avionics, sensors, aerodynamic testing (e.g., wind tunnel) and analysis, analytical tool development and control systems. The Contractor shall provide support for and generate products associated with research and new technology development for aerodynamics design, analysis and test areas.

Elaboration of WBS structure including the WBS identifier shown in the examples below can be found in Attachment J-11, *Work Breakdown Structure (WBS)*.

Two WBS examples are:

ES.1.7.33.xx.xx.xx.xx.xx.
ESSSA Contractor Aerodynamics Design, Analysis and Test skills supporting Spacecraft & Vehicle Systems, Aerosciences for Program X for Project Y.

ES.1.10.61.xx.xx.xx.xx.xx

ESSSA Contractor Aerodynamics Design, Analysis and Test skills supporting Science and Mission Systems, Earth Science for Program X for Project Y.

3.2 Avionics Design, Analysis and Test

The Contractor shall provide avionics skills to support the design, development, analysis, and testing of space systems, propulsion systems, space transportation systems, scientific experiments, ground support equipment, and special equipment for current and future programs or projects. The Contractor shall deliver products associated with areas such as aerospace integrated systems health management, aerospace systems avionics fault management, avionics fault management, avionics control, avionics emulators (real-time & non real-time), instrumentation and controls, data systems, digital systems, embedded control electronics, avionics sensors and instrumentation, avionics video, avionics control electronics, avionics motors, signal conditioning, data systems, flight and ground computers, Radio Frequency (RF) systems, Global Positioning System (GPS), range safety, audio, Field-Programmable Gate Array (FPGA), optics, expert avionics and software systems integration. Example products include the design, development, assembly, test, analysis, modeling and/or simulation of the following: development hardware, prototype hardware, flight hardware, ground hardware, payloads, subsystems, science investigations, exploration initiatives, and analytical tools. In some cases, as detailed in a TO or sub-element, real-time support for investigation of flight system anomalies shall be required. The Contractor shall provide support for and generate products associated with research and new technology development for avionics design, analysis and test areas.

Five WBS examples are:

ES.2.5.12.xx.xx
ESSSA Contractor Avionics Design, Analysis and Test skills supporting Space Systems, Avionics & Systems Integration for Program X for Project Y.

ES.2.5.31.xx.xx
ESSSA Contractor Avionics Design, Analysis and Test skills supporting Space Systems, Sensors, Imaging & Optics for Program X for Project Y.

ES.2.5.41.xx.xx
ESSSA Contractor Avionics Design, Analysis and Test skills supporting Space Systems, Electrical Power for Program X for Project Y.

ES.2.5.53.xx.xx
ESSSA Contractor Avionics Design, Analysis and Test skills supporting Space Systems, Avionics and Software Ground Systems Test for Program X for Project Y.

ES.2.10.20.xx.xx
ESSSA Contractor Avionics Design, Analysis and Test skills supporting Science & Missions Systems, Science Program & Projects for Program X for Project Y.

3.3 Electrical Engineering Design, Analysis and Test

The Contractor shall provide electrical engineering skills to support the design, development, analysis, and testing of space systems, propulsion systems, space transportation systems, scientific instruments, ground support equipment, and special equipment for current and future programs or projects. The Contractor shall deliver products in areas such as: electrical design and integration, electro-mechanical design, analysis and assembly, power electronics (converters, inverters, regulators), power quality, electrical power systems (batteries, solar arrays, fuel cells), electrical integration (cable design, cable interconnect diagrams, electrical system schematics), electromagnetic environmental effects (EMI/EMC, lightning, electrostatic discharge), Electrical, Electronic and Electromechanical parts (EEE Parts), electronic packaging, electrical/electronic failure analysis, control and signal conditioning electronics, low power amplifiers, instrumentation, data acquisition systems hardware and software, control system design and test, automatic feedback control circuits and systems (neural networks, fuzzy logic, adaptive control), sensor micro-fabrication, harsh environment sensor research, precision rate and position environmental control systems, optical sensor research, structural health monitoring research, avionics emulators (real-time and non real-time). The Contractor shall provide electrical engineering technician skills which include Printed Circuit Board (PCB) design and construction, surface-mount component installation, test and characterization of new technology such as vendor supplied electric motors, cable fabrication, harsh environment sensor research and Computer-Aided Design (CAD) for cables and schematics. Examples of these products include the research, design, development, implementation, assembly, verification, test, analysis, and modeling and simulation of: prototype hardware, flight hardware, ground hardware, payloads, subsystems, science investigation hardware, and analytical tools. In some cases, real-time support for an investigation of flight system anomalies shall be required. The Contractor shall provide support for and generate products associated with research and new technology development for electrical engineering design, analysis and test areas.

Six WBS examples are:

ES.3.7.43.xx.xx
ESSSA Contractor Electrical Engineering Design, Analysis and Test skills supporting Spacecraft & Vehicle Systems, Integrated Systems Health Management & Sensors for Program X for Project Y.

ES.3.6.60.xx.xx
ESSSA Contractor Electrical Engineering Design, Analysis and Test skills supporting Test, Propulsion Systems Test for Program X for Project Y.

ES.3.5.51.xx.xx
ESSSA Contractor Electrical Engineering Design, Analysis and Test skills supporting Space Systems, Software Systems Engineering for Program X for Project Y.

ES.3.6.32.xx.xx
ESSSA Contractor Electrical Engineering Design, Analysis and Test skills supporting Test, Structural Strength Test for Program X for Project Y.

ES.3.6.40.xx.xx

ESSSA Contractor Electrical Engineering Design, Analysis and Test skills supporting Test, Structural Dynamics Test for Program X for Project Y.

ES.3.10.22.xx.xx
ESSSA Contractor Electrical Engineering Design, Analysis and Test skills supporting Science & Mission Systems, Space Systems Programs/Projects for Program X for Project Y.

3.4 Guidance, Navigation, and Control (GN&C) Design and Analysis

The Contractor shall provide GN&C skills to support the design and analysis of space systems, propulsion systems, space transportation systems, scientific research experiments, and special equipment for current and future programs or projects. The Contractor shall be proficient in performing six degree of freedom vehicle simulation and frequency domain control system design and stability analysis. The Contractor shall deliver products such as aerodynamic flight control components, trajectory design, navigation design, separation systems analysis, orbital mechanics, control theory and algorithms, vehicle dynamics, dynamical system theory, control systems design, and propulsion dynamics. These products shall include design, development, analysis, integration, analytical tool development, simulation and modeling. The Contractor shall provide support for and generate products associated with research and new technology development for GN&C design and analysis areas.

Two WBS examples are:

ES.4.7.41.xx.xx.xx.xx.xx.
ESSSA Contractor Guidance, Navigation, and Control (GN&C) Design and Analysis skills supporting Spacecraft & Vehicle Systems, Control Systems Design and Analysis for Program X for Project Y.

ES.4.4.35.xx.xx.xx.xx.xx.
ESSSA Contractor Guidance, Navigation, and Control (GN&C) Design and Analysis skills supporting Propulsion Systems, Thrust Vector Control Systems Integration & Components for Program X for Project Y.

3.5 Manufacturing and Assembly (M&A)

The Contractor shall provide M&A engineering and technical skills to support, operate, service, maintain, and deliver products related to the development, design, and analysis of aerospace manufacturing, fabrication, production, integration, assembly, inspection, repair, refurbishment, and materials processes, including the associated tooling, capabilities, and facilities used to construct and produce materials, parts, components, subsystems, and hardware systems for space flight and launch vehicles, spacecraft, scientific instruments or experiment hardware, prototype/test articles, ground support and special test equipment. M&A products shall include advanced materials manufacturing and processing of composites, hybrid composites, structural, coatings/protective finishes, thermal protection/insulation systems; propulsion systems; and light-weight, high-temperature and other high performance metallic, non-metallic, and materials. Additional M&A skills and products shall include advanced, large scale, automated, and robotic processes such as: thermo-mechanical (e.g. forming, heat treatment, curing); chemical and formulation; Non-Destructive Evaluation (NDE); rapid prototyping; machining;

contamination control/precision cleaning; coating/finishing and surface treatment; materials joining technologies (e.g. fusion and solid state welding, brazing, soldering, adhesive bonding); digital manufacturing assembly and photogrammetry and statistical process control/lean six sigma methodologies. The Contractor shall also provide products supporting the development, integration, verification, and validation of M&A processes including: production of demonstration/prototype and test articles; producibility and inspectibility analysis; tooling design and processing standards; intelligent, integrated, digital manufacturing planning and solutions; kinematic and photogrammetry analysis; data management/engineering tools for simulation, modeling, and product life cycle/supply chain integration. The Contractor shall provide products for fabrication and purchase of fixtures, equipment, tooling and analytical tool development required for the operation, maintenance, and testing of MSFC M&A facilities and capabilities. The Contractor shall provide support for and generate products associated with research and new technology development for manufacturing and assembly areas.

Three WBS examples are:

ES.5.2.32.xx.xx.xx.xx.xx.
ESSSA Contractor Manufacturing and Assembly skills supporting Materials and Processes Laboratory, Metals Joining and Processes for Program X for Project Y.

ES.5.5.23.xx.xx.xx.xx.xx.
ESSSA Contractor Manufacturing and Assembly skills supporting Space Systems, Mechanical Fabrication for Program X for Project Y.

ES.5.2.42.xx.xx.xx.xx.xx.
ESSSA Contractor Manufacturing and Assembly skills supporting Materials and Processes Laboratory, Nonmetallic Manufacturing for Program X for Project Y.

3.6 Materials Design, Analysis and Test

The Contractor shall provide materials engineering and technical skills to deliver products supporting the design, analysis and testing of metallic and non-metallic materials for use in parts, components, subsystems, and hardware systems for space flight and launch vehicles, spacecraft, scientific instruments or experiment hardware, test articles, ground support and special test equipment. The Contractor shall deliver products in areas such as research, development, evaluation, selection, specification, and verification of engineering materials, processing and systems for specific hardware design applications and usage environments. Examples of testing and analysis products include the following: characterization of materials to define their design properties/allowables and determine how they will perform/degrade in their intended or worse case natural, induced, operational or space usage environments; determine materials tolerance to damage, fracture and fatigue in order to predict their service and safe life capabilities; and determine if materials are compatible with the reactive or working fluid systems in which they are used (e.g., oxygen, hydrogen, coolants, hydraulic fluids, chemical media/working fluids, hypergolic and chemical propellants). The Contractor shall also deliver analysis products such as: analytical and environmental chemistry; fracture mechanics/fatigue and service/useful life assessments; sustainability/risk assessment of materials obsolescence and impact due to Environmental, Safety, and Health restrictions/regulations; and failure analysis. Materials engineering skills shall be provided to deliver advanced material products which may include: advanced/hybrid composites; polymeric/elastomeric

materials; structural/adaptive materials; coatings/protective finishes; tribology/lubrication systems; high temperature, leading edge and aerothermal surface insulation/TPS materials and processes development, thermal protection/insulation system cryogenic/high-temperature materials (e.g., foams, ablatives, ceramics, nozzle/leading edge composites); and other light-weight/high-performance metals and non-metals. Additional products, skills, and services shall be required for operations and maintenance of materials test, analysis, formulation, and development facilities, as well as development of materials data management, modeling and analytical tools for materials selection, assessment, and evaluation. The Contractor shall provide support for and generate products associated with research and new technology development for materials design, analysis and test areas.

Three WBS examples are:

ES.6.2.31.xx.xx.xx.xx.xx.
ESSSA Contractor Materials Design, Analysis and Test skills supporting Materials and Processes, Failure Analysis and Metallurgy for Program X for Project Y.

ES.6.2.41.xx.xx.xx.xx.xx.
ESSSA Contractor Materials Design, Analysis and Test skills supporting Materials and Processes, Nonmetallic Materials for Program X for Project Y.

ES.6.2.60.xx.xx.xx.xx.xx.
ESSSA Contractor Materials Design, Analysis and Test skills supporting Materials and Processes, Materials Selection and Control and Project Engineering for Program X for Project Y.

3.7 Structural and Mechanical Design and Analysis

The Contractor shall provide structural and mechanical skills to support the design and analysis of space systems, including but not limited to space vehicle structures, thrust structures, propellant and oxidizer tanks, vehicle health maintenance/management systems, stage and payload separation systems, pyrotechnics systems, rocket engines, propulsion systems and components, space transportation systems, scientific experiment or instrument hardware, ground support equipment, special test equipment including items such as optical system support stands and translation stages, precision alignment devices, helium-cooled enclosures, and optical instrumentation access platforms as well as special test equipment for current and future programs or projects. Design and analysis support shall include integration and support of testing activities (e.g., interfacing with manufacturing, hardware integration, and testing disciplines) as well as post-flight correlation and reconstruction. The Contractor shall provide multi-body integrated vehicle loads analyses for all ground, flight, in-space, and return flight events (i.e., rollout, on pad pre-launch, liftoff, first stage flight, second stage flight, separation, docking, reentry, landing and water impact). The Contractor shall provide development and integration of finite element models within the NASTRAN structural analysis code (substructure modeling, dynamic reductions, and extraction of math models from NASTRAN to independent analysis code formats including Fortran and MATLAB). The Contractor shall provide skills to provide analyses and tools for computing loads associated static elastic air loads, wind induced oscillations, Monte Carlo simulations for liftoff, dynamic gust loads, transonic buffet loads, elastic vehicle maneuvering loads, probabilistic loads combination equations, and analysis of parachute and water impact loads. The Contractor shall deliver

products in areas such as design and analysis of: structures, mechanical devices, ground support equipment, special test equipment, tooling, mechanisms, composite designs, CAD standards and processes, strength (stress) analysis, fatigue analysis, fracture analysis, damage tolerance assessment, component loads analysis, vehicle coupled loads analysis, linear and nonlinear dynamics analysis, rotordynamic analysis of high speed machinery such as turbopumps, vibroacoustic analysis, microgravity analysis, shock, payload isolation analysis, pressure systems management, structural dynamic analysis of turbomachinery, turbopump rotordynamic analysis, modeling of physics effects of alumina accretion, film cooling thermal analysis and analysis of ground and flight test data. The Contractor shall deliver products such as test criteria and requirements (e.g., load, vibration, acoustic, and shock), models and simulations for verification activities. Structural and mechanical design and analysis products shall be required for all phases of flight, ground and research projects, such as conceptual design, primary and secondary structure detailed design, mechanical drawings, 3D models, test articles, breadboard units, turbomachinery (including inducers, impellers, diffusers, turbines, bearings, seals, and housings), combustion devices (including injectors, cooled and uncooled chambers, nozzles, pre-burners, gas generators, and ignition systems), actuators, valves, regulators, lines, ducts, thrust vector control systems (including actuators, valves, reservoirs, and power units), pyrotechnics systems design, electrical cable routing between components, loads analysis, stress analysis, fracture analysis, and meteoroid-orbital debris impact and other debris assessments. The Contractor shall provide support for and generate products associated with research and new technology development for structural and mechanical design and analysis areas.

Five WBS examples are:

ES.7.5.21.EC.xx.xx.10.34.IS.
ESSSA Contractor Structural and Mechanical Design and Analysis skills supporting Space Systems, Structural and Mechanical Design for the International Space Station (ISS) Program for the Environmental Control and Life Support Systems (ECLSS) Project.

ES.7.5.22. EC.xx.xx.10.34. IS.
ESSSA Contractor Structural and Mechanical Design and Analysis skills supporting Space Systems, Thermal and Mechanical Analysis for the International Space Station (ISS) Program for the Environmental Control and Life Support Systems (ECLSS) Project.

ES.7.7.31.xx.xx.xx.xx.xx.
ESSSA Contractor Structural and Mechanical Design and Analysis skills supporting Spacecraft & Vehicle Systems, Dynamics Loads and Strengths for Program X for Project Y.

ES.7.4.34.xx.xx.xx.xx.xx.
ESSSA Contractor Structural and Mechanical Design and Analysis skills supporting Propulsion Systems, Propulsion Detailed Design for Program X for Project Y.

ES.7.6.50.xx.xx.xx.xx.xx.
ESSSA Contractor Structural and Mechanical Design and Analysis skills supporting Test Laboratory, Special Test Equipment for Program X for Project Y.

3.8 Operability Design, Analysis and Test

The Contractor shall provide operability skills to support the design and analysis of space systems, propulsion systems, space transportation systems, scientific experiments and instruments, ground support equipment, and special equipment for current and future programs or projects. The Contractor shall deliver products in areas such as ground operations integration and implementation; ground support equipment integration and implementation; ground support systems development; logistics planning and analysis; and test integration and implementation. These products include *Ground Operations Plan, Ground Operations Requirements Document, Ground Support Equipment (GSE) Plan,* GSE Mechanical and Electrical Design Specifications, Support Equipment Management Database, *Integrated Logistics Plan,* Supportability Analysis, Availability Analysis, Vehicle Operations Analysis, Verification Planning and Implementation, Functional Objective Development, Ground Processing Timelines and Detailed Technical Operations Based Cost Assessment. The Contractor shall provide support for and generate products associated with research and new technology development for operability design and analysis areas.

Two WBS examples are:

ES.8.3.40.xx.xx.xx.xx
ESSSA Contractor Operability Design, Analysis and Test skills supporting the Ground Operations and Logistics for Program X for Program Y.

ES.8.3.30.xx.xx.xx.xx
ESSSA Contractor Operability Design, Analysis and Test skills supporting the Ground Operations, Space Systems Operations for Program X for Program Y.

3.9 Natural and Induced Environments Design, Analysis and Test

The Contractor shall provide natural and induced environments skills to support design, analysis, and testing of space systems, space transportation systems, science experiments and instruments, ground support equipment, and special equipment for current and future programs or projects. The Contractor shall deliver products in areas such as atmospheric science, atmospheric influence on launch vehicles and spacecraft, atmospheric influence on operations, atmospheric modeling and programming, space environment characterization, space environment modeling and programming, spacecraft charging and plasma environment, lightning effects, meteoroid and orbital debris environment physics, meteoroid and orbital debris environment modeling and programming, meteoroid and orbital debris impact analysis, and plume induced environments. The Contractor shall deliver products to include the design, development, assembly, test, analysis, modeling and simulating of the following: prototype hardware, flight hardware, ground hardware, payloads, subsystems, science investigations, data management and analytical tools. The Contractor shall provide support for and generate products associated with research and new technology development for natural and induced environments design, analysis and test areas.

Three WBS examples are:

ES.9.7.44.xx.xx

ESSSA Contractor Natural and Induced Environments Design, Analysis and Test skills supporting Spacecraft & Vehicle Systems, Natural Environments for Program X for Project Y.

ES.9.7.32.xx.xx
ESSSA Contractor Natural and Induced Environments Design, Analysis and Test skills supporting Spacecraft & Vehicle Systems, Structural and Mechanical Design for Program X for Project Y.

ES.9.7.33.xx.xx
ESSSA Contractor Natural and Induced Environments Design, Analysis and Test skills supporting Spacecraft & Vehicle Systems, Aero-sciences for Program X for Project Y.

3.10 Optics Design, Analysis and Test

The Contractor shall provide optics skills to support the design, analysis, and testing of space systems, propulsion, space transportation systems, scientific instrument components, ground support equipment, and special equipment for current and future programs or projects. The Contractor shall provide skills to support on-going flight hardware for advanced optical systems and initiatives for advancing state-of-the-art optics design and manufacturing technologies (e.g., manufacturing of mandrels and Fresnel lenses) for experimental and prototype ground, aircraft, and space instruments in the visible, ultraviolet, infrared, and x-ray spectrums. The Contractor shall provide skills that include expertise in optical and optomechanical design and analysis, camera design, optical inspection devises, lasers, lenses, medical imaging devices, navigation equipment, safety monitoring devices, satellites, telescopes and video hardware to provide optical products such as design, analysis, hardware fabrication, optical sensor research and testing of high-quality optics. The Contractor shall deliver products in areas such as advanced optical systems development; diffractive optics, coatings, and surface metrology; optical design, analysis and fabrication; optical test and manufacturing.

The Contractor shall provide optics skills and deliver products to support the fabrication, cleaning, integration, and installation of Special Test Equipment (STE) in support of cryogenic optical testing at the X-Ray Calibration Facility (XRCF). The Contractor shall provide support for and generate products associated with research and new technology development for optics design, analysis and test areas.

Two WBS examples are:

ES.10.5.31.xx.xx.xx.xx.xx.
ESSSA Contractor Optics Design, Analysis and Test skills for Program X for Project Y.

ES.10.10.63.xx.xx.xx.xx.JW.
ESSSA Contractor Optics Design, Analysis and Test skills for Science & Mission Systems, Optics Office for the James Webb Space Telescope

3.11 Propulsion System Design, Analysis and Test

The Contractor shall provide propulsion system design, analysis and testing skills to support and deliver products in areas such as components, subsystems, and systems for liquid (cryogenic, storable, monopropellant, bipropellant, and dual mode), gas, solid, and advanced propulsion systems for both launch vehicle and in-space applications. Examples of these products shall include design, analysis, development, evaluation, integration, and verification of systems such as liquid main propulsion, pump-fed engine, pressure fed engine, orbital maneuvering, roll control, reaction control, de-orbit propulsion, solid motor, booster tumble, booster deceleration, upper stage settling, launch abort, jettison, altitude control, thrust vector control, nuclear power, nuclear fission propulsion, nuclear fusion propulsion, antimatter, electric propulsion, solar thermal propulsion, solar electric, solar power, solar sail, tether, aero-capture, advanced chemical propulsion, pressurization, propellant storage, valves, lines, ducts, advanced cryogenic fluid management, advanced in-space non-chemical, electric and plasma based propulsion and propellant delivery. Other products shall include the design, analysis, development, evaluation, and/or verification of propulsion system trade studies, solid propellant grain designs, solid motor igniters, solid motor nozzles, ground testing of propulsion system hardware, advanced propellants, green propellants, solid motor ballistics, analytical tools and techniques used to model engine and main propulsion systems, and cryogenic fluid management approaches. The Contractor shall provide support for and generate products associated with research and new technology development for propulsion design, analysis and testing areas.

Two WBS examples are:

ES.11.4.33.xx.xx.xx.xx.xx.
ESSSA Contractor Propulsion System Design, Analysis and Test skills supporting Propulsion Systems, Spacecraft and Auxiliary Propulsion Systems, for Program X for Project Y.

ES.11.10.61.xx.xx.xx.xx.xx
ESSSA Contractor Propulsion System Design, Analysis and Test skills supporting Propulsion Systems, Structural and Dynamics Analysis for Program X for Project Y.

3.12 Scientific Disciplines Design, Analysis and Test

The Contractor shall provide engineering and science skills to support scientific disciplines such as ground and space based research investigations, programs and projects in areas such as space science, earth science and related technologies. Space science discipline skills shall include solar physics, space plasma physics, x-ray astronomy, gamma-ray astronomy, cosmic ray research, and other astrophysics disciplines. Earth science discipline skills shall include infrared and microwave remote sensing technology, lightning studies, land processes, atmospheric chemistry, atmospheric aerosols, atmospheric modeling, Light Detection and Ranging (LIDAR), wind measurements, airborne experiments and field campaigns, advanced information systems requirements definition, and archeological studies associated with the global water cycle. The Contractor shall provide skills and products in areas such as program, project and portfolio formulation and implementation consisting of concepts and requirements definition; technology assessment and development; reviews; analytical integration; test operations; hardware development, maintenance, refurbishment, and certification; systems integration; mission

operations; Environmental Control and Life Support System (ECLSS) water recovery, ECLSS air revitalization; Taurus/Cygnet, ECLSS, Materials Science Research Rack (MSRR), Microgravity Science Glovebox (MSG), Express Rack, Window Observation Research Facility (WORF), and James Webb Space Telescope (JWST) mission support; JWST/XRCF operation and maintenance, and data analysis. The Contractor shall provide support for and generate products associated with research and new technology development for scientific discipline areas.

Two WBS examples are:

ES.12.10.61.xx.xx.xx.xx.xx
ESSSA Contractor Space science support to the GLAST Burst Monitor (GBM) for the Science Mission Directorate.

ES.12.10.62.xx.xx.xx.xx.xx
ESSSA Contractor Earth science discipline support to the Omega: Instruments for Soil Moisture Mapping project for the Science Mission Directorate.

3.13 Spacecraft and Space Systems Software Design, Analysis and Test

The Contractor shall provide spacecraft and space systems software skills to support and deliver products in areas such as embedded vehicle flight control software, ground support software, software based avionics redundancy management and simulation systems software. The Contractor shall provide skills necessary to define, design, code, integrate, test, certify, configuration control, operate and maintain software development facilities; ground systems test facilities, and operations facilities. The Contractor shall provide the skills to support all software life-cycle development phases for Capability Maturity Model Integration (CMMI) maturity level 3 embedded flight software, CMMI maturity level 2 ground test software, and reconfigurable computing and mission critical GN&C software (for both manned and unmanned missions). The Contractor shall provide products in support of software requirements development, processes and planning, formal validation and verification planning, test planning, and development of software. The Contractor shall also be required to provide support for and generate products associated with research and new technology development for spacecraft and space systems software requirements, design, code, integration, test, and analysis areas.

Two WBS examples are:

ES.13.7.41.xx.xx.xx.xx.xx.
ESSSA Contractor Spacecraft and Space Systems Software Design, Analysis and Test skills supporting Spacecraft & Vehicle Systems, Control Systems Design and Analysis for Program X for Project Y.

ES.13.5.52.xx.xx.xx.xx.xx
ESSSA Contractor Spacecraft and Space Systems Software Design, Analysis and Test skills supporting Space Systems, Software Development for Program X for Project Y.

3.14 Systems Engineering

The Contractor shall provide systems engineering skills in support of programs, projects and activities to manage, assess, and perform systems engineering life cycle processes. The Contractor shall develop products/tools associated with technical requirements definition, logical decomposition, design solution definition, product implementation, product integration, product verification, product validation, product transition, technical planning, requirements management, interface management, technical risk management, technical assessment, decision analysis, and support of technical data. These skills may require use of various systems engineering tools such as Model-Based Systems Engineering (MBSE), and requirements and validation tools.

Three WBS examples are:

ES.14.7.91.xx.xx.xx.xx.xx.
ESSSA Contractor Systems Engineering skills supporting Spacecraft & Vehicle Systems, Vehicle Systems Design and Integration for Program X for Project Y.

ES.14.4.20.xx.xx.xx.xx.xx
ESSSA Contractor Systems Engineering skills supporting Propulsion Systems Design and Integration for Program X for Project Y

ES.14.5.13.xx.xx.xx.xx.xx
ESSSA Contractor Systems Engineering skills supporting Space Systems, Systems and Engineering for Program X for Project Y.

3.15 Test Design and Operations

The Contractor shall provide test skills to support areas such as flight vehicles, spacecraft, and associated subsystems; ground support equipment; ground test systems, control test systems, propulsion systems and components; structural test articles; payload systems and space experiments/environments; maintenance and repair of cryogenic and vacuum systems; and experimental evaluation of technology and research investigations as well as any other commercial or Governmental requested test that may not be related to aerospace technology. The Contractor shall deliver products such as test design, plans, procedures, testing schedules, coordination, facility adaptation and activation, test conduction, data acquisition, data recording, data evaluation, and test reporting. The Contractor shall also provide engineering and integral technician support, for areas such as design, analysis, fabrication oversight, integration, and operation of fluid systems (including high pressure gases, hazardous propellants, cryogenics, and hydraulics), equipment (including valves, actuators, pumps, vessels, sensor signal conditioning electronics, data acquisition components, and hardware control electronics), fixtures, specific tooling, test instrumentation systems (including sensor specifications and installation, validation, and usage approaches), automation and control (including remote operation, closed loop control, man-machine interfaces, real-time sequences and interlocks, power supplies, relays, conversion, protection and control and electrical power distribution), and data acquisition (including recording, viewing, calibration, verification, and feedback).

The Contractor shall provide pressure systems management engineering and integral technician "certification team" skills to support the performance and certification

maintenance for pressure systems at MSFC. In order to accomplish initial certifications and to maintain the certification status of existing systems, the Contractor shall provide various specific tasks and products such as development of pressure system designs per applicable ASME/ANSI Code; periodic inspections and tests; maintenance of operating records; re-evaluation of certification status when changes occur; and maintenance of certification data packages as official quality records. The Contractor shall provide support for and generate products associated with research and new technology development for test design and operations areas.

Two WBS examples are:

ES.15.7.83.xx.xx.xx.xx.xx.
ESSSA Contractor Test Design and Operations skills supporting Spacecraft & Vehicle Systems, Stage Test & Flight Evaluations for Program X for Project Y

ES.15.4.32.xx.xx.xx.xx.xx
ESSSA Contractor Test Design and Operations skills supporting Propulsion Systems, Combustion Devices Design & Development for Program X for Project Y

3.16 Thermal and Fluids Design, Analysis and Test

The Contractor shall provide the thermal and fluids design, analysis and testing skills required to support areas such as components, subsystems, and systems for instruments, payloads, launch vehicles, space transportation vehicles, spacecraft and propulsion systems for both launch vehicle and in-space applications. The Contractor shall provide analytical and testing skills in the fields of computational fluid dynamics, coupled system dynamics, gas dynamics, thermochemical modeling, ablation modeling, thermal modeling, orbital heat rate calculations, heat transfer, active and passive thermal control, and conjugate fluid flow analysis. The Contractor shall provide design and analysis skills in the areas of physical and chemical processes to include distillation, absorption, catalytic reaction, filtration, phase separation, electrochemical processes and ion exchange used in life support flight systems and new technologies. The Contractor shall provide engineering and integral technician design and analysis support for physical and chemical laboratory for environmental control and life support system processes. The Contractor shall provide products such as thermal analyses of launch/ascent/descent environments, separation environments, plume induced environments, space environments, and vacuum test environments with associated thermal design options (e.g., thermal protection and insulations). The Contractor shall also provide analyses of thermal characteristics, flow dynamics, and/or acoustics of: liquid, solid, and gas engines; main propulsion systems; propellant and pressurization systems; tanks; ducts; valves; turbopump components; manifolds; reacting flows in injectors, chambers, and nozzles. The Contractor shall provide the products needed to support the development, acquisition, validation, quality control, and application of new and improved analytical tools and methods for thermal and fluids design and analysis required for design, analysis and test support (e.g., thermal balance and thermal vacuum). The Contractor shall provide support for and generate products associated with research and new technology development for thermal and fluids design, analysis and testing areas.

Three WBS examples are:

ES.16.4.43.xx.xx.xx.xx.xx.
ESSSA Contractor Thermal and Fluids Design, Analysis and Test skills supporting Propulsion Systems, Thermal Analysis for Program X for Project Y.

ES.16.5.22.xx.xx.xx.xx.xx
ESSSA Contractor Thermal and Fluids Design, Analysis and Test skills supporting Space Systems, Thermal and Mechanical Analysis for the International Space Station (ISS) program for the Environmental Control and Life Support Systems (ECLSS) project.

ES.16.7.34.xx.xx.xx.xx.xx
ESSSA Contractor Thermal and Fluids Design, Analysis and Test skills supporting Spacecraft Vehicle Systems, Thermal Analysis and Control for Program X for Project Y

3.17 Systems Management

The Contractor shall provide engineering and science skills to support the technical management of programs and projects from formulation through execution. Products include, but are not limited to, the documentation and other materials generated during support of technical implementation and management, technical risk analysis review, technical problem identification, technical problem resolution review, and technology identification, development, and assessment. Support shall include technology assessment and planning, advanced concepts definition, preliminary design, systems analysis support, and analysis and innovative strategies to facilitate utilization of Center technical capabilities. Systems analysis support includes the establishment of technical mission objectives, mission planning, development of concept and configuration alternatives, system modeling and simulations, optimization and trade studies involving technical, cost, schedule, and their associated risks with safety, affordability, and reliability. These programs and projects may require use of various systems engineering tools such as Model-Based Systems Engineering (MBSE), Dynamic Object-Oriented Requirements System (DOORS), or Cradle.

The Contractor shall provide technical experts in the areas of technical management and systems management as needed to support evaluation of MSFC programs and projects. This shall include support to the management and integration of requirements and functionality for developing/upgrading systems management tools to support the management and systems engineering functions; definition and facilitation of systems management processes; systems management guidance to program/projects; and membership on technical evaluation teams to assess the program's/project's progress toward meeting established technical commitments.

Five WBS examples are:

ES.17.10.23.LQ.xx.xx.10.34.DI.
ESSSA Contractor Systems Management skills supporting the Discovery, New Frontiers and Lunar Quest Programs for the Science Mission Directorate.

ES.17.10.34.EC.0.0.10.34.IS.

ESSSA Contractor Systems Management skills supporting systems on-orbit replaceable units (ORUs) of the Environmental Control and Life Support System (ECLSS) for the ISS program.

ES.17.xx.xx.xx.xx
ESSSA Contractor Systems Management skills supporting special studies in technology capability development.

ES.17.xx.xx.xx.xx
ESSSA Contractor Systems Management skills supporting the Technology Demonstration Missions (TDM) Program.

ES.17.xx.xx.xx.xx
ESSSA Contractor Systems Management skills supporting the Centennial Challenges Program.

3.18 Hardware and Hardware/Software Integration and Test

The Contractor shall provide hardware and hardware/software integration engineering skills to support the design, development, test, and evaluation of hardware and the associated configuration control, interface identification and interface management of integrated hardware and software data packages; simulation systems software, Change Request (CR) and Program/Project Interface Revision Notice (PIRN) review and coordination; hardware and software pedigree data package in support of integrated rack verification submittals and Certification of Flight Readiness (CoFR); manifesting; integrated analysis; sustaining engineering; on-orbit operations support, troubleshooting, and anomaly resolution for existing hardware, such as, International Space Station (ISS) racks, payloads, On-orbit Replaceable Units (ORUs); the modification/upgrade of existing hardware; or the development of new hardware such as racks, payloads, or modules for the ISS or equivalent space platform.

The Contractor shall provide hardware engineering and science skills to support the development of real-time software, hardware/software integration, real-time modeling and simulation definition, design, development, integration, test, certification, configuration control, operation and evaluation of real-time hardware-in-the-loop facilities such as the Software Integration Laboratory (SIL) or Systems Integration Test Facility (SITF). The Contractor shall provide the skills to support all software life-cycle development phases for Capability Maturity Model Integration (CMMI) maturity level 2 ground test software. The Contractor shall provide products such as: lab automation tools and displays, real-time vehicle and subsystem models; cable interconnect diagrams; cable harness drawings; grounding diagrams/analysis; avionics emulators and associated breakout boxes for both data and power; integrated engineering analysis for voltage drop and grounding systems (anchoring of model to flight data); hardware integration analysis; design integration; analytical tool development; and simulation and modeling. The Contractor shall be proficient in tools/languages such as: DOORS, VxWorks 653, MATLAB, UML/SysML, C/C++ and LabView.

One WBS example is:

ES.18.10.34.EC.0.0.34.IS

ESSSA Contractor Hardware and Hardware/Software Integration and Test skills supporting the On-orbit Replaceable Units (ORUs) for the Environmental Control and Life Support System (ECLSS) for the ISS Program.

3.19 Propulsion System Design, Analysis and Test - Main Propulsion Systems

The Contractor shall provide propulsion system design, analysis and testing skills to support and deliver products in areas of main propulsion systems, subsystems and components for liquid (cryogenic, storable, monopropellant, bipropellant, and dual mode), gas, and advanced propulsion systems for both launch vehicle and in-space applications. Examples of these products shall include design, analysis, development, evaluation, integration, and verification of liquid main propulsion systems. Other products shall include the design, analysis, development, evaluation, and/or verification of propulsion system trade studies, ground testing of propulsion system hardware, advanced propellants, green propellants, and analytical tools and techniques used to model main propulsion systems. The Contractor shall provide support for and generate products associated with research and new technology development for main propulsion system design, analysis and testing areas.

3.20 Propulsion System Design, Analysis and Test - Spacecraft and Auxiliary Propulsion Systems

The Contractor shall provide propulsion system design, analysis and testing skills to support and deliver products in areas such as spacecraft and auxiliary propulsion systems, subsystems, and components for liquid (cryogenic, storable, monopropellant, bipropellant, and dual mode), gas and advanced propulsion systems for in-space applications. Examples of these products shall include design, analysis, development, evaluation, integration, and verification of systems such as liquid propulsion, pump-fed engine, pressure fed engine, orbital maneuvering, roll control, reaction control, de-orbit propulsion, altitude control, advanced chemical propulsion, pressurization, propellant storage, valves, lines, ducts, advanced cryogenic fluid management, and advanced in-space propulsion and propellant delivery. Other products shall include the design, analysis, development, evaluation, and/or verification of propulsion system trade studies, ground testing of propulsion system hardware, advanced propellants, green propellants, analytical tools and techniques used to model engine and propulsion systems, and cryogenic fluid management approaches. The Contractor shall provide support for and generate products associated with research and new technology development for spacecraft and auxiliary propulsion system design, analysis and testing areas.

3.21 Propulsion System Design, Analysis and Test - Propulsion Research and Technology

The Contractor shall provide support for and generate products associated with research and new technology development for propulsion design, analysis and testing areas. The Contractor shall provide propulsion system design, analysis and testing skills to support and deliver products in areas such as components, subsystems, and systems for liquid (cryogenic, storable, monopropellant, bipropellant, and dual mode), gas and advanced propulsion systems for in-space applications. Examples of these products shall include design, analysis, development, evaluation, integration, and verification of systems such as liquid propulsion, pump-fed engine, pressure fed engine, orbital maneuvering, roll control, reaction control, de-orbit propulsion, altitude control, nuclear power, nuclear

fission propulsion, nuclear fusion propulsion, antimatter, electric propulsion, solar thermal propulsion, solar electric, solar power, solar sail, tether, aero-capture, advanced chemical propulsion, pressurization, propellant storage, valves, lines, ducts, advanced cryogenic fluid management, advanced in-space non-chemical, electric and plasma based propulsion and propellant delivery. Other products shall include the design, analysis, development, evaluation, and/or verification of propulsion system trade studies, ground testing of propulsion system hardware, advanced propellants, green propellants, and cryogenic fluid management approaches.

3.22 Propulsion System Design, Analysis and Test - Turbomachinery

The Contractor shall provide propulsion system turbomachinery design, analysis and testing skills to support and deliver products in areas such as components, subsystems, and systems for liquid (cryogenic, storable, monopropellant, bipropellant, and dual mode), gas and advanced propulsion systems for both launch vehicle and in-space applications. Examples of these products shall include design, analysis, development, evaluation, integration, and verification of systems. Other products shall include the design, analysis, development, evaluation, and/or verification of propulsion system trade studies, ground testing of propulsion system hardware, advanced propellants, green propellants, analytical tools and techniques used to model engine and main propulsion systems. The Contractor shall provide support for and generate products associated with research and new technology development for propulsion turbomachinery design, analysis and testing areas.

3.23 Propulsion System Design, Analysis and Test - Combustion Devices

The Contractor shall provide propulsion system combustion devices design, analysis and testing skills to support and deliver products in areas such as components, subsystems, and systems for liquid (cryogenic, storable, monopropellant, bipropellant, and dual mode), gas and advanced propulsion systems for both launch vehicle and in-space applications. Examples of these products shall include design, analysis, development, evaluation, integration, and verification of systems such as liquid propulsion, pump-fed engine, pressure fed engine, orbital maneuvering, roll control, reaction control, de-orbit propulsion, advanced in-space non-chemical. Other products shall include the design, analysis, development, evaluation, and/or verification of propulsion system trade studies, ground testing of propulsion system hardware, advanced propellants, green propellants, analytical tools and techniques used to model engine and main propulsion systems. The Contractor shall provide support for and generate products associated with research and new technology development for propulsion combustion devices design, analysis and testing areas.

3.24 Propulsion System Design, Analysis and Test - Valves, Actuators and Ducts

The Contractor shall provide propulsion system valves, actuators, and ducts design, analysis and testing skills to support and deliver products in areas such as components, subsystems, and systems for liquid (cryogenic, storable, monopropellant, bipropellant, and dual mode), gas, and advanced propulsion systems for both launch vehicle and in-space applications. Examples of these products shall include design, analysis, development, evaluation, integration, and verification of systems such as liquid propulsion, pump-fed engine, pressure fed engine, orbital maneuvering, roll control, reaction control, launch abort, jettison, altitude control, nuclear power, nuclear fission

propulsion, nuclear fusion propulsion, antimatter, electric propulsion, solar thermal propulsion, solar electric, solar power, solar sail, tether, aero-capture, advanced chemical propulsion, pressurization, propellant storage, valves, lines, ducts, advanced cryogenic fluid management, advanced in-space non-chemical, electric and plasma based propulsion and propellant delivery. Other products shall include the design, analysis, development, evaluation, and/or verification of propulsion system trade studies, solid motor nozzles, ground testing of propulsion system hardware, advanced propellants, green propellants, analytical tools and techniques used to model engine and main propulsion systems. The Contractor shall provide support for and generate products associated with research and new technology development for propulsion valves, actuators and ducts design, analysis and testing areas.

3.25 Propulsion System Design, Analysis and Test - Propulsion Detail Design

The Contractor shall provide propulsion system design, analysis and testing skills to support and deliver products in areas such as the detail design of propulsion components, subsystems, and systems, including but not limited to flight payloads and special test equipment. Design support shall include integration and support of testing activities (e.g., interfacing with manufacturing, hardware integration, and testing disciplines). The Contractor shall deliver products in areas such as design of propulsion components/systems with interface to their structures, mechanical devices, ground support equipment, special test equipment, tooling, mechanisms, composite designs, along with CAD standards and processes. The Contractor shall provide support for and generate products associated with research and new technology development for propulsion design, analysis and testing areas.

3.26 Propulsion System Design, Analysis and Test - Thrust Vector Control Systems

The Contractor shall provide propulsion system design, analysis and testing skills to support and deliver products in areas such as components, subsystems, and systems for thrust vector control systems. Examples of these products shall include design, analysis, development, evaluation, integration, and verification of thrust vector control systems. Other products shall include the design, analysis, development, evaluation, and/or verification of trade studies and ground testing of system hardware. The Contractor shall provide support for and generate products associated with research and new technology development for propulsion thrust vector control systems design, analysis and testing areas.

3.27 Propulsion System Design, Analysis and Test - Solid Propulsion Systems

The Contractor shall provide propulsion system design, analysis and testing skills to support and deliver products in areas such as components, subsystems, and systems for solid propulsion systems for both launch vehicle and in-space applications. Examples of these products shall include design, analysis, development, evaluation, integration, and verification of systems such as solid motor, booster tumble, booster deceleration, upper stage settling, launch abort, jettison, and altitude control motors. Other products shall include the design, analysis, development, evaluation, and/or verification of propulsion system trade studies, solid propellant grain designs, solid motor igniters, solid motor nozzles, ground testing of propulsion system hardware, solid motor ballistics, analytical tools and techniques used to model motors. The Contractor shall

provide support for and generate products associated with research and new technology development for solid propulsion system design, analysis and testing areas.

3.28 Thermal and Fluids Design, Analysis and Test - Thermal and Combustion Analysis

The Contractor shall provide the thermal\fluids and combustion design, analysis and testing skills required to support areas such as components, subsystems, and systems for instruments, payloads, launch vehicles, space transportation vehicles, and propulsion systems for both launch vehicle and in-space applications. The Contractor shall provide analytical and testing skills in the fields of coupled system dynamics, gas dynamics, thermochemical modeling, ablation modeling, thermal modeling, heat transfer, active and passive thermal control, and conjugate fluid flow analysis. The Contractor shall provide products and analyses of thermal characteristics and flow dynamics of: liquid, solid, and gas engines; main propulsion systems; propellant and pressurization systems; tanks; ducts; valves; turbopump components; manifolds; reacting flows in injectors, chambers, and nozzles. The Contractor shall provide the products needed to support the development, acquisition, validation, quality control, and application of new and improved analytical tools and methods for thermal and fluids design and analysis required for design, analysis and test support (e.g., thermal balance and thermal vacuum). The Contractor shall provide support for and generate products associated with research and new technology development for thermal/fluids and combustion design, analysis and testing areas.

3.29 – 3.49 Reserved

3.50 Materials Design, Analysis and Test - Material Test

The Contractor shall provide materials engineering and technical skills to deliver products supporting the design, analysis and testing of metallic and non-metallic materials for use in parts, components, subsystems, and hardware systems for space flight and launch vehicles, scientific instruments or experiment hardware, test articles, ground support and special test equipment. The Contractor shall deliver products in areas such as research, development, evaluation, selection, specification, testing and verification of engineering materials, processing and systems for specific hardware design applications and usage environments. Examples of testing and analysis products include the following: characterization of materials to define their design properties/allowables and determine how they will perform/degrade in their intended or worse case natural, induced, operational or space usage environments; and determine if materials are compatible with the reactive or working fluid systems in which they are used (e.g. oxygen, hydrogen, coolants, hydraulic fluids, and chemical media/working fluids, hypergolic and chemical propellants). The Contractor shall also deliver analysis products such as: analytical and environmental chemistry; and material tests, assessments and impact due to Environmental, Safety, and Health restrictions/regulations. Additional products, skills, and services shall be required for operations and maintenance of materials test and development facilities. The Contractor shall provide support for and generate products associated with research and new technology development for materials design, analysis and test areas.

3.51 Materials Design, Analysis and Test - Material Damage Tolerance Assessment

The Contractor shall provide materials engineering and technical skills to deliver products supporting damage tolerance assessment, including analytical and nondestructive evaluation (NDE), for the design, analysis, and testing of metallic and non-metallic parts, components, subsystems, and hardware systems for space flight and launch vehicles, spacecraft, scientific instruments or experimental hardware, test articles, ground support, and special test equipment. The Contractor shall deliver products regarding research, development, evaluation, selection, specification, and verification of engineering materials, processing, and systems for specific hardware design applications and usage environments. Examples of analysis and NDE products include materials tests analysis to determine materials tolerance to damage, fracture and fatigue to predict their service and safe life capabilities; fracture mechanics/fatigue and service/useful life assessments; failure analysis; and NDE and examination of results. Analysis and NDE support shall include development of damage tolerance and fracture control techniques and processes; development of NDE techniques and processes; performance of fracture control reviews and insight support; materials reviews; and support of failure investigations that may involve materials-related issues. The Contractor shall provide support for and generate products associated with research and new technology development for materials design, analysis and test in the area of material damage tolerance assessment.

3.52 Materials Design, Analysis and Test - Metallurgy and Diagnostics

The contractor shall provide materials engineering and technical skills to deliver products supporting metallurgical analysis and diagnosis of materials failure for the design, analysis and testing of metallic materials for use in parts, components, subsystems, and hardware systems for space flight and launch vehicles, spacecraft, scientific instruments or experiment hardware, test articles, ground support and special test equipment. The Contractor shall deliver products regarding research, development, evaluation, selection, processing, specification, and verification of engineering materials, processing and systems for specific hardware design applications and usage environments. Examples of metallurgy and diagnostics products include the following: characterization of materials using metallography and microscopy to determine material morphology and composition; failure analyses of hardware and equipment using metallography and microscopy; corrosion testing and analysis to determine if materials are compatible with the environments and reactive or working fluid systems in which they are used and to evaluate corrosion mitigation systems. Materials engineering skills shall be provided to develop improved materials processing methods and deliver advanced light-weight/high-performance metals. Additional products, skills, and services shall be required for operations and maintenance of materials diagnostic and processing facilities. The Contractor shall provide support for and generate products associated with research and new technology development for materials design, analysis and test in the area of metallurgy and diagnostics.

3.53 Materials Design, Analysis and Test - Nonmetallic Materials

The Contractor shall provide materials engineering and technical skills to deliver products supporting the design, analysis, and testing, including material characterization, specimen preparation, automatic and manual application of SOFI (spray on foam insulation) and in-process testing, of non-metallic materials for use in parts, components,

subsystems, and hardware systems for space flight and launch vehicles, test articles, ground support and special test equipment. The Contractor shall deliver products in areas such as research, development, evaluation, selection, specification, and verification of engineering materials, processes and systems for specific hardware design applications and usage environments. The Contractor shall deliver analysis products such as: sustainability/risk assessment of materials obsolescence and impact due to Environmental, Safety, and Health restrictions/regulations; material failure analysis; and process hazard analysis. Materials engineering skills shall be provided to deliver advanced material products which may include: polymeric/elastomeric materials; coatings/protective finishes; high temperature, leading edge and aero-thermal surface insulation/Thermal Protection Systems (TPS) materials and processes development; thermal protection/insulation system cryogenic/high-temperature materials (e.g. foams, ablatives, ceramics, nozzle/leading edge composites); and other light-weight/high-performance non-metallic materials. Additional products, skills, and services shall be required for operation and maintenance of TPS materials facilities. The Contractor shall provide support for and generate products associated with research and new technology development for materials design, analysis and test in the area of nonmetallic materials.

3.54 Materials Design, Analysis and Test - Material Environmental Effects

The Contractor shall provide materials science, engineering, and technical skills for design, analysis and testing of metallic and non-metallic materials for use in parts, components, subsystems, and hardware systems for space flight and launch vehicles, spacecraft, scientific instruments or experiment hardware, test articles, ground support and special test equipment. The Contractor shall deliver products in areas such as research, development, evaluation, selection, specification, and verification of materials, processes, and systems for performance and survival in space and launch system environments, including vacuum, atomic oxygen, ultraviolet and ionizing radiation, plasma, fluid systems, contamination and foreign object debris. Examples of material environmental effects products include the following: development, review and coordination of program/project/customer test plans and procedures; program/project level documentation; and material and process specifications. The Contractor shall also deliver products such as derived design requirements, trade studies, operations control plans, test plans, test data, test reports, training and awareness materials, Standard Operating Procedures, and technical analysis reports. Technical expertise shall be provided in levitation of a variety of materials including metals and alloys. Additional products, skills, and services shall be required for operations and maintenance of materials test, analysis, formulation, and development facilities and equipment supporting material environmental effects. The Contractor shall provide support for and generate products associated with research and new technology development for materials design, analysis and test in the area of material environmental effects.

3.55 Materials Design, Analysis and Test - Material Systems

The contractor shall provide materials engineering and technical skills to deliver products supporting manufacturing producibility evaluations and analysis of designs for research, development, manufacturing, flight, and in-space related programs and projects. The Contractor shall provide skills in manufacturing and materials processes such as forging, brake forming, extrusions, corrosion, surface treatment, heat treatment, welding, and/or metal. The contractor shall deliver products in areas such as the generation, evaluation and/or assessment of materials and processes specifications/ standards, material

control plans, engineering change proposals, hardware manufacture, and post flight evaluations. The Contractor shall also provide skills to support areas such as program/project documentation review, design reviews, review of metallic and non-metallic specifications/ standards, Material Usage Agreements (MUA) and Materials Application and Evaluation Board (MAEB) review participation, Materials and Processes Working Group, and materials databases such as the Materials and Processes Technical Information System (MAPTIS-II) projects/programs. The Contractor shall also deliver products such as Materials Identification and Usage Lists (MIULs) and MUAs that will require access to the MAPTIS database. The Contractor shall provide support for and generate products associated with research and new technology development for materials design, analysis and test in the area of material systems.

3.56 Manufacturing and Assembly (M&A) - Welding and Manufacturing

The Contractor shall provide M&A engineering and technical skills to support, operate, service, maintain, and deliver products related to the development, design, and analysis of aerospace manufacturing, fabrication, production, integration, assembly, inspection, repair, refurbishment, and materials processes, including the associated tooling, capabilities, and facilities used to construct and produce materials, parts, components, subsystems, and hardware systems for space flight and launch vehicles, scientific instruments or experiment hardware, prototype and test articles, ground support and special test equipment. M&A products shall include advanced materials manufacturing and processing of structural and coatings/protective finishes; propulsion systems; and light-weight, high-temperature and other high performance metallic materials. Additional M&A skills and products shall include advanced, large scale, automated, and robotic processes such as: thermo-mechanical (e.g. forming and/or heat treatment); machining; coating/finishing and surface treatment; and materials joining technologies (e.g. fusion and solid state welding, brazing, soldering, adhesive bonding). The Contractor shall also provide products supporting the development, integration, verification, and validation of welding and manufacturing processes including: production of demonstration/prototype, test articles, and flight articles; tooling design and processing standards. The Contractor shall provide support for and generate products associated with research and new technology development for manufacturing and assembly areas.

3.57 Manufacturing and Assembly (M&A) - Composite Manufacturing

The Contractor shall provide M&A engineering and technical skills to support, operate, service, maintain, and deliver products related to the development, design, and analysis of aerospace manufacturing, fabrication, production, integration, assembly, inspection, repair, refurbishment, and materials processes, including the associated tooling, capabilities, and facilities used to construct and produce materials, parts, components, subsystems, and hardware systems for space flight and launch vehicles, spacecraft, scientific instruments or experiment hardware, prototype/test articles, ground support and special test equipment. M&A products shall include additive manufacturing, composites manufacturing and structured light scanning of test panels, test specimens and flight test articles. Additional M&A skills shall include structured light scanning and photogrammetry required to perform a variety of tasks and analyses. The Contractor shall provide support for and generate products associated with research and new technology development for manufacturing and assembly areas.

3.58 Test Design and Operations - Propulsion Systems Test

The Contractor shall provide test skills to support propulsion systems test in areas such as ground test systems, control test systems, propulsion systems and components and propulsion test systems; structural test articles and structural test systems; maintenance and repair of cryogenic and vacuum systems; and experimental evaluation of technology and research investigations as well as any other commercial or Governmental requested test that may not be related to aerospace technology. The Contractor shall deliver products such as test design, plans, procedures, testing schedules, coordination, facility adaptation and activation, test conduction, data acquisition, data recording, data evaluation, and test reporting. The Contractor shall also provide engineering for areas such as design, analysis, fabrication oversight, integration, and operation of fluid systems (including high pressure gases, hazardous propellants, cryogenics, and hydraulics), equipment (including valves, actuators, pumps, vessels, sensor signal conditioning electronics, data acquisition components, and hardware control electronics), fixtures, specific tooling, test instrumentation systems (including sensor specifications and installation, validation, and usage approaches), automation and control (including remote operation, closed loop control, man-machine interfaces, real-time sequences and interlocks, power supplies, relays, conversion, protection and control and electrical power distribution), and data acquisition (including recording, viewing, calibration, verification, and feedback). The Contractor shall provide support for and generate products associated with research and new technology development for test design and operations in the area of propulsion systems test.

3.59 Test Design and Operations - Experimental Fluids & Environmental Test

The Contractor shall provide test skills to support experimental fluids and environmental tests in areas such as flight vehicles, spacecraft, and associated subsystems; ground support equipment; ground test systems, control test systems, payload systems and space experiments/environments; and experimental evaluation of technology and research investigations as well as any other commercial or Governmental requested test that may not be related to aerospace technology. The Contractor shall deliver products such as test design, plans, procedures, testing schedules, coordination, facility adaptation and activation, test conduction, data acquisition, data recording, data evaluation, test reporting. The Contractor shall also provide engineering and integral technician support for areas such as fabrication oversight, integration, and operation of fluid systems (including high pressure gases, cryogenics, and hydraulics), equipment (including valves, actuators, pumps, vessels, sensor signal conditioning electronics, data acquisition components, and hardware control electronics), fixtures, specific tooling, test instrumentation systems (including sensor specifications and installation, validation, and usage approaches), automation and control (including remote operation, closed loop control, man-machine interfaces, real-time sequences and interlocks, power supplies, relays, conversion, protection and control and electrical power distribution), and data acquisition (including recording, viewing, calibration, verification, and feedback). The Contractor shall provide support for and generate products associated with research and new technology development for test design and operations in the area of experimental fluids and environmental test.

3.60 Test Design and Operations - Structural Strength Test

The Contractor shall provide test skills to support structural strength tests in areas such as flight vehicles and associated subsystems; ground support equipment; ground test systems; propulsion systems and components; structural test articles; payload systems and space experiments/environments; cryogenic and vacuum systems; and experimental evaluation of technology and research investigations as well as any other commercial or Governmental requested test that may not be related to aerospace technology. The Contractor shall deliver products such as test estimates, design, plans, procedures, testing schedules, coordination, facility adaptation and activation, test conduction, load application and control systems, data acquisition, data recording, data evaluation, and test reporting. The Contractor shall also provide engineering and integral technician support, for areas such as design, analysis, fabrication oversight, integration, and operation of fluid systems (including high pressure gases, hazardous propellants, cryogenics, and hydraulics), equipment (including valves, actuators, pumps, vessels, sensor signal conditioning electronics, data acquisition components, and hardware control electronics), fixtures, specific tooling, test instrumentation systems (including sensor specifications and installation, validation, and usage approaches), automation and control (including remote operation, closed loop control, man-machine interfaces, real-time sequences and interlocks, power supplies, relays, conversion, protection and control and electrical power distribution), and data acquisition (including recording, viewing, calibration, verification, and feedback). The Contractor shall provide support for and generate products associated with research and new technology development for test design and operations in the area of structural strength test.

3.61 Test Design and Operations - Structural Dynamics Test

The Contractor shall provide test skills to support structural dynamics tests in areas such as flight vehicles, spacecraft, and associated subsystems; ground support equipment; ground test systems, control test systems, propulsion systems and components; structural test articles; payload systems and space experiments/environments; and experimental evaluation of technology and research investigations as well as any other commercial or Governmental requested test that may not be related to aerospace technology. The Contractor shall deliver products such as test design, plans, procedures, testing schedules, coordination, facility adaptation and activation, test conduction, data acquisition, data recording, data evaluation, and test reporting. The Contractor shall also provide engineering and integral technician support, for areas such as design, analysis, fabrication oversight, integration, and operation of fluid systems (including high pressure gases and hydraulics), equipment (including valves, actuators, pumps, vessels, sensor signal conditioning electronics, data acquisition components, and hardware control electronics), fixtures, specific tooling, test instrumentation systems (including sensor specifications and installation, validation, and usage approaches), automation and control (including remote operation, closed loop control, man-machine interfaces, real-time sequences and interlocks, power supplies, relays, conversion, protection and control and electrical power distribution), and data acquisition (including recording, viewing, calibration, verification, and feedback). The Contractor shall provide support for and generate products associated with research and new technology development for test design and operations in the area of structural dynamics test.

3.62 Test Design and Operations - Special Test Equipment Design

The Contractor shall provide the test skills to support special test equipment design in areas such as flight vehicles and associated subsystems; ground support equipment; ground test systems; propulsion systems and components; structural test articles; payload systems and space experiments/environments; cryogenic and vacuum systems; and experimental evaluation of technology and research investigations as well as any other commercial or Governmental requested test that may not be related to aerospace technology. The contractor shall deliver design products of special test equipment (defined as structure, hardware, piping systems, pressure vessels, or equipment intended to be used for testing or simulation, or associated with the manufacturing, process development, and preparation of facilities for testing or simulation) for areas such as test stands, test beds, load reaction and application structures, load line components, hot fire testing of engines and engine components, fluid flow and pressure tests, high pressure and/or cryogenic storage and/or run systems, solid propellant tests, flight hardware mockups and simulators, hardware support stands and dollies, personnel access stands, lifting and handling hardware, and tooling used to facilitate the fabrication and/or assembly of flight/non-flight hardware such as master drill templates or alignment/clamping fixtures used during machining and welding processes. The Contractor shall also deliver products such as concepts, detailed drawings, analysis reports, procedures, and schedules. The Contractor shall also provide engineering and integral technician liaison support for areas such as fabrication, assembly and integration, and operations during testing. The Contractor shall provide support for and generate products associated with research and new technology development for test design and operations in the area of special test equipment design.

3.63 Test Design and Operations - Pressure Systems Certification

The Contractor shall provide pressure systems management engineering and integral technician "certification team" skills to support the performance and certification maintenance for pressure systems at MSFC. In order to accomplish initial certifications and to maintain the certification status of existing systems, the Contractor shall provide various specific tasks and products such as development of pressure system designs per applicable ASME/ANSI Code; periodic inspections and tests; maintenance of operating records; re-evaluation of certification status when changes occur; and maintenance of certification data packages as official quality records.

3.64 Guidance, Navigation, and Control (GN&C) Design and Analysis - Control Systems Design and Analysis

The Contractor shall provide flight control systems skills to support the design and analysis of space systems, propulsion systems, space transportation systems, scientific research experiments, ground support equipment, and special equipment for current and future programs or projects. The Contractor shall deliver products such as aerodynamic flight control components control theory and algorithms vehicle dynamics, dynamical system theory control systems design. Examples of products shall include design, development, analysis, integration, analytical tool development, simulation and modeling, requirements definition, trade studies, and test analysis. The Contractor shall provide support for and generate products associated with research and new technology development for flight control systems design and analysis areas.

3.65 Guidance, Navigation, and Control (GN&C) Design and Analysis – Guidance, Navigation, and Mission Analysis

The Contractor shall provide guidance and navigation skills to support the design and analysis of space systems, propulsion systems, space transportation systems, scientific research experiments, ground support equipment, and special equipment for current and future programs or projects. The Contractor shall deliver products such as trajectory design, navigation design, separation systems analysis, orbital mechanics, vehicle dynamics, dynamical system theory, and propulsion dynamics. These products shall include design, development, analysis, integration, analytical tool development, simulation and modeling, requirements definition and trade studies. The Contractor shall provide support for and generate products associated with research and new technology development for guidance and navigation systems design and analysis areas.

3.66 Structural and Mechanical Design and Analysis - Structural Strength and Dynamics

The Contractor shall provide structural and mechanical skills to support the structural design, analysis, and verification of space systems, including but not limited to launch vehicles, spacecraft, payloads, secondary structures, test articles, and other related hardware. The Contractor shall deliver products such as strength (stress) and stability analysis, fatigue and fracture analysis, component loads analysis, vehicle coupled loads analysis, linear and nonlinear dynamics analysis, vibroacoustic analysis, microgravity analysis, shock, and payload isolation analysis. Analysis activities shall support all phases of the hardware lifecycle from initial research and concept development, to production, testing and verification, and through sustaining activities. The Contractor shall also deliver products such as analytical models, analysis results, and analytical tools as well as review of analytical products. Products delivered shall support verification activities such as test criteria and requirements, instrumentation locations, pre-test predictions, and post-test data correlation. The Contractor shall provide support for and generate products associated with research and new technology development in the areas of stress, loads, and dynamic analysis.

3.67 Structural and Mechanical Design and Analysis - Structural Mechanical Design and Pyrotechnics

The Contractor shall provide structural and mechanical skills to support the design and analysis of space systems, including but not limited to space vehicle systems, propulsion systems and components, space transportation systems, and scientific experiment or instrument hardware. Design and analysis support shall include integration of vehicles across programs. The Contractor shall deliver products in areas such as design and analysis of: vehicles, structures, mechanical devices, composite designs, CAD standards and processes, pressure systems management, and analysis of ground and flight test data. The Contractor shall deliver products such as test criteria and requirements (e.g., load, vibration, acoustic, and shock), models and simulations for verification activities. Structural and mechanical design and analysis products shall be required for all phases of flight, ground and research projects, such as conceptual design, primary and secondary structure detailed design, mechanical drawings, 3D models, pyrotechnic systems design, electrical cable routing between components, and meteoroid-orbital debris impact assessments. The Contractor shall provide support for

and generate products associated with research and new technology development for structural and mechanical design and analysis areas.

3.68 Systems Engineering - Structural Environment Design & Integration

The Contractor shall provide systems engineering skills in the area of structures and environments for vehicle designs. The Contractor shall provide expertise in skills including, but not limited to, dynamics, stress, integrated design, aerosciences, thermal, and blast and vehicle debris. The Contractor shall deliver integrated vehicle products associated with the required skills. Support shall include, but not be limited to the following: technical assessment of the Structural Thermal Environment (STE) of vehicle designs along with identification of issues/concerns and suggested resolutions; project review participation to represent the STE technical area for the project; STE technical risk management; STE tests and milestones schedule monitoring; and development or review of STE sections of vehicle design documentation.

3.69 Systems Engineering - Mission and Fault Management

The Contractor shall provide systems engineering skills in support of the definition, design, development, analysis, test, and integration of a Mission and Fault Management system for integrated vehicles. The Contractor shall provide the skills necessary to develop, manage, validate and verify Mission and Fault Management requirements in support of Vehicle specifications and\or Vehicle Management Specifications. The Contractor shall develop products such as Integrated Vehicle Fault Management models, Goal Tree/Success Tree models to evaluate the functionality of a vehicle and its sub-systems, identify potential failures, and develop appropriate responses.

3.70 Systems Engineering - Vehicle Systems Engineering and Technical Management

The Contractor shall provide system engineering skills in the area of system technical management in support of programs, projects and activities to manage, assess, and perform systems engineering life cycle processes. The Contractor shall provide skills necessary to lead the development of programmatic processes and documentation, process definition, and other systems engineering management and planning functions; and support technical review planning, administration, and completion. The Contractor shall develop products associated with as the following: vehicle design and analysis planning; integration and control for vehicle requirements analysis; modeling and simulation; technical implementation; Design and Analysis Cycle (DAC) planning and execution; verification methods; and facilitation of risk management.

3.71 Systems Engineering - Requirements and Design Integration

The Contractor shall provide systems engineering skills in the area of system definition and functional design in support of programs, projects and activities to manage, assess, and perform systems engineering life cycle processes. The Contractor shall develop products associated with the following: integrated systems, elements, and subsystems technical hardware requirement development and validation; system level functional design; vehicle and subsystems development and analyses; systems engineering and integration; system interface identification, definition, and management; and identification, communication, and resolution of development issues through the project life cycle. The Contractor shall provide skills to lead and/or support design definition

activities such as trade studies or Requirements and Design Analysis Cycles (RACs/DACs), coordinate with and provide support to engineering planning and the technical review processes. The Contractor shall provide system engineering and integration of the functional design through the development, validation, and control of requirements including performance, operational, interface, and workmanship requirements. The skills shall require use and implementation of systems engineering tools and/or databases such as Cradle, Dynamic Object-Oriented Requirements System (DOORS), and Enterprise Architect.

3.72 Systems Engineering - Systems Test and Verification

The Contractor shall provide systems engineering skills in the area of systems test and verification in support of programs, projects and activities to manage, assess and perform systems engineering life cycle processes. The Contractor shall develop products associated with the following: system test planning and operations, development of test plans and test implementation plans, verification and validation planning and coordination, verification compliance status and monitoring, verification tool(s) implementation, and flight evaluation planning and coordination. Support shall include the integration of verification strategies and approaches; management of verification plans and compliance data throughout project life cycle (qualification, acceptance and certification); support, development, and communication of processes for requirement verification and assessment; and coordination of approval for derived verification plans. The Contractor shall provide systems engineering, vehicle integration, propulsion systems integration, and flight evaluation planning including the identification of Operational and Development Flight Instrumentation (DFI) and allocation recommendations.

3.73 Systems Engineering - Systems Analysis

The Contractor shall provide systems engineering skills in the area of systems analysis in support of programs, projects and activities to manage, assess and perform systems engineering life cycle processes. The Contractor shall develop products associated with the following: leading or supporting activities associated with multi-disciplinary system-level analysis, trade-off analysis, mathematical modeling and analysis, mass properties, technical performance measures, modeling and simulation, and human factors engineering; and coordinating mass estimations and providing technical insight and appraisal of the estimating process. The Contractor shall provide skills necessary to lead or support the identification, acquisition, development, and/or implementation of models, prototypes, and simulations to accomplish system analysis activities. The Contractor shall develop products such as engineering documentation necessary for the development and operation of the models/mockups.

3.74 Electrical Engineering Design, Analysis and Test - Electrical Power

The Contractor shall provide electrical engineering skills to support the design, development, test, and evaluation of power systems for launch vehicles, space vehicles, satellites, payloads, science experiments, and associated ground support equipment for current and future programs, projects, and activities. The Contractor shall deliver products associated within areas such as power supply design, power quality analysis, battery design and analysis, power system sizing analysis, derating analysis, solar array sizing and selection, power distribution system design and analysis, high voltage power

supply design, circuit protection selection, and power system testing. Example products include schematics and design drawings, analysis reports, test reports, power system models and simulations, prototype hardware, flight hardware, and ground support equipment. In some cases, real-time support for investigation of flight system anomalies shall be required. The Contractor shall provide support for and generate products associated with research and new technology development for power system design, analysis, and test areas.

3.75 Electrical Engineering Design, Analysis and Test -Electrical Integration

The Contractor shall provide electrical engineering skills in the area of Electromagnetic Environmental Effects (E3) and Electrical Integration to support the design, analysis, and testing of space systems, propulsion systems, space transportation systems, scientific instruments, ground support equipment, and special equipment for current and future programs or projects. The Contractor shall deliver products in areas such as: electrical design and integration, electro-mechanical design, analysis and assembly, power quality, electrical integration (cable design, cable interconnect diagrams, electrical system schematics), electromagnetic environmental effects (EMI/EMC, lightning, electrostatic discharge). The Contractor shall provide electrical engineering technician skills that include cable fabrication and Computer-Aided Design (CAD) for cables and schematics. Examples of these products include the research, design, development, implementation, assembly, verification, test, analysis, and modeling and simulation of: prototype hardware, flight hardware, ground hardware, payloads, subsystems, science investigation hardware, and analytical tools. The Contractor shall provide support for and generate products associated with research and new technology development for electrical engineering design, analysis and test in the area of E3 and Electrical Integration.

3.76 Electrical Engineering Design, Analysis and Test - EEE Parts and Packaging

The Contractor shall provide electrical engineering skills to support the design, development, analysis, and testing of space systems, propulsion systems, space transportation systems, scientific instruments, ground support equipment, and special equipment for current and future programs or projects. The Contractor shall deliver products in the areas of electrical design and integration, electro-mechanical design, Electrical, Electronic and Electromechanical parts (EEE Parts), electronic packaging, electrical/electronic failure analysis, control and signal conditioning electronics, low power amplifiers, instrumentation, data acquisition systems hardware and software, control system design and test, sensor micro-fabrication, harsh environment sensor research, precision rate and position environmental control systems, optical sensor research, structural health monitoring research, avionics emulators (real-time and non real-time). Examples of these products include the research, design, development, verification, test, analysis, and modeling and simulation of: prototype hardware, flight hardware, ground hardware, payloads, subsystems, science investigation hardware, and analytical tools. The Contractor shall provide support for and generate products associated with research and new technology development for electrical engineering design, analysis and test in the areas of electronic packaging research and technical support for Electrical, Electronic and Electro-mechanical (EEE) parts, Parts Assurance, and failure analysis.

3.77 Structural and Mechanical Design and Analysis - Mechanical Design

The Contractor shall provide structural and mechanical skills to support the design of space systems, including but not limited to scientific experiments, fluidic and pressure systems, ground support equipment, and special test equipment for current and future programs or projects. Design support shall include integration and support of testing activities (e.g., interfacing with manufacturing, hardware integration, and testing disciplines). The Contractor shall deliver products in areas such as the design of: structures, mechanical devices, ground support equipment, special test equipment, tooling, mechanisms, composite designs, as well as CAD standards and processes. Structural and mechanical design products shall be required for all phases of flight, ground and research projects such as conceptual design, primary and secondary structure detailed design, mechanical drawings, 3D models, test articles, and breadboard units. The Contractor shall provide support for and generate products associated with research and new technology development for structural and mechanical design areas.

3.78 Structural and Mechanical Design and Analysis - Mechanical Analysis

The Contractor shall provide mechanical skills to support the analysis of space systems, including but not limited to space transportation systems, scientific experiments, payloads or instrument hardware, ground support equipment, special test equipment for current and future programs or projects. Analysis support shall include detailed stress and dynamic analyses and the support of structural test activities. The Contractor shall deliver products in areas such as analysis of: structures, mechanical devices, ground support equipment, special test equipment, tooling, mechanisms, composite designs, strength (stress) analysis, fatigue analysis, fracture mechanics analysis, linear and nonlinear stress and dynamics analyses, component loads analysis, vehicle coupled loads analysis, vibroacoustic analysis, microgravity analysis, shock, payload isolation analysis. The Contractor shall deliver products including detailed structural analysis reports, computer models, test criteria and requirements (e.g., static load, vibration, acoustic, and shock), and other analysis related data applicable for hardware structural verification activities. Structural and mechanical analysis products shall be required for all phases of the program. The Contractor shall also provide support for and generate products associated with research and new technology development for structural and mechanical analysis areas.

3.79 Hardware and Hardware/Software Integration and Test - Avionics and Software Ground Systems Test

The Contractor shall provide hardware and hardware/software integration engineering skills to support the real-time modeling and simulation design, development, test, and evaluation of real-time hardware-in-the-loop facilities such as the System Integration Laboratory (SIL) or System Integration Test Facility (SITF). The Contractor shall provide products such as: system integration of lab automation tools and displays, avionics and avionics software models; cable interconnect diagrams; cable harness drawings; grounding diagrams/analysis; avionics emulators and associated breakout boxes for both data and power; integrated engineering analysis for voltage drop and grounding systems (anchoring of model to flight data); hardware integration analysis; design integration; analytical tool development; and simulation and modeling.

3.80 Hardware and Hardware/Software Integration and Test - Flight Systems Integration and Test

The Contractor shall provide hardware and hardware/software integration and test engineering skills to support the design, development, test and evaluation of flight systems. The Contractor shall deliver products such as: system verification and validation; test plan, procedure, and report documentation; development of test scripts; review of program and project documents; testing of development and flight hardware; development and use of data reduction and manipulation tools; data acquisition, software loading/configuration; data archiving and data analysis; evaluation of test data and investigation of potential anomalies.
The contractor shall provide hardware and hardware/software integration and test skills to support launch programs requiring software and hardware integration. The Contractor shall deliver products such as: maintenance, fabrication, integration, operation, assembly, and testing of project hardware and software; system verification and validation; test plan, procedure, and report documentation; development of test scripts; review of program & project documents; testing of development and flight hardware; development and use of data reduction and manipulation tools; data acquisition, software loading/configuration; data archiving and data analysis; evaluation of test data and investigation of potential anomalies; and obtain and maintain pertinent safety certifications..
The Contractor shall provide hardware and hardware/software integration and test skills to support mechanical components. The Contractor shall deliver products such as: development and implementation of test procedures; vacuum and pressure leak and proof testing; mechanical fabrication; mechanical assembly; tubing fabrication; flare and compression fittings; data acquisition systems; operation of helium mass spectrometers; proof and leak tests with test articles under cryogenic cooling; cryogen handling, piping and flow.

3.81 Thermal and Fluids Design, Analysis and Test - Fluid Systems Design Development and Test

The Contractor shall provide fluids systems design, analysis, and testing skills to support human space exploration missions through the sustainment and evolution of International Space Station (ISS) Environmental Control and Life Support flight systems The Contractor shall provide products such as environmental acceptance tests of spare ISS ECLS flight equipment, and preparation of flight equipment for delivery. The Contractor shall provide engineering and integral technician support to manufacture, assemble, operate, and maintain ground based test systems and test stands used as aids to sustain ISS ECLS systems and the ISS Urine Processor Assembly (UPA). The Contractor shall provide engineering and integral technician support to manufacture, assemble, operate, and maintain ground-based test systems and test stands to demonstrate and assess the evolution of areas such as : ISS ECLS atmosphere resource recovery and environmental monitoring components, subsystems, and systems; advanced, next generation ECLS oxygen recovery components, subsystems, and systems; and advanced, pressure-swing oxygen concentrator components, subsystems, and systems.

Pages 48 through 51 redacted for the following reasons:
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