

**ATTACHMENT J-1**

**Performance Work Statement (PWS)**

**Introduction**

This Performance Work Statement (PWS) broadly defines the requirements for Marshall Engineering Technicians and Trades Support (METTS) Services provided to the Marshall Space Flight Center (MSFC) by the Contractor. These services cover a wide range of engineering technicians and other trade skills to perform testing; ground and space based research; test operations; data analysis; machine and electrical shop operations; and other technical activities. This contract will include professionals to oversee and manage the work performed by the technical staff.

The Contractor's work on these activities is controlled by means of a Mission Services portion for work that the Government intends to remain on the contract for its duration, and by an IDIQ portion implemented through the issuance of Task Orders (TOs) for work that the Government cannot adequately define. The Mission Services contract and TOs require the Contractor to coordinate with the MSFC Directorates/Offices that exercise MSFC responsibility for the activities. MSFC Directorates and Offices are responsible for the technical excellence of MSFC managed projects, MSFC in-house projects, and technology development and application initiatives. MSFC Civil Service personnel are also deployed in support of these projects and frequent coordination between Contractor personnel and Civil Service personnel is likely. This PWS is constructed in accordance with the Level 3 Work Breakdown Structure (WBS) provided in Attachment J-3.

A Contracting Officer's Technical Representative (COTR) will be appointed for technical oversight and direction on this contract. Due to the size and complexity of this contract, Technical Monitors (TM) will also be appointed to assist the COTR in the day-to-day functions of the major areas of the contract (the Government anticipates approximately 4 civil service Technical Monitors to cover section 2.0). In addition, each IDIQ order will have a Technical Monitor appointed. This may be an existing TM or a new TM depending on the nature of the order. The TM duties will include overseeing the technical work of the Contractor in their respective work areas, ensuring that the COTR is informed of problems, and advising the COTR with respect to Contractor performance.

**Scope**

The Contractor shall provide all the necessary management and personnel required to perform the technical and business tasks broadly defined by the Mission Services contract and TOs issued by the Government in accordance with Clause H.4 and H.5 of this solicitation. Responses to any Task Order Requests will be in the form of a Task Order Plan (TOP). The TOPs shall be provided in accordance with Data Requirements Description (DRD) 1163MA-002, Task Order Plan. A graphical depiction of the Task Flow Process can be found in Attachment J-4. With the exception of the property listed in Clause G.6 and Attachment J-9, the Contractor shall procure all materials, supplies, incidental services, tools, and equipment necessary for the accomplishment of this PWS. Any equipment purchases must be coordinated with the COTR, Technical Monitors, and Contracting Officer and shall not include any equipment \$1M in value or higher. The Contractor shall only be enabled to purchase equipment to meet the requirements of this contract. The Contractor shall comply with NASA/MSFC regulations, policies, directives, procedures, and standards when performing all work under this PWS.

## 1.0 Management

**1.1 Contract Management.** The Contractor shall provide the planning, coordination, technical direction, and surveillance of the activities necessary to ensure disciplined performance of work and timely and efficient application of resources for the accomplishment of all Mission Services contract work and TOs issued under the contract. The Contractor shall be responsible for maintaining communication with each supported organization and alerting the Contracting Officer's Technical Representative (COTR) and Contracting Officer (CO) immediately of any problems that would prevent meeting established objectives. A Management Plan shall be provided in accordance with DRD 1163MA-001 Management Plan.

The Contractor shall provide an Organizational Conflict of Interest (OCI) Avoidance Plan in accordance with DRD 1163MA-009.

1.1.1 Task Management - The Contractor shall provide planning, coordination, and surveillance of overall project activities to ensure disciplined performance of work and the timely and efficient application of resources necessary for the completion of all tasks of this PWS. The Contractor shall make adjustments in the application of resources to specific WBS elements, as demands and priorities require, in consultation with the COTR. The Contractor shall develop a TOP for Task Order Requests received from the Government in accordance with DRD1163MA-002, Task Order Plan. The Contractor shall commence work once the TOP has been issued as a Task Order by the Contracting Officer.

The Contractor shall plan and conduct an informal progress review (format to be agreed upon between Contractor and COTR) scheduled as coordinated with COTR. All work being accomplished shall be addressed, by WBS element and/or Task Order, in these progress reports.

(b)(4)



1.1.2 Contractor Employee Center-wide Training and Certifications – MSFC requires certification for certain center-wide job functions (e.g., crane operator, fork truck operator, etc.; reference MWI 3410.1, "Personnel Certification Program"). For these job functions, the Contractor shall ensure that their workforce is properly certified to the MSFC standards prior to conducting any work requiring these job functions.

When performing work or operating equipment in direct support of NASA MSFC, within the Contractor's quality management system, including requirements for Industrial Safety (See DRD 1163SA-001), the Contractor shall establish, implement, and maintain a training and certification program as required to accomplish the requirements of this PWS, reference DRD 1163QE-001. Monitoring of these training, qualification, and certification processes will be as specified in J-20, NASA MSFC Safety & Mission Assurance Surveillance Plan.

The Contractor shall keep its employees trained and certified in order to properly perform tasks requiring certification. The Contractor shall ensure all employee certifications are recorded in the MSFC CERTRAK database. Training methods include formal training and on-the-job training in order to maintain all employee levels of technical competence. Any Contractor employee authorized to operate a given test instrument or piece of equipment shall be trained on the current operating techniques of the equipment. Any Contractor request for unique training related to the specific job functions shall be approved by the COTR. Training costs approved by the COTR shall be charged to the WBS element to which it specifically supports.

The Contractor shall provide a comprehensive plan describing how they will manage all certification requirements on this contract. The certification plan shall be provided in accordance with DRD 1163SA-002, Personnel Certification Plan.

**1.1.3 Contractor Employee Specialized Training and Unique Certifications** – In direct support of facility unique MSFC operations under MSFC processes (facility unique OWIs, SOPs, etc.), the Contractor shall obtain specialized training and facility unique certification in all areas where required for performing a WBS element, or as directed by the COTR. The Contractor employees shall perform work in areas where certification is required only after certification is obtained, or under the supervision of an employee who has obtained certification. For unique technical capabilities where a certification program does not exist, the Contractor shall develop a certification program, to be listed in and tracked through the MSFC SHE CERTRAK database, within 90 days of contract award. All employees working in areas requiring unique certifications shall be certified and listed in the CERTRAK database within 180 days of contract award. The Contractor shall maintain all required certifications throughout the contract. As examples, within 90 days of contract award, the Contractor shall develop certification plans which will encompass certification requirements for operation of all vacuum, thermal vacuum and turbine technology, pressure systems, and instrumentation and data collection.

For facility unique operations requiring certification, the Contractor shall designate employee(s) who will serve as certification granting authorities for their specific areas of expertise. These employee(s) shall be technically competent in the areas for which they serve as the certification granting authority and approved by the COTR. Within 90 days after completion of the certification plans, all certification requirements defined in these plans, along with a list of all individuals certified to these requirements, shall be included in the MSFC SHE CERTRAK database. The MSFC SHE CERTRAK database shall be the official record of certification and the Contractor shall maintain this record to reflect current status.

The Contractor shall address specialized and unique certifications in their comprehensive certification plan. The certification plan shall be provided in accordance with DRD 1163SA-002, Personnel Certification Plan.

**1.1.4 Monthly Status Reports** - The Contractor shall support a formal monthly status meeting and provide a Monthly Status Report broken out by WBS element and/or Task Order, in accordance with DRD 1163MA-004, Monthly Status Report. The Monthly Status Report shall include accomplishments during the month, work upcoming for the next month, problems encountered during the reporting month, new discoveries and/or inventions. In addition, the report shall include summaries of training, travel, overtime, consulting, procurements, and commercial work. This Monthly Status Report shall be provided to the COTR on, or before, the 10th day of each month and will cover the previous month's status. The Monthly Status Report shall not exceed two pages for each WBS element. The Contractor shall produce minutes for

each of the meetings and these minutes shall include copies of all presentation charts, if applicable, and shall provide special cost analyses and projection reports, as required. Minutes shall be provided to the COTR within 5 days of meeting date.

1.1.5 Contractor Employee Clearance Document - For Contractor badged employees who no longer require access to MSFC, the Contractor shall provide verification these employees have properly cleared all accounts when the access is no longer needed. The Contractor shall establish and maintain the document in accordance with DRD1163MA-006, Contractor Employee Clearance Document.

1.1.6 Position Risk Designation for Non-NASA Employee - The position risk designation for non-NASA employees provides information necessary to determine the type of investigation required and how closely an individual is screened for a position. The Contractor shall provide the required information in accordance with DRD1163MA-007, Position Risk Designation for Non-NASA Employee.

1.1.7 Quality Systems Management - The Contractor's quality system shall be compliant to SAE AS9100 (excluding Section 7.3 "Design and Development") by transitioning from the existing quality management system within 120 days after the contract award date. The Contractor shall be verified as compliant by a MSFC audit of their quality management system to the requirements of MWI 5330.1. The Contractor shall detail their quality management system in a quality plan prepared in accordance with DRD 1163QE-001, Quality Management System Plan. The Contractor's quality management system shall be sufficiently broad in scope and cover all aspects of the technical support, testing support, and fabrication/assembly requirements of this PWS.

NASA MSFC shall approve all quality controlled special processes prior to those processes being performed to provide products to NASA and/or any other customer. Processes previously approved will be considered acceptable for use and shall be reviewed again after those documented processes have been transitioned into the Contractor quality management system format. Transition time periods for process re-approval shall be provided by NASA through the COTR.

## **1.2 Planning and Control**

1.2.1 Work Management - The Contractor shall provide surveillance and management oversight to meet the operations of each WBS element. Each WBS element consists of diverse technical activities with unique work skills. Most WBS elements have different planning, implementing, and progress tracking systems that maintain work flow in specific work areas. The systems or processes may be manual, electronic, or both and may consist of meetings daily, weekly, or monthly.

The Contractor shall coordinate, report, and ensure the timely completion of the work specified. This encompasses the planning, coordination, technical direction, and surveillance of all activities necessary to execute all work.

- a) The Contractor shall provide the overall management effort required to integrate technical and programmatic functions.
- b) The Contractor shall ensure the technical excellence, cost effectiveness, and timeliness of all required work and deliverable products.

- c) The Contractor shall evaluate new or used equipment to assure compatibility with directed tasks. This shall include travel to Government depots or to equipment manufacturers' or distributors' plants, as required.

1.2.2 Property Management - The Contractor shall establish and maintain a report in accordance with DRD 1163LS-001, Government Property Management Plan for all equipment, tools, etc., provided by the Government for use by the Contractor in the performance of contracted effort, and for which the Contractor has been given physical custody.

1.2.3 Technology Reports - 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. Technology reports shall be prepared in accordance with DRD 1163CD-002, Technology Reports.

1.2.4 Security and Information Technology - The Contractor shall incorporate appropriate safeguards to ensure the availability, integrity, and confidentiality of information and information technology resources utilized in support of this contract. Safeguards shall be commensurate with the sensitivity or criticality of the resources and shall be sufficient to minimize the risk to NASA's mission and credibility.

The contractor shall be responsible for information and information technology (IT) security when physical or electronic access to NASA's computer systems, networks, or IT infrastructure is required or when information systems are used to store, generate, process or exchange information with NASA or on behalf of NASA, regardless of whether the information resides on NASA's or a contractor's information system. At the completion of the contract, the contractor shall return all NASA information and IT resources provided to the contractor during the performance of the contract and certify that all NASA information has been purged from contractor-owned systems used in the performance of the contract. The contractor shall submit a Contractor Information Technology Security Program Plan (CITSP) in accordance with DRD 1163CD-001.

1.2.5 Contractor Employee Travel - The Government will reimburse the Contractor for any necessary travel expenses, in accordance with the Federal Travel Regulations. The Government shall not be charged with travel expenses, unless the travel is coordinated and concurred, in writing, by the COTR prior to the beginning of the travel. Travel costs shall be charged to the WBS to which it specifically supports.

1.2.6 Contractor Employee Overtime - The Contractor shall work a five-day work week and define their work schedule within Marshall's normal work hours (6:30 AM through 5:30 PM) unless an alternate work schedule has been approved by the COTR.

Notwithstanding Clause B6, "Premiums for Scheduled Overtime," overtime for employees under WBS elements 1.0, 2.0, and 3.0 shall be coordinated with the COTR, and receive concurrence from the COTR, prior to the commencement of any overtime work. Overtime costs shall be charged to the WBS to which it specifically supports.

1.2.7 Badged Employee and Remote IT User Listing - The Contractor shall establish and maintain a report listing of all Contractor personnel working onsite at MSFC in accordance with DRD1163MA-005, Badged Employee and Remote IT User Listing.

1.2.8 Commercial Work - Upon written permission by the Contracting Officer, the Contractor may use the facilities provided under this contract for a rental fee for commercial work.

When requesting permission to use the facilities, the Contractor shall provide the following information with its request:

- 1). Description of the work to be accomplished
- 2). Estimated man hours
- 3). Period of Performance
- 4). Name of the customer
- 5). Amount the customer is paying the Contractor

If granted, approval to use the Government facilities will be provided on a non-interference basis with other Government work. Authorizing such use of the facilities does not waive any rights of the Government to terminate the Contractor's right to use the facilities.

The Contractor shall indemnify the Government and hold it harmless against claims for injury to persons or damage to property of the Contractor or others arising from the Contractor's possession or use of the facilities. A copy of the indemnification notice shall be included in each subcontract issued by the Contractor. The Contractor is fully liable for all damages to Government property being used for commercial purposes.

Rental rates for the facilities shall be 10 percent of each individual commercial contract. However, the Contractor may use, with the written approval of the COTR, the rates set forth in FAR 52.245-9, "Use and Charges" if the Contractor determines 10 percent to be inequitable. The Contractor shall credit future payment vouchers for rental costs incurred.

1.2.9 Contractor Procurements – Per NFS 1852.245-71, all items procured under this contract are accountable to the Government and the contractor assumes user responsibilities. The contractor shall establish a record of property procured using contract funds and transfer to the Government within 5 working days after receipt of the property. The contractor will use DD1149 (or equivalent) along with the contractor's Purchase Order (PO) and provide to the installation central receiving area prior to delivery by the vendor. The contractor will be accountable and liable for the property until it is transferred to the Government's accountability (Reference MWI 4200.1, "Equipment Control" and NFS 1852.245-71).

1.2.9.1 Operations - The Contractor shall procure general operating supplies, materials, tools and equipment necessary for the accomplishment of this PWS. Any equipment purchases must be coordinated with the COTR, Technical Monitors, and Contracting Officer and shall not include any equipment \$1M in value or higher. Procurement costs shall be charged to the WBS element to which it specifically supports.

1.2.9.2 Direct - The Contractor shall procure direct materials (e.g. aluminum, titanium, stainless and carbon steels, etc) and incidental services (e.g. necessary for completion of fabrication shop customer orders) as necessary to accomplish requirements of this PWS.

**1.3 Safety, Health and Environmental.** The Contractor shall establish and implement an industrial safety, health, and environmental program and provide a plan in accordance with

DRD 1163SA-001, Safety, Health, and Environmental (SHE) Plan. The Contractor's industrial safety, health, and environmental program shall incorporate the following:

- a) Management leadership and employee involvement
- b) System and worksite analysis
- c) Hazard prevention and control
- d) Safety and health training
- e) Environmental compliance

The Contractor shall report mishaps and safety statistics in accordance with DRD 1163SA-002, Mishap and Safety Statistics Report.

The Contractor shall follow all MSFC safety, health, and environmental regulations. Contractor personnel will engage in hazardous operations including, but not limited to, hazardous waste generation, oxygen deficiency, high voltage, confined space entry, machine shop operations, overhead crane operations, forklift operations, aerial lift operations, cryogen handling, high pressure and cryogenic systems, vertical and boom aerial lift operations, high amplitude noise exposure, and high rpm rotating objects. The Contractor shall produce, and keep current, a Job Hazard Analysis for each employee. The Contractor shall also be responsible for maintaining the data associated with each hazardous operation in MSFC's Inventory of Hazardous Operations (IHOPS) database. This requires evaluation and update of this database annually as a minimum.

In addition, the Contractor shall perform a monthly inventory to ensure all chemicals have Material Safety Data Sheets (MSDS) and are properly bar coded, inventoried, and stored per MSFC Center (MWI 8550.5) and ISO14001, or latest version, guidelines. The Contractor, as requested, shall provide an oral report at NASA team safety meetings verifying that an inventory has been completed, all MSDS notebooks have been updated, and all chemicals are properly bar coded, inventoried, and stored per MSFC Center (MWI 8550.5) and ISO14001, or latest version guidelines.

All Contractor personnel shall attend an established monthly safety meeting and document their attendance. The Contractor shall document the safety meeting attendance of employees in MSFC's Supervisor's Safety Webpage (SSWP). In addition, all Contractor supervisory personnel shall conduct a monthly safety walk through of areas under their responsibility, report their findings in SSWP, and close findings within 30 days.

**1.4 Financial Reporting.** The Contractor shall utilize a financial reporting system in accordance with the NFS 1852.242-73, NASA Contractor Financial Management Reporting and NASA Policy Guide (NPG) 9501.2C, NASA Contractor Financial Management Reporting. The Contractor shall submit financial management reports in accordance with DRD 1163 MA-003, Financial Management Report (533M). The 533 will be reported at the Task and WBS Level(s).

This report shall summarize standard labor hours and costs, overtime labor hours and costs, Other Direct Cost (ODC) incurred, travel, training, procurements (including materials), and commercial work for each WBS by NASA Project funding code, or reporting category, as directed by the COTR.



## **2.0 Mission Services Technicians and Trades Support**

**2.1 Materials Testing.** The Contractor shall perform materials testing to support NASA and MSFC missions and objectives, and shall support engineering oversight of these tests. This testing includes, but is not limited to, ignition and combustion testing on metallic and nonmetallic materials, toxic offgas testing on materials and components, thermal vacuum stability outgassing testing on materials, and advanced materials testing supporting space exploration.

**2.1.1 Promoted Ignition-Combustion Testing** - The Contractor shall perform the Upward Flammability of Materials in Gaseous Oxygen (GOX) testing of materials in a high-pressure gaseous oxygen environment, with both the Elevated Temperature and the Ambient Temperature Promoted Ignition-Combustion Testers. These tests are defined by Test 17 of NASA-STD-6001, *Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments That Support Combustion*, and any variations or revisions thereof. Test pressures range from ambient pressure to 10,000 psi, with temperatures ranging from ambient to 2,200°F. The Contractor shall lead the effort to produce any standards related to the elevated temperature test. The Contractor shall be responsible for ensuring that all equipment is properly calibrated prior to beginning a test. Any test equipment not properly calibrated shall be replaced with calibrated equipment prior to performing any test. The Contractor shall validate the test data and ensure the test data correlates with test data generated by other sources. Any test data that cannot be validated or correlated with the test data from other sources shall be immediately brought to the attention of the COTR. This task also involves data analysis, and inputting all test data and results into the Materials and Processes Technical Information System (MAPTIS) database.

**2.1.2 Flammability Testing** - The Contractor shall perform Flammability and Wire Insulation Flammability Testing of materials in air and in oxygen enriched atmospheres. These tests are as defined by Tests 1, 4 and 10 of NASA-STD-6001 and any variations or revisions thereof. The Contractor shall lead the effort to produce any standards related to the elevated temperature test. The Contractor shall be responsible for ensuring that all equipment is properly calibrated prior to beginning a test. Any test equipment not properly calibrated shall be replaced with calibrated equipment prior to performing any test. The Contractor shall validate the test data and ensure the test data correlates with test data generated by other sources. Any test data that cannot be validated or correlated with the test data from other sources shall be immediately brought to the attention of the COTR. This task also involves data analysis, and inputting all test data and results into the Materials and Processes Technical Information System (MAPTIS) database.

**2.1.3 Liquid and Gaseous Oxygen Mechanical Impact Testing** - The Contractor shall perform Mechanical Impact for Materials in Ambient Pressure Liquid Oxygen (LOX) testing and Mechanical Impact for Materials in Variable Pressure LOX and GOX testing for materials, as defined by Test 13A and 13B of NASA-STD-6001 and any variations or revisions thereof. The test temperature at ambient pressure is approximately -297°F. The variable pressure test utilizes test temperatures from -297°F to +1,000°F, and test pressures from ambient to 10,000 psi. The Contractor shall lead the effort to produce any standards related to the elevated temperature test. The Contractor shall be responsible for ensuring that all equipment is properly calibrated prior to beginning a test. Any test equipment not properly calibrated shall be replaced with calibrated equipment prior to performing any test. The Contractor shall validate the test



data and ensure the test data correlates with test data generated by other sources. Any test data that cannot be validated or correlated with the test data from other sources shall be immediately brought to the attention of the COTR. This task also involves data analysis, and inputting all test data and results into the MAPTIS database.

2.1.4 Advanced Materials Ignition/Combustion Testing - The Contractor shall perform advanced materials ignition testing. These include: Adiabatic Compression (Pneumatic Impact) for Materials in ambient and high pressure gaseous oxygen environments, as defined by Test 14 of NASA-STD-6001; Oxygen Index Testing of materials to determine the minimum oxygen concentration that will support the combustion of a material, as defined by the American Society for Testing and Materials (ASTM) document ASTM D2863; Multimodal Friction Ignition Testing; Heat of Combustion Testing; Wire Arc Tracking Testing; Puncture Testing; Reactivity in Aerospace Fluids Testing; and Autogenous Ignition Temperature Testing of materials to determine the temperature at which a material will spontaneously ignite without the presence of a spark or open flame, as defined by ASTM G72. This task shall also include the development and utilization of new test equipment and the development of new test methods. The Contractor shall lead the effort to produce any standards related to the elevated temperature test. The Contractor shall be responsible for ensuring that all equipment is properly calibrated prior to beginning a test. Any test equipment not properly calibrated shall be replaced with calibrated equipment prior to performing any test. The Contractor shall validate the test data and ensure the test data correlates with test data generated by other sources. Any test data that cannot be validated or correlated with the test data from other sources shall be immediately brought to the attention of the COTR. This task also involves data analysis, and inputting all test data and results into the MAPTIS database.

2.1.5 Thermal Vacuum Stability (Outgassing) Testing

The Contractor shall perform Thermal Vacuum Stability Testing of materials to determine the characteristics of materials when exposed to vacuum conditions, as defined by the Johnson Space Center (JSC) document SP-R-0022/ASTM-E-595, and any variations thereof. The Contractor shall lead the effort to produce any standards related to the elevated temperature test. The Contractor shall be responsible for ensuring that all equipment is properly calibrated prior to beginning a test. Any test equipment not properly calibrated shall be replaced with calibrated equipment prior to performing any test. The Contractor shall validate the test data and ensure the test data correlates with test data generated by other sources. Any test data that cannot be validated or correlated with the test data from other sources shall be immediately brought to the attention of the COTR. This task also involves data analysis, and inputting all test data and results into the MAPTIS database.

2.1.6 Toxic Offgassing (Toxicity) Testing - The Contractor shall perform Toxic Offgassing Testing of materials and assembled articles. Toxicity testing includes the *Determination of Combustion By-Products from Upward Flame Propagation Testing*, *Determination of Offgassed Products* and *Determination of Offgassed Products from Assembled Articles*. These tests are defined by Tests 7 and 16 of NASA-STD-6001 and any variations or revisions thereof. The Contractor shall lead the effort to produce any standards related to the elevated temperature test. The Contractor shall be responsible for ensuring that all equipment is properly calibrated prior to beginning a test. Any test equipment not properly calibrated shall be replaced with calibrated equipment prior to performing any test. The Contractor shall validate the test data and ensure the test data correlates with test data generated by other sources. Any test data

that cannot be validated or correlated with the test data from other sources shall be immediately brought to the attention of the COTR. This task also involves data analysis, and inputting all test data and results into the MAPTIS database.

**2.1.7 Test Sample Verification and Preparation** - The Contractor shall perform a complete analysis on each test sample received for the testing to ensure that the information is complete and accurate. The Contractor shall verify that each sample sent for testing has all of the information needed for identification, and that all of the information is accurate. This sometimes requires coordination with the test requester, the materials supplier, the manufacturer, and other sources. The Contractor shall also prepare each required test sample in the form in which it is needed, including substrate preparation, sample curing and sample sizing. The collected information shall be entered into the MAPTIS database. This database is currently used by the Government for the management and tracking of all work under PWS 2.1. The Contractor shall receive notification from the requester indicating if the sample and data are to be labeled as one of the following: Sensitive but Unclassified (SBU); Proprietary; International Trafficking in Arms (ITAR); Export Administration Regulations (EAR) or other security related classification. The data shall be appropriately labeled. The samples and data shall be tracked and protected in accordance with NASA guideline and procedures.

**2.1.8 Engineering Analysis of Materials Testing, Data, and Results** - The Contractor shall perform engineering analyses for the areas covered under this PWS element and any Task Orders developed. This effort includes analysis of test setups, test procedures, and data generated by the testing. These engineering analyses shall ensure that test data is generated using existing organizational instructions, and the data is either consistent with previous test data or valid explanations exist why anomalies have occurred. The Contractor shall receive instructions from the requester indicating if the sample and data are to be labeled as one of the following: Sensitive but Unclassified (SBU); Proprietary; International Traffic in Arms Regulations (ITAR); Export Administration Regulations (EAR); or other security related classification. The data shall be appropriately labeled. The samples and data shall be tracked and protected in accordance with NASA guideline and procedures.

**2.1.9 Test Innovations** - The Contractor will strive to provide innovations and improvements to the existing ways of performing tasks and interpreting data for the testing covered under this PWS. These tasks include analysis of MSFC produced test data, analysis of test data from other sources, application requests and systems evaluations. The Contractor shall maintain sufficient skill and knowledge of the test capabilities to provide technical expertise and guidance to MAPTIS database personnel for data approval and data entry.

**2.1.10 Oxygen Compatibility Assessments** - The Contractor shall perform oxygen compatibility assessments. These assessments are conducted for the safe operation of oxygen systems for NASA and/or private industries. The Contractor shall perform an Oxygen Compatibility Assessment, also known as Oxygen Hazards Analysis, for an oxygen system or component. Upon completion, the Contractor shall provide a complete analysis in final presentation form as agreed upon with the COTR. The Contractor shall maintain sufficient skill and knowledge of an Oxygen Compatibility Assessment to provide necessary technical guidance or expertise.

2.1.11 Development of Internal, Scientific and Data Documentation and Publications

The Contractor shall create scientific, technical and data documents, and internal documentation and publications as needed and as directed by the COTR. The documents required include research papers to be published by scientific organizations, periodical sections, newspaper articles, failure analyses, problem assessments, problem resolutions, anomaly investigations, preferred materials applications documents, data explanation documents, technical evaluation documentation, and other similar scientific and engineering documentation. The Contractor shall also create needed internal documentation, which include Organizational Instructions, safety documents and communications documentation. The Contractor shall work with the MSFC printing office to ensure that all documents are in the proper format, printed properly and delivered when required. The Contractor shall also be responsible for supporting the distribution effort of all documents created under this task.

2.1.12 Materials Research and Special Studies - The Contractor shall use supplemental research tasks to fill any available time when employees and equipment are not fully utilized for testing and analysis in WBS elements 2.1.1 through 2.1.11, or for commercial work. The Contractor shall conduct materials research in areas related to this PWS and have research tasks ongoing at all times. The Contractor shall also perform research and special studies for other materials and processes disciplines, when directed by, or with the approval of, the COTR. These research and special studies shall enhance the general knowledge base of the scientific community. The Contractor shall publish the research in readily available publications and in a format used by the specific publication or by the scientific community. Acceptable publications include periodicals and standards published by nationally recognized organizations, such as the Society of Automotive Engineers (SAE), ASTM International, the International Organization for Standardization (ISO), and the American Society for Materials (ASM) International, or other as approved by the COTR. The Contractor shall, when directed by the COTR, present these publications at meetings, conferences, symposia, etc.

**2.2 ETF/EFDTF Test Support.** The Contractor shall operate and maintain MSFC's Environmental Test Facility (ETF) and Experimental Fluid Dynamics Test Facility (EFDTF). Environmental and fluid dynamics test activities are planned and executed in these facilities to support the design, development, certification, and operation of flight structures, payloads, systems, and components.

Testing performed at the ETF requires frequent, around-the-clock operations. During these periods, with approval of the COTR, alternate work schedules shall be established to support weekend and second and third shift operations.

2.2.1 Planning and Control - The Contractor shall ensure the planning, coordination, technical direction, and surveillance of all activities necessary to execute all Customer Test Requests (CTR) issued for these facilities. In doing so, the Contractor shall possess and provide technical expertise on all ETF test chambers and EFDTF facilities. Currently, the Government uses a Test Preparation Sheet (TPS) (reference ET01-PRO-OWI-003, Test Preparation Sheet Instructions) to direct the contractor to perform technician work. The Contractor shall:

- a) Oversee test operations and perform personnel scheduling to maintain a sufficient number of Contractor employees overseeing the facilities and test equipment to complete testing safely and on schedule.

- b) Coordinate contract personnel to ensure an adequate skill mix when supporting frequent, around-the-clock testing in the Environmental Test Facility.
- c) Maintain and track a sufficient inventory of supplies, materials, tools and equipment required to perform the requirements of PWS 2.2.
- d) Ensure all technician personnel have the autonomy to immediately report testing anomalies, chamber concerns, or operational concerns directly to the Civil Service Point of Contact (POC).
- e) Support Civil Service personnel at all Test Readiness Reviews and other customer meetings as requested by the COTR.
- f) Ensure the technical excellence, cost effectiveness, and timeliness of all required work and deliverable products.
- g) Ensure that when performing second or third shift operations there is a senior, designated technical person in a position of authority.

The Contractor shall support MSFC personnel in planning facility maintenance and chamber, equipment, and facility upgrades to complement customer support. This shall include, but not be limited to, test facility, chamber, and equipment installation and modification, test facility, chamber, and equipment relocation, test facility, chamber, and equipment refurbishment, and test, chamber, and equipment facility teardown.

The Contractor shall be responsible for maintaining a clean and organized work environment within ETF and EFDTF work areas. This shall include supporting major, facility-wide cleaning actions.

**2.2.2 Maintenance and Repair** - The Contractor shall be responsible for implementation of the preventive maintenance program. It is anticipated that preventive maintenance will primarily be performed during non-test periods. The Contractor shall perform and document preventive maintenance per procedure requirements.

**2.2.3 Test Coordination and Scheduling** - The Contractor shall be responsible for scheduling tests and providing cost information necessary for the ETF and EFDTF business office to provide the customer with a cost estimate for testing. The Contractor shall be the initial point of contact for customers requesting testing in the ETF and serve as a liaison between customers and ETF POCs. The Contractor shall make an initial determination of which test chamber best fits the customer's needs, then coordinate testing arrangements between the MSFC chamber POC and the customer. The Contractor shall maintain all ETF test schedules and resolve any conflicts between test schedules. The Contractor shall be responsible for providing a Customer Test Request (CTR) to potential customers, receiving completed CTRs from the customers, and providing CTRs to chamber POCs. Using the CTR, the chamber POC generates a TPS to initiate the necessary work to conduct the test. The Contractor shall support Civil Service personnel at all Test Readiness Reviews and other customer meetings, as requested. The Contractor shall be responsible for coordinating access to MSFC between the customer and MSFC Security. The Contractor shall conduct guided tours for potential customers and tour groups as requested by Civil Service management.

The Contractor shall maintain a master ETF, EFDTF, and Structural Test Facility combined testing schedule. The Contractor shall give an oral presentation of the test schedule at weekly ETF and EFDTF team meetings.

The Contractor shall be responsible for coordinating, developing, and producing placards, brochures and leaflets describing the ETF's and EFDTF's technical capabilities. This includes, but is not limited to, working with MSFC Graphics in developing page layouts, generating computer graphics, and coordinating with MSFC photographers. All placards, brochures, and leaflets shall be approved by MSFC Graphics prior to production.

The Contractor shall develop presentation charts, as requested, by ETF and EFDTF personnel, and directed by the COTR.

The Contractor shall provide coordination support for onsite and off-site meetings and conferences. The Contractor shall escort foreign nationals and support all visits by foreign nationals. This will require special security training for Contractor personnel performing this function.

**2.2.4 ETF Chamber Operations and Support** - The Contractor shall perform all test chamber operations within the ETF and perform the mechanical, electrical, welding, machining, refrigeration (including cascade), helium leak detection and other work that supports testing. This includes, but is not limited to, chamber and support equipment installation and buildup, chamber and support equipment maintenance and preventive maintenance, instrumentation installation and checkout, test support fabrication and setup, data acquisition and reduction, equipment calibration, video monitoring, test article handling, and the installation and use of high-pressure and cryogenic systems. In the past, this work has required technicians with ancillary skills including, but not limited to, machining, welding, soldering, refrigeration, leak checking, electrical wiring (high and low voltage), pipe fitting, instrumentation, data acquisition, helium leak detection and sheet metal.

The Contractor shall provide engineering expertise, including guidance for, and operation of, the thermal chambers located in MSFC's ETF. The Contractor, as a minimum, shall maintain expertise in facility layout and design with an emphasis on electrical systems; create and maintain MicroStation® CAD drawings (electrical and mechanical) of all ETF test facilities; maintain the ETF's repository of specific facility engineering drawings; maintain proficiency in data acquisition and control systems for all thermal test systems with the ability to manage the data systems and retrieve data.

The Contractor shall, within 60 days of contract award, develop and maintain a certified Welding Program to include the ability/capability of Gas Tungsten Arc Welding (GTAW) in accordance with the American Welding Society (AWS). This requires the Contractor to be certified by an independent, third party. The program, as a minimum, shall include:

- a) A Weld Procedure Specification (WPS), Procedure Qualification Record (PQR), and a Welding Operator Qualification (WPQ) Test (Welding Position 6G)) for each of the following:

Base Metals P- No.1 to P- No.1 (Carbon Steel to Carbon Steel) and Base Metals P- No.8 to P- No.8 (Stainless Steel to Stainless Steel) for Pipe Diameters of 1.00" & Larger, Base Metal Groove of 0.0625"-0.436" (Wall Thickness).

- b) A Welder/Welding Operator qualified and certified to the stated WPSs in the 6G Welding position.

**2.2.5 EFDTF Facilities Operations and Support** -The Contractor shall build-up models or test items in the EFDTF with instrumentation that is tested and measured in the facilities. The Contractor shall install and connect models to the test fixtures and record data during tests. The Contractor shall configure the chamber elements and facilities to accommodate the test requirements and perform maintenance between runs. In the past, this work has required technicians with ancillary skills including, but not limited to, CAD drafting, machining, welding, soldering, refrigeration, leak checking, electrical wiring (high and low voltage), pipe fitting, instrumentation, data acquisition, and sheet metal work.

**2.3 Structural Test Support.** The Structural Test Facility is a high bay facility complex that provides office space, laboratory space, test cells, machine shop, fabrication areas, material handling systems, load control systems, data acquisition systems, and utilities to support aerospace structural testing. Structural strength test and dynamic load test activities are planned and executed in this facility to support the design, development, certification, and operation of flight structures, payloads, systems, and components. Although Structural Strength Test and Structural Dynamics Test are regarded as separate engineering disciplines at MSFC, the personnel and facility resources for these engineering disciplines are co-located within the Structural Test Facility. In some cases, other facilities at MSFC may be utilized for structural testing operations when test article size, test hazards, or other specific test requirements preclude test operation at the Structural Test Facility.

Structural Strength testing is an engineering discipline involved primarily with the application of static or quasi-static loads (e.g., mechanical, thermal, pneumatic) to aerospace hardware in an effort to accurately determine the hardware response to such loading (e.g., deflection, stress, strain). Structural Strength testing is primarily performed in the Structural Test Facility located in Building 4619 at MSFC. There are numerous structural test positions within the Structural Test Facility. Each test position has specific test capabilities with regard to load application limits (tensile load, compressive load, shear load) and test article size. Structural Dynamics testing involves investigation into the dynamic response of structures during the application of various types of loads. The Structural Test Facility has dedicated test areas for vibration, acoustic, modal and shock testing.

**2.3.1 Structural Test Facility Planning and Control** - The Contractor shall be responsible for daily planning, coordination, and technical direction of Contractor activities performed at the Structural Test Facility. The Contractor shall be responsible for coordinating daily with Structural Test Facility engineers and management as required to ensure that Contractor personnel are utilized in a cost effective and productive manner to fully support Structural Test Facility priorities and objectives. Currently, the Government uses a Test Preparation Sheet (TPS) (reference ET01-PRO-OWI-003, Test Preparation Sheet Instructions) to direct the contractor to perform technician work.

**2.3.2 Structural Test Facility Support** - The Contractor shall provide technician support for all structural strength and structural dynamics work activities managed through the Structural Test Facility whether work is performed at the Structural Test Facility or at MSFC on-site test facilities. The scope of this WBS includes technician support required for maintenance, upgrade, modification and refurbishment of existing Structural Test Facility systems and equipment. This work also involves support during test buildup and test operations, and support

during buildup and fabrication of new facility capabilities required to accomplish the mission of the Structural Test Facility. Typical work activities include, but are not limited to:

- power hand tool operation (drills, metal cutting saws, etc.)
- power equipment/machining operations (drill press, table saws, CNC mills and lathe, manual mills and lathe, metal cutting band saw, etc)
- hydraulic pump maintenance, troubleshooting and operation
- load control system maintenance, troubleshooting and operation
- vacuum system maintenance, troubleshooting and operation
- pneumatic system maintenance, troubleshooting and operation (air, GN2, helium, hydrogen, etc.)
- cryogenic system maintenance, troubleshooting and operation (LN2, LH2, LHe)
- electrical wire termination
- electrical cable fabrication
- tensile test machine maintenance, troubleshooting and operation
- material handling, mobile crane operation, bridge crane operation, aerial lift operation, fork lift operation
- rigging operations required to support lift operations
- data system operations support (fabricating drag-on cables, wiring termination, etc)
- data sensor installation (pressure transducers, strain gages, temperature sensors, load cells, etc)
- welding operations (MIG, TIG, stick)
- digital audio/video equipment installation and operation

**2.3.3 Master Schedule** - The Contractor shall maintain a master Structural Test Facility, ETF, EFDTF combined testing schedule.

**2.4 Fabrication and Assembly of R&D Space Flight and Associated Hardware.** The Contractor shall perform fabrication and assembly of R&D products that are within MSFC's manufacturing capability. The manufacturing capability is defined as R&D hardware products and manufacturing processes for MSFC in-house designs that require close and continual collaboration with design personnel, development of manufacturing processes, or are schedule critical.

The Contractor shall perform tasks that will consist of manufacturing R&D space flight hardware and experiments, flight ground support hardware and equipment, test fixtures (dynamic, thermal vacuum, and structural), and prototype/mockup hardware or end items made from various materials. The tasks may also require refurbishment (re-machining, reprocessing, and/or cleaning) of existing hardware.

MSFC is transitioning to Digital Design to Fabrication (DDTF). The Contractor shall have knowledge of DDTF, which includes the ability to accept and read CAD models from a variety of CAD/Modeling systems housed in a common Product Data Management (PDM) configuration system, and understand the datum to cost and plan. The Contractor shall have expertise in geometric dimensions and tolerances (GD&T). The Contractor shall provide a skill mix that includes both traditional and DDTF cost estimating and planning to meet the technical requirements of this contract.

The Contractor shall establish, implement, and maintain a system for reporting performance in accordance with DRD1163MA-007, Monthly and Semi-Annually Performance Reports.



2.4.1 Precision and General Assembly - The Contractor shall perform precision and general assembly in the open shop and in environmentally controlled clean rooms on both flight experiment hardware and test hardware. Some assembly operations require adhesive bonding technology.

2.4.2 Machining - The Contractor shall perform machining processes which shall consist of, but not be limited to, operations performed on lathes, mills, grinders, shapers, and electrostatic discharge machines. Selected machines are computer numerically controlled (CNC) and can be programmed both off- and on-line. Machining and grinding operations frequently require dimensional control to less than .001 inch. Foam machining shall include operation of conventional or CNC equipment in the foam shop or controlled areas of the primary machine shop. As a minimum, the Contractor shall be capable of operating a four machining centers at one time and ensure the machining centers are manned while operating.

2.4.3 Sheet Metal - The Contractor shall perform sheet metal processes which shall consist of, but not be limited to, operations requiring shearing, bending, punching, and fastening. The Contractor shall fabricate high and low-pressure metal tubing and flexible hose systems.

2.4.4 Surface Treatment - The Contractor shall perform surface treatment operations which shall involve, but not be limited to, glass bead/sandblasting operations, acid and alkaline metal etching, painting (spray and brush), chemical passivation, and chemical phosphate metal treatment. Electrochemical metal processing shall involve, but not be limited to, anodizing and electroless nickel plating processes. Various other plating processes may be required but only at the direction of the Technical Monitor. Cleaning processes are conducted using special chemicals. Some precision cleaning processes require particulate and nonvolatile residue sample preparation. The Contractor shall be responsible for emptying containers of spent chemical into Government-furnished receptacles or into neutralization processing tanks. The Government shall be responsible for all disposal activity including waste/waste water permits. As a minimum, the Contractor shall have the capability to provide minimal services of surface treat, precision cleaning and painting at one time.

Dry-film lubrication application shall consist of all the functions necessary to pre-treat material and apply and burnish various solid (dry film) and liquid lubricants. These lubricants shall include, but not be limited to, un-bonded solids (granular or powdered) and resin-bonded solids.

2.4.5 Welding and Heat Treatment - The Contractor shall perform fusion welding operations which shall consist of, but not be limited to, metallic inert gas, tungsten inert gas, electron beam, and plasma arc and resistance and electrostatic discharge processes. Brazing processes shall consist of, but not be limited to, acetylene and vacuum oven techniques. The Contractor shall conduct heat treatment operations in electric and gas heated ovens and furnaces using controlled (vacuum and special gases) and non-controlled environments.

2.4.6 Fabric Shop - The Contractor shall provide, on a very limited basis, services that include a fabric shop. Fabric shop tasks primarily consist of, but are not limited to, fabrication of banners, curtains, safety harnesses, lifting slings, and multi-layer insulation (MLI) blankets. The Contractor shall lay-up, sew, ultrasonically weld, bond, and inspect as specified on the Customer Order. Some special items require fabrication in a clean room environment.

2.4.7 Maintenance - The Contractor shall provide mechanical and electrical/electronic maintenance to maintain shop equipment furnished by the Government. This shall include, but not be limited to, mechanical controls in the machine shop, sheet metal shop, heat treatment area, surface treatment area, precision cleaning area, and welding shop. The Contractor shall provide machine coolant servicing to consist of, but not limited to, replenishing, replacing, and reclaiming the machine coolants as required in the fabrication shops. Excessing, repair and/or replacement of equipment shall be approved by the Technical Monitor.

2.4.8 Calibration - The Contractor shall use Government-furnished software to track and maintain calibrated equipment. Onsite MSFC calibration service is available for use as needed. As directed by the COTR, the Contractor may utilize approved outsource calibration services. Records of contracted services shall be maintained in the Contractor's record center.

2.4.9 Chemical Analysis - The Contractor shall perform sample collection, analysis, and reporting as described below:

- a) Monitor by chemical analysis all chemical tanks and rinse tanks in buildings 4760 and 4705 used in various plating, degreasing, etching, cleaning, and dye processes. These tanks shall be strictly monitored to assure that chemical parameters adhere to the requirements.
- b) The Contractor shall analyze the various solvents/fluids used in the precision cleaning facility in building 4705 for non-volatile residue and particle count to certify cleanliness of the aerospace hardware.
- c) The Contractor shall evaluate JP-8 fuel according to Military Specification, MIL-T-83133, Turbine Fuels, Aviation, Kerosene Types, NATO Code Numbers F-34 (JP-8) and F-35. The Contractor shall inspect for the presence of algae according to a demonstrably reliable method selected by the Contractor.
- d) The Contractor shall analyze hydraulic oil per MIL-PRF-83282, Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Aircraft Metric, NATO Code Number H-537, moisture per Karl Fischer method or equal, and for particulate.
- e) The Contractor shall ultrasonically clean liquid oxygen filters, run Nonvolatile residue (NVR) and particulate count, and report results prior to normal precision cleaning.

2.4.10 Quality Control -

- a) The Contractor's quality department shall provide layout, in-process, and final inspection to ensure that all requirements are met.
- b) The Contractor's quality department shall prepare an Acceptance Data Package (ADP) for each Deliverable End Item (DEI) products. The ADP shall provide the Government with the documentation necessary to determine the acceptability of products as specified in the DEI work request. The ADP shall be prepared, maintained, and/or delivered in accordance with the requirements of DRD 1163CM-001, Acceptance Data Package.

- c) The Contractor's quality department shall be the primary interface with the Government quality assurance organization. The Government quality engineering organization shall provide project level quality inspection and test requirements prior to fabrication and assembly of quality sensitive hardware. The Government quality assurance organization will perform mandatory inspection points (MIPs) as specified by the Government quality engineering organization on quality sensitive Products.
- d) For all shop operations of quality sensitive products, certification/qualification shall be required for all personnel controlling special processes and performing fabrication and inspection operations of a specialized nature. The Government will provide the requirements for applicable certifications.
- e) The Contractor shall request, through the Technical Monitor, Government support for x-ray nondestructive evaluation (NDE) inspections when specialized inspection equipment already exists within other Government organizations.

All NDE inspections performed by NASA shall be verified by the NASA MSFC quality assurance organization or other work request designated personnel prior to return of the articles and materials for further processing by the Contractor.

The Contractor, when requested by the COTR, shall provide ultrasonic, magnaflux and dye penetrant for non-destructive evaluation (NDE) inspections.

- f) The Contractor shall support a Functional Configuration/Physical Configuration Audit Documentation process. This process is known as FCA & PCA respectively and shall be governed by DRD 1163CM-002, Functional Configuration/Physical Configuration Audit Documentation.

The Contractor shall classify nonconformities for quality sensitive products as either "Minor" or "Major." Minor nonconformities shall be defined as a nonconformance that involves a single occurrence in failing to meet a requirement that does not affect a safety related characteristic or for equipment/tooling failure. Major nonconformities will consist of all other nonconformities, including nonconformities as a result of a trend analysis. A correction action process shall be required for all major nonconformities that shall be verified as effective in preventing the nonconformity from reoccurring. The Contractor shall document all product and Quality Management System (QMS) nonconformities in Contractor's QMS.

Discrepancies for quality sensitive products that are for "Rework" shall be documented as a SQUAWK in the Visual Quality (VQ) database. All other quality sensitive product nonconformities shall be documented in the nonconformance module of the VQ database.

For non-quality sensitive products, non-conformances shall be documented within VISUAL Manufacturing™.

All dispositions except "rework" shall be approved by NASA by submittal of a Deviation Approval Request (DAR), MSFC-FORM-847 and instructions; or through a Material Review Board (MRB) process on the Contractors discrepancy record, as specified by MPR 8730.3 and by the designated project level representative.

The Contractor shall be responsible, when applicable, for material certification of all materials used to fabricate quality sensitive hardware and other hardware when specified on the Customer Order. This shall include, but not be limited to, requests for Government certification, certification from commercial sources, or spectrographic analysis using Government-furnished equipment (GFE). The Contractor shall verify raw material test reports for both chemical composition and tensile strength in conjunction with SAE AS9100, paragraph section 7.4.3 and/or as requested by the NASA quality assurance organization through the COTR. The current raw material testing verification process shall be approved by NASA. When requested, material certification records shall be part of the acceptance data package maintained in the Contractor's record center. The Contractor shall investigate MSFC or vendor Alerts on materials and hardware when requested by the COTR.

The Contractor shall maintain an optical alignment, weight, and center of gravity capability.

The Contractor's subcontracts shall comply with the applicable portions of the Contractor's approved internal ANSI/ISO/ASQC Q9001:1994 or Q9001:2000 requirements. The Contractor shall utilize the MSFC Audited Vendor List (AVL).

- 1) All subcontracts let for quality sensitive products shall utilize the MSFC supplier listings as identified for use in MWI 5330.1, section 6.2 and the links herein:

AVL: Audited Vendor List

LVL: Limited Vendor List

PSAL: Project Specific Approved Supplier List

AVL: [https://msfcsma3.msfc.nasa.gov/dbwebs/apps/lvl/default\\_avl.asp](https://msfcsma3.msfc.nasa.gov/dbwebs/apps/lvl/default_avl.asp)

LVL: <https://msfcsma3.msfc.nasa.gov/dbwebs/apps/lvl/default.asp>

PSASL: [https://msfcsma3.msfc.nasa.gov/dbwebs/apps/lvl/default\\_psasl.asp](https://msfcsma3.msfc.nasa.gov/dbwebs/apps/lvl/default_psasl.asp)

- 2) All non-quality sensitive products subcontracted proposed suppliers that are not on the above referenced supplier lists (AVL, LVL, PSAL) shall be evaluated for their ability to meet purchase requirements by the Contractor. If NASA product requester specifies a vendor, the Contractor shall evaluate specified vendor based on information provided by the requestor. If Contractor feels that the submitted supplier cannot meet the requirements of the purchase order, coordination for resolution shall be requested through the designated project level representative.

**2.4.11 Planning and Control** - The Contractor shall plan, schedule, track, and status manufacturing tasks through the fabrication shops.

The Contractor shall perform manufacturing planning to accomplish the requirements of the Customer Orders. The Contractor's planning department shall coordinate problems through the Technical Monitor and ensure "as-built" configuration agrees with the "as-designed" configuration. In addition, the Contractor's planning department shall be the primary interface between the Technical Monitor and the Contractor's other organizational departments for information, status, schedules, and estimates relative to the Customer Orders.

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The Contractor shall use Government-owned "Micro" from Estimating Systems, Inc <sup>TM</sup> to perform estimates for Customer Orders. The current Government provided seat subscriptions are fully subscribed in the fabrication shop area. Integrated with Micro is the CAD package SolidWorks <sup>®</sup> by SolidWorks Corporation for CAD model acceptance. The current Government provided seat subscriptions are fully subscribed in the fabrication shop area.

The Contractor shall perform production control functions as necessary to accomplish the requirements of both the Customer Order and Work Order. The Contractor shall provide accurate and reliable Work Order status and schedule information when requested by the COTR. The Contractor's production control shall assign manpower allocations to all approved Customer Orders.

The Contractor shall operate and maintain the storeroom. This task shall include, but not be limited to, inventory control, receipt, issue, storage and handling of hardware, parts, and materials for both the Government and Contractor.

The Contractor shall not be responsible for any Program Critical Hardware (PCH) handling or moves. When PCH handling or moves becomes necessary, the Contractor shall be responsible for coordinating the move with the Government and the Government's contractors that provide this service. The Contractor shall also request assistance for oversized equipment moves from the Government when such moves are required. The Contractor shall provide certified forklift and crane operators for handling normal equipment and material moves in their areas of responsibility.

The Contractor shall provide proof-load capability for lifting slings and fixtures used in normal material and hardware handling operations within the Contractor's work area. The Contractor shall request through the Technical Monitor support from the Government for proof-loading of oversized lifting slings and fixtures when applicable.

The Contractor shall operate and maintain the tool crib and inventory system utilizing CribMaster<sup>TM</sup>. The current Government provided seat subscriptions are fully subscribed in the fabrication shop area. This shall include, but not be limited to, the identification and bar coding of each tool room item, issuing and tracking tool withdrawals, purchasing supplies and materials for the tool crib including new and replacement tools, performing periodic inventories, and providing reporting.

The Government-owned online computer system is VISUAL Enterprise 6.3.8 software application. The Government is responsible for maintaining this software package with all seats currently fully subscribed in the managing of the fabrication shop area only. The current modules used within Visual Enterprise are: Manufacturing, Automated Material Tracking System, Automated Labor Tracking System, and Visual Quality Data Collection Seats.

The Contractor shall use VM to manage the planning, tracking, scheduling, procuring, and inventorying of parts and work flow through the fabrication shop. The VM major functional areas are Quotations, Customer Order Entry, Engineering Definition (Routing and Bill of Material), Production Planning, Material Planning, Scheduling, Shop Floor Barcode Control, Job Costing, Purchasing (both to the Work Order and Inventory), Inventory Control, Shipping, Invoicing, and Customer Inquiry.

The following details the work processing procedures currently used by the Government to request services from the Contractor and how the work is monitored and accepted.

Fabrication services receive requests for fabrication and assembly tasks on a MSFC Form 3751 (Fabrication Request). Once requirements are clearly identified, a Government Manufacturer Engineer (ME) will develop the requirements for and issue a Customer Order in Visual Manufacturing™ (VM). The Contractor utilizes the issued Customer Order and Form 3751 to define the hardware configuration, quantity, documentation, GFE, end-item disposition, any other special requirements, estimated cost and delivery date. All Customer Orders are approved by the Technical Monitor. The Technical Monitor may delegate authority to the MEs.

The Contractor reviews the Customer Order and documentation package, plans, coordinates, procures parts and materials, and generates a Work Order (WO) in VM. The Contractor's planning department is the primary interface between the MEs and the Contractor's other organizational departments for information, status, schedules, and estimates.

The WO package is routed to the Contractor's Production Control (PC) department, where work is assigned and scheduled with the proper manufacturing groups. The PC department monitors the fabrication and assembly work process, expedites moves from shop station to shop station, and coordinates inputs to accomplish the requirements of both the Customer Order and WO.

The Contractor fabricates and/or assembles, inspects and verifies that hardware meets the requirements of the Customer Order, WO and design drawing documentation.

Upon completion of the Customer Order requirements, the Contractor transfers the Deliverable End Item (DEI) along with the Acceptance Data Package (ADP) to the fabrication services storeroom. Storeroom personnel notify the customer and obtain the signature of the individual picking up the completed item(s).

The Contractor shall use the following Government provided software packages for job simulation and for "computer-aided manufacturing." Detailed specifics of suites and modules are to be verified by the Contractor.

- a) Delmia                      Machine Tool Builder  
                                    Machine Tool Path Simulation
- b) ICAM Software        D-M5 CAM-POST
- c) CATIA v5                Manufacturing
  - (a) Design and Advanced Machinist
  - (b) Lathe Machining
  - (c) Prismatic Machining Preparation Assistant

## **2.5 Electrical Fabrication, Test, and Assembly.**

2.5.1 Fabrication - The Contractor shall perform electrical fabrication, which typically involves, but is not limited to, hand soldering, printed circuit board population, automated assembly of surface mount technology, strain gage installation, coil winding, electrical cable harness assembly, potting, staking, conformal coating, fiber optics assembly, and electrical/mechanical "black box" assembly. Selected items of electrical work require electrostatic protection of electrically sensitive components during processing.

**2.5.2 Testing** - The Contractor shall perform electrical testing, which typically involves, but not limited to, various testing methods and techniques on Electrical, Electronic and Electromechanical (EEE) parts, components, sub-systems and systems. These tests include; functional acceptance tests of EEE parts before board population; electrical integrity tests of flight and Ground Support Equipment (GSE) cable assemblies to ensure proper wiring, isolation and workmanship; and the electrical acceptance tests of flight and engineering hardware. The Contractor shall perform fabrication and test of GSE and special test equipment (STE), operation of automated test systems, fabricate and test prototype circuit boards, interconnecting cables, control boxes and breakout boxes, with fabrication and testing supporting GSE and Flight Hardware.

**2.5.3 Assembly** - The Contractor shall perform precision and general assembly in the open shop and in environmentally controlled clean rooms on both flight experiment hardware and test hardware. Some assembly operations require adhesive bonding technology.

**2.5.4 Calibration** - The Contractor shall use Government-furnished software to track and maintain calibrated equipment. Onsite MSFC calibration service is available for use as needed. As directed by the COTR, the Contractor may utilize approved outsource calibration services. Records of contracted services shall be maintained in the Contractor's record center.

The Contractor shall ensure all non-quality items fabricated for commercial customers shall be inspected by non-contract personnel prior to customer delivery.

**2.5.5 Quality Control** - The Contractor shall ensure all quality sensitive items fabricated for commercial customers shall be procured and inspected through a Space Act Agreement.

The Contractor shall ensure all subcontracts comply with the applicable portions of the Contractor's approved internal ANSI/ISO/ASQC Q9001:1994 or Q9001:2000 requirements. The Contractor shall utilize the MSFC Audited Vendor List (AVL).

- 1) All subcontracts let for quality sensitive products shall utilize the MSFC supplier listings as identified for use in MWI 5330.1, section 6.2 and the links herein:

AVL: Audited Vendor List

LVL: Limited Vendor List

PSAL: Project Specific Approved Supplier List

AVL: [https://msfcsma3.msfc.nasa.gov/dbwebs/apps/lvl/default\\_avl.asp](https://msfcsma3.msfc.nasa.gov/dbwebs/apps/lvl/default_avl.asp)

LVL: <https://msfcsma3.msfc.nasa.gov/dbwebs/apps/lvl/default.asp>

PSASL: [https://msfcsma3.msfc.nasa.gov/dbwebs/apps/lvl/default\\_psasl.asp](https://msfcsma3.msfc.nasa.gov/dbwebs/apps/lvl/default_psasl.asp)

- 2) All non-quality sensitive products subcontracted proposed suppliers that are not on the above referenced supplier lists (AVL, LVL, PSAL) shall be specified by the NASA product requester and evaluated for their ability to meet purchase requirements by the Contractor based on the information provided by the requester on the supplier. Supplier use for these products shall be limited to articles and materials purchased for the specific work request. If the Contractor feels that the submitted supplier cannot meet the requirements of the purchase order, coordination for resolution shall be requested through the designated project level COTR representative.



MSFC is transitioning to automated fabrication of surface mount assemblies. The Contractor shall provide a skill mix that includes both hand assembly and machine assembly experience to meet the technical requirements of this WBS.

All Contractor employees shall obtain certification to the requirements of NASA-STD-8739.

## **2.6 Reserved.**

## **2.7 Space Environmental Effects Testing.**

**2.7.1 Contamination Control Support** -The Contractor shall provide contamination control support for various programs to include review of program requirements, plans for implementation of those requirements, review of production processes and facilities, and participate in program audits as required. Processes that will require review include cleaning, cleanliness inspection, and contamination sampling. The Contractor shall operate laboratory instrumentation such as Fourier Transform Infrared (FTIR) spectrometers, contamination application systems, and vacuum test chambers for materials outgassing tests. A general knowledge of general laboratory protocol, basic spectroscopic techniques, materials analysis /characterization instrumentation operation, chemical solution mixing, sample preparation (cleaning, grit blast, contamination application, etc) and handling procedures is required. The Contractor shall interpret the results of testing, and provide written reports at the completion of each test. The Contractor shall attend meetings, present results and interact at the Program/Project level.

**2.7.2 Space Environmental Effects Testing** - The Contractor shall perform literature research and testing for materials exposed to space environments in order to accurately simulate a mission specific space environment within the laboratory, subject a material or system to that environment, and measure performance metrics after space environment exposure. The Contractor shall perform thorough literature research for past data and history on Space Environments Effects (SEE) including all data developed during Apollo, Skylab, other NASA missions, and missions of other agencies and countries whose data is available for public review. The Contractor shall also design, configure, modify, operate, and maintain the multiple and varied SEE test systems utilized for atomic oxygen (AO), ultraviolet (UV) radiation, charged particle radiation, plasma, and contamination including combined environments exposure testing. The Contractor shall also support Impact Test Facility operations including hypervelocity, ballistic, and environmental gun capabilities. The testing and operation includes performing the necessary calculations for accurate SEE irradiations, aid in the design and assembly of data acquisition systems, pre-test and post-test materials analyses, and impact assessments. The Contractor shall perform limited fabrication and assembly of test hardware, operate associated materials analysis/characterization instrumentation, interpret the results of testing, and provide written reports at the completion of each test. The Contractor shall attend meetings, present results and interact at the Program/Project level. Special training is required for radiation source, propellant and explosives handling as well as test system operation.

**2.7.3 Electrostatic Levitator (ESL) System Operations** - The Contractor shall provide ESL support to configure, modify, operate, and maintain the test systems and associated support equipment including vacuum hardware, operating control systems, data acquisition systems, and multiple class lasers. The Contractor shall prepare samples and operate laboratory instrumentation such as optical pyrometers and spectrometers. The Contractor shall interpret

the results of testing, and provide written reports at the completion of each test. The Contractor shall attend meetings, present results and interact at the Program/Project level.

**2.7.4 Development of Internal, Scientific and Data Documentation and Publications -** The Contractor shall create scientific, technical and data documents, and internal documentation and publications as needed and as directed by the COTR. The documents required include research papers to be published by scientific organizations, periodical sections, newspaper articles, failure analyses, problem assessments, problem resolutions, anomaly investigations, preferred materials applications documents, data explanation documents, technical evaluation documentation, and other similar scientific and engineering documentation. The Contractor shall also create needed internal documentation, which include Organizational Instructions, safety documents and communications documentation. The Contractor shall work with the MSFC printing office to ensure that all documents are in the proper format, printed properly and delivered when required. The Contractor shall also be responsible for supporting the distribution effort of all documents created under this task.

## **2.8 Reserved.**

**2.9 Environmental Gas Laboratory Support.** MSFC has the requirement to verify the cleanliness of a variety of hardware and facilities that prevents the contamination of space flight hardware. These facilities and equipment include clean rooms at all cleanliness levels, flow benches, small hardware and equipment, and large hardware and cross-country cryogenic liquid and gas lines.

The cleanliness verifications are requested in two ways; (1) MSFC customer organizations request regularly scheduled verification checks, or (2) MSFC customers who do not need regular verifications request special one-time verifications performed within a specified time period. All data analyses and findings for the week are compiled into one Excel spreadsheet and sent to all customers for whom evaluations were performed.

The Contractor shall evaluate, as directed by the COTR, MSFC clean rooms, MSFC propellant lines and their components, and propellant storage vessels and their components to determine contamination or cleanliness levels. The Contractor shall follow a scheduled sampling routine to check the clean rooms and propellant systems at MSFC to determine contamination levels. The Contractor shall also perform any analysis not included on the routine checklist, if requested by the COTR. The Contractor shall develop and implement an effective electronic Special Test Order (STO) system, formerly called an Avoid Verbal Orders (AVO) system. This system will serve to request special or one-time only evaluations of clean rooms or lines. The Contractor shall track all data and evaluations from a central location, and provide a written report of all findings weekly. The Contractor shall inform the COTR immediately if any test result is out of the tolerance levels established by MSFC or by the COTR.

**2.10 Computer-Aided Design (CAD) Drawing.** The Contractor shall provide design, drafting, and library support services in order to prepare, maintain, reproduce and store detailed CAD drawings. The Contractor shall provide functional designs and design drawings utilizing state of the art Computer-Aided Design (CAD) software to numerous customers, both internal (NASA) and external (other Government Agencies and/or Industry Partners), in order to support the checkout and testing of various space flight systems and components, engine systems and

components, and ground support hardware through the application of static and/or dynamic loads, fluid flow tests involving water, cryogenic liquids, heated liquids, and their associated gasses, and hot fire tests of engines or engine components. The Contractor shall prepare the CAD drawings via verbal and written inputs from a Civil Servant engineer assigned as the design lead for projects that require special equipment designs to accomplish testing. The Contractor shall also use inputs from other government and non-government customer contacts, existing design drawings, and field and/or shop measurements, as necessary to accomplish the task assigned. The Contractor shall work with customers to prepare clear, complete and accurate working plans and detail drawings from rough sketches, detailed sketches, field and/or shop measurements, or notes. The Contractor shall produce final drawings showing the dimensions of parts, materials to be used, relationships of parts, and the relationship of various parts to the whole structure or project. The Contractor shall create detailed CAD format drawings from existing pencil drawings as required to accommodate testing on existing test stands or to allow for reuse of previously designed hardware to improve delivery dates of hardware and to reduce overall project cost. Designs shall be accomplished following approved standards as specified in the Branch's OWIs and accepted industry standards, such as, AISC – Steel Construction Manual, ASME Boiler and Pressure Vessel Code inclusive of all sections, ASME B31.1, Power Piping Systems, and ASME B31.3, Process Piping Systems, as well as other MSFC and Industry Partner generated documents as required to produce special equipment needed to satisfy test requirements. The test facilities and test positions at MSFC are active and include high pressure storage and run systems including pressure vessels, vacuum systems including vacuum chambers, large thrust reaction systems, static and dynamic load application systems, and personnel work and access platforms which must be worked on and around frequently requiring trips to the various test areas located at MSFC to make measurements, take photographs, and get visual confirmation related to the scope of the assigned design task. A number of the test stands and/or positions are large, with high elevations and open grating that must be accessed during the production of detailed design drawings, during hardware fabrication efforts, and during hardware installation to ensure proper fit up and to aid installation of the fabricated hardware.

The Contractor shall produce finished drawing prints and take the completed engineering drawings to MSFC organizations in order to acquire the required signatures after their design review has been completed and any modifications to the originally delivered drawings have been evaluated and applied to the drawing package.

**2.11 Data Analysis and Database Entry for Material and Processes Technical Information System (MAPTIS).** The Contractor shall obtain materials information and test data from manufacturers, suppliers, MSFC testing organizations, other NASA certified testing facilities, government agencies, and private companies. The Contractor shall perform engineering analyses on these for validity and enter the verified data into the MAPTIS database.

**2.12 Optics Support.** The Contractor shall perform optical coating, optical fabrication and metrology at MSFC, including support of JWST testing in the X-Ray Calibration Facility. The Contractor shall maintain and operate the vacuum coating facilities and coating deposition equipment, perform inspection, precision cleaning and handling of optics and vacuum hardware, and perform optical testing. The Contractor shall also perform optical fabrication, which includes, but is not limited to, resizing glass substrates via Blanchard or curve generator grinding. The Contractor shall perform optical metrology, which includes, but is not limited to, the use of the Coordinate Measuring Machine or ZYGO interferometer.

**2.13 Tool Crib Operations.** The Contractor shall operate the two MSFC Tool Crib (unassociated with the tool crib supporting shop operations). The Contractor shall be responsible for the order preparation, receipt, storage, and restocking of all tools and materials, and the proper distribution of stock items to employees. The Contractor shall keep the tool cribs fully stocked by purchasing all items necessary to do so without depleting existing stock. Tool Crib items include hand tools, calibrated tools, reusable or returnable items, hazardous chemicals, controlled items and expendable items, both for flight and non-flight use. The Contractor shall also request supplies, enter into the existing inventory system any purchase order data on items received, utilize the existing bar coding system, and generate special reports on equipment usage.

### **3.0 IDIQ Support**

Any of the following sections that do not have specific requirements will include the requirements for the respective function specified in 2.0.

#### **3.1 Materials Testing.**

#### **3.2 ETF/EFDTF Test Support.**

#### **3.3 Structural Test Support.**

#### **3.4 Fabrication and Assembly of R&D Space Flight and Associated Hardware.**

#### **3.5 Electrical Fabrication, Test, and Assembly.**

**3.6 Calibration.** The Contractor shall perform timely and accurate (1) servicing, repair, and calibration of inspection, measuring, and test equipment (IM&TE) assigned for calibration by authorized users of the MSFC Calibration Facility; (2) standards maintenance and certifications; (3) calibration procedure maintenance and preparation; (4) maintain calibration data in the Marshall Calibration Management Systems (MCMS) ensuring that the data stays current; (5) instrument pick-up and delivery; (6) resolution of measurement problems associated with the effort; and (7) maintenance of a dedicated metrology workforce.

#### **3.7 Space Environmental Effects Testing.**

#### **3.8 Reserved.**

#### **3.9 Environmental Gas Laboratory Support.**

#### **3.10 Computer-Aided Design (CAD) Drawing.**

#### **3.11 Data Analysis and Database Entry for Material and Processes Technical Information System (MAPTIS).**

#### **3.12 Optics Support.**

#### **3.13 Tool Crib Operations.**

**3.14 Engineering Technician Support.** The Contractor shall provide engineering technician services. This includes technician support needed to design, develop, analyze, and sustain space transportation systems, payloads, and spacecraft. This also includes technical support for mission operations, research investigations, and technology development initiatives.

**3.15 Trade Service Support.** The Contractor shall provide trade services. This includes technical support needed to design, develop, analyze, and sustain space transportation

systems, payloads, and spacecraft. This also includes technical support for mission operations, research investigations, and technology development initiatives.

**3.16 Valve and Component Servicing.** The Contractor shall provide support for operating the center's Valve and Component Shop (V&CS). The work shall involve servicing components from fluid systems throughout the center. This includes components used for hazardous fluids such as oxygen and hydrogen. Typically, components are removed from systems by others and delivered to the V&CS for servicing. Servicing involves disassembling the component, having the component parts properly cleaned by the Government, replacing the damaged parts and soft goods, reassembling the component, pressure testing for structural integrity and leaks, and packaging for pickup by the customer. Components range from small instrumentation hand valves to very large high pressure components weighing as much as several tons. In many cases, soft goods must be fabricated from properly tested raw material to ensure compatibility with hazardous fluids. Along with the work of disassembling, cleaning, repairing, assembling, and testing components, the Contractor will be required to manage a parts room to ensure parts necessary to routinely service all anticipated components are readily available.

**3.17 Space Systems Integrated Test Facility Support.** The Contractor shall provide support for operating the center's Space Systems Integrated Test Facility. System tests encompass those activities required for the development, qualification, and acceptance testing of components, subsystems, and integrated space systems. Such activities include: prototype hardware/software development and test; ground support equipment development, checkout, and operation; test fixture design, fabrication, and assembly; flight hardware assembly and integration; preparation and development of test plans and procedures; functional, performance, and environmental test and checkout operations; test data analysis; test reporting; test discrepancy resolution; post shipment test and integration support; and flight operations and post mission support.

**3.18 Propulsion Test Support.** The Contractor shall provide support for Propulsion Testing. Marshall has numerous facilities capable of all types of rocket space transportation testing. Propulsion Test encompasses those activities required for the development, qualification, and acceptance testing of components to full-up engine systems. Test data is developed to evaluate aerospace technologies and hardware. This involves, but not limited to, facility buildup and modification, facility drawing maintenance and updates, test preparation, test operation, facility and equipment maintenance, instrumentation installation and checkout, test support fabrication and set-up, data acquisition, equipment calibration, video monitoring, test article handling, and the installation and use of high-pressure and cryogenic systems.

**3.19 Support Functions.** The Contractor shall provide support services to execute the PWS. This includes technical support needed to design, develop, analyze, and sustain space transportation systems, payloads, and spacecraft. This also includes technical support for mission operations, research investigations, and technology development initiatives.

**3.19.1 Chemical Analysis** - The Contractor shall perform sample collection, analysis, and reporting. The Contractor shall monitor, by chemical analyses, all chemical tanks and rinse tanks in buildings 4760 and 4705 used in various plating, degreasing, etching, cleaning, and dye processes. These tanks shall be strictly monitored to ensure that chemical parameters adhere to the requirements.

**3.19.2 Quality Systems Management** - The Contractor shall perform quality functions to accomplish customer requirements.

3.19.3 Planning and Control - The Contractor shall perform manufacturing and test planning, including scheduling, to accomplish customer requirements.

3.19.5 Contamination Control - The Contractor shall provide support which includes, but is not limited to, requirements definition, requirements implementation, process controls, facilities controls, and testing techniques related to materials, processes and facilities. The Contractors shall provide support for a wide range of disciplines, from the ground processing of propulsion elements to the simulated on-orbit spacecraft exposure environments. Specific applications also include monitoring techniques, cleaning processes, cleanliness verification and foreign object debris program assessment.

3.19.8 Engineering - The Contractor shall provide engineering expertise necessary to support PWS area when requested.

3.19.9 Other Support Functions - There may be future requirements for support services that are not identified or implied in the PWS. If future additional support services are required, these requirements will be identified via Task Order. The Contractor shall perform and complete all technical requirements that meet the intent of the PWS and shall be provided adequate resources requested through this WBS.

## Glossary

**Acceptance:** The activity performed on all production articles generally consisting of inspections, measurements, and tests that demonstrate that each article was manufactured as designed and with acceptable quality and workmanship, performs in accordance with specified requirements, and is acceptable for delivery.

**Acceptance Review:** The Acceptance Review examines the equipment, documentation, and data that support verification. An acceptance review is accomplished to assure that equipment (at any level of assembly) is ready for transfer of ownership or custody or is ready for integration into a next-higher assembly.

**Acquisition:** The acquiring, by contract, of supplies or services through purchase or lease, whether the supplies or services are already in existence or must be created, developed, demonstrated, or evaluated. Acquisition begins at the point when the Agency needs are established and includes the description of requirements to satisfy the Agency needs, solicitation and selection of sources, awards on contracts, contract financing, performance, administration, technical and management functions directly related to the process of fulfilling Agency needs by contract.

**Adiabatic Compression Test (Pneumatic Impact Test):** A test used to determine the propensity of a material to ignite when subjected to rapid confined pressurization which does not allow the dissipation of heat. The Marshall Space Flight Center (MSFC) Adiabatic Compression Tester uses oxygen gas to rapidly pressurize a small sample of material, which is then used to determine if the heat generated by the pressurization is sufficient to ignite the material.

**Aerothermal Environment:** Aerothermodynamic heat transfer associated with radiation or convection induced by supersonic flight or rocket plume flow fields.

**Annual Operating Agreement:** A NASA Center management plan which defines customer requirements, processes, and resources required to meet customer requirements, and the metrics defining effectiveness and efficiency of project processes.

**Atomic Oxygen:** Atomic Oxygen is formed by solar ultraviolet (UV) radiation dissociating oxygen molecules into free oxygen atoms in the outer ionosphere from altitudes greater than 100 km. Atomic oxygen reacts with many materials, eroding organic materials and oxidizing metals.

**Autogenous Ignition Temperature Test** is used to determine the temperature at which liquids and solids will spontaneously ignite. The material must ignite without the application of spark or flame in a high pressure oxygen enriched environment.

**CAD Drawing:** Computer Aided Design of systems and components typically using Microstation for 2-D designs, Solid Edge for 3-D designs, and other software packages as required by the customer.

**Component End Item (CEI):** Defined as the sub-assemblies and/or components data for measuring contractor's cost and schedule performance on a NASA Acquisition Contract.

**Certification of Qualification (COQ):** Provides a uniform method for design qualification and certification of US components and subsystems.



**Clean Room:** An environmentally controlled area in which temperature, humidity, particulate, molecular species, process and personnel controls are implemented to insure hardware exposure environments result in an acceptable level of cleanliness.

**Commercial-Off-The-Shelf (COTS):** Commercially available products that can be purchased and integrated with little or no customization.

**Component:** An aggregate of hardware and/or software that can be characterized by one specification, is designed by a single activity to be functionally tested, and is verified as a unit.

**Contamination Control:** Responsibilities encompassing materials and contamination control during all phases of hardware development including design, manufacturing, assembly, test, transportation, launch site processing, on-orbit exposure, return and refurbishment if required. Control also includes reducing the risk of hardware/system failure due to molecular or particulate contamination. Contamination is a concern in a wide range of areas including critical bondlines, reactive fluids (e.g. liquid oxygen) compatibility, and sensitive optics. Contamination control also addresses applications of a variety of facilities and instrumentation capable of contaminant detection, identification, and monitoring. Material applications dealing with environments, including production facilities, clean rooms, and on-orbit exposure area also included. Contamination control personnel advise on contamination and foreign object debris control programs as well as clean room operations by compliance with imposed standards.

**Cost Performance Report:** This report consists of five formats containing data for measuring contractor's cost and schedule performance on a NASA Acquisition Contract.

**Critical Design Review (CDR):** The CDR discloses the complete system design in full detail, ascertains that technical problems and design anomalies have been resolved, and ensures that the design maturity justifies the decision to initiate fabrication/manufacturing, integration, and verification of mission hardware and software.

**Critical Processes (Quality Assurance):** Are processes where uniform high quality cannot be ensured by inspection alone.

**Critical Processes (Manufacturing Processes):** An operation, treatment, or procedure used as a step in manufacturing, testing, or inspection that, if improperly or inadequately performed, can have a significant performance, including safety, or schedule impact on new or unique processes, hardware designed for fracture control or processes identified on the Critical Items List (CIL) or as safety hazard control items.

**Demonstration Test Articles:** Test articles that are used to demonstrate a manufacturing and/or assembly process or technique.

**Design:** The approach that engineering disciplines use to specify how to create or do something. A successful design must satisfy a functional specification, conform to the limitations of the target medium, meets implicit or explicit requirements on performance and resource usage.

**Design Definition Document:** Provides a detailed description of the US at the end of a design analysis cycle.

**Design for Manufacturability:** The process of proactively designing products to (1) optimize all the manufacturing functions: fabrication, assembly, test, procurement, shipping, delivery, service, and repair, and (2) assure the best cost, quality, reliability, regulatory compliance, safety, time-to-market, and customer satisfaction.

**Dynamic Test:** Structural dynamics test technologies and facility capabilities are planned, developed, and applied to the requirements of structural analysis, flight criteria, and institutional objectives. Primary emphasis is on: certification testing to simulated flight levels; development tests to determine structural performance characteristics; experimental tests to derive structural dynamic properties, expand test technologies, and support related technology development; and experimental tests to evaluate control system technologies and concepts to mitigate structural, thermal, and control system interactions for large space structures. Test control and response data processing includes time, frequency, and spatial domain analysis formatted for compatibility with analytical models, certification criteria, and experimental objectives. A wide range of skills provide the customer with a rapid response for structural dynamics testing needs. Test engineers provide overall management and coordination of test activities. These engineering services span a wide variety of dynamics testing: modal survey, vibration, acoustics, control dynamics, and pyrotechnic shock. Force inputs are provided through electromagnetic shakers, instrumented hammers, pyrotechnic charge devices, and forced air horn loaded drivers. Measured responses are obtained through piezoelectric accelerometers, high-speed video, dynamic strain gauges, electronic speckle pattern interferometry, and non-contact laser vibrometry. Test data are provided to support correlation of the experimental results with the analytical structural models and to qualify and certify flight hardware.

**Environmental Testing:** Usage of thermal vacuum, thermal humidity, and thermal altitude chambers to simulate conditions related to ascent, descent, and on-orbit environments as well as conditions related to shipping and ground storage environments.

**Equipment:** A generic term used to refer to hardware at any level-of-assembly from a component up through an integrated system.

**Evaluation Factors:** Factors by which a contractor's proposal will be evaluated to make a contract award.

**Export Control:** United States export control laws and regulations, including the International Traffic in Arms Regulations (ITAR), and the Export Administration Regulations (EAR.)

**Export Licenses:** Licenses or other approvals from the Department of State or the Department of Commerce related to export of hardware, technical data, or software, or provides technical assistance to a foreign destination or "foreign person."

**Flammability Test:** A test method used to analyze the ignition potential of aerospace materials and small components, and to determine their burning characteristics. The MSFC Flammability test system is used to determine the ability of materials to resist ignition or to self-extinguish without transferring burning debris to adjacent materials.

**Fluid Dynamics:** Fluid mechanics or fluid dynamics is the study of the physical behavior of fluids. Fluids used at the cold flow facilities are liquids and gases - normally water and air. Testing of a fluid dynamic problem typically involves experimentally measuring various properties of the fluid, such as velocity, pressure, density, and temperature, as functions of space and time. The discipline has a number of sub disciplines, including aerodynamics (the

study of gases) and hydrodynamics (the study of liquids). Fluid mechanics has a wide range of applications engineering and aerospace. For example, it is used to determine forces and moments on spacecraft, the mass flow of fluid through turbopumps, and prediction of aerodynamic environment in turbines.

**Full Time Equivalent (FTE):** A FTE for civil service personnel working for NASA.

**Government Furnished Equipment:** Equipment used during the project lifecycle that is not property of the contractor (machine tools, test equipment, furniture, vehicles, and accessory and auxiliary items).

**Government Furnished Property:** Property in possession of the Government and subsequently made available to the contractor (facilities, materials, special tooling and special test equipment).

**Guidance Document:** A document that the Contractor will use as guidance in developing a Data Requirements Document (DRD) or a subsystem.

**Inputs:** A contractor provides “inputs” to a NASA document or study to allow NASA to produce a final product that may integrate the contractor’s submission with submissions from various other sources. The format for inputs is defined in a contractual Data Requirements Document.

**Levitation (Electrostatic):** Charged specimens are maintained floating in the desired position between electrodes. Specimens are free from contact with any equipment or container. (Reference website: <http://esl.msfc.nasa.gov/>)

**Materials and Processes Technical Information System (MAPTIS):** MAPTIS is a NASA-wide materials database established for the purpose of recording and disseminating information about materials to help assure safe material selections for NASA produced space flight hardware.

**Mechanical Impact Test:** A test used to determine the propensity of a material to ignite when subjected to an impact by a free-falling weight. The MSFC Ambient and High-Pressure Mechanical Impact testers use a plummet to impact a disk of the sample material which is immersed in liquid or gaseous oxygen.

**Metrology:** Calibrated measurement or characterization of the fine dimensions, shape or surface roughness of precision manufactured hardware or optical components (lenses, mirrors and other specialized optics). Typically, government furnished equipment is provided for such tasks.

**Material Usage Agreement (MUA):** An agreement between the contractor and the government encompassing all agreed upon materials for use in the launch vehicle or spacecraft.

**National Center for Advanced Manufacturing (NCAM):** Located within Materials and Processes Laboratory, NCAM addresses the manufacturing requirements of space transportation systems. Through NCAM, partnerships between National Aeronautics and Space Administration (NASA), other government agencies, industry, and academia are formed that leverage assets and successfully meet the requirements of future aerospace systems-- systems that will ultimately provide safe and low-cost access to space.

**Organizational Issuances (OI):** Documents that provide procedures, instructions, etc., for internal use within an organization. OI's include Organizational Work Instructions (OWI's), procedures, plans, etc.

**Organizational Work Instructions (OWI):** Documents that provide detailed instructions stating how to perform specific Marshall Management System directed duties that apply to one or more Marshall Space Flight Center organizations, but not all. The OWI document type can be used when other document type designations do not apply.

**Oxygen Index Test:** A test used to determine the minimum oxygen concentration in a mixture of oxygen and nitrogen that will support flaming combustion of a material initially at room temperature.

**Past Performance:** Factual information about the performance of a contractor against the performance requirements in past contracts.

**Performance Assessment Plan:** Describes the Contractor's overall approach to contract performance assessment and the implementation process for accomplishing metric evaluation and reporting.

**Performance Management Review:** Integrated review of cost, schedule, and technical performance on the contract.

**Plasma:** A quasi-neutral gas of charged and neutral particles which exhibit collective behavior.

**Promoted Ignition-Combustion Test:** Promoted Ignition-Combustion Test is a test used to determine the flammability of materials, mainly metals, in 50 to 10,000 psi gaseous oxygen (GOX), through the utilization of a promoter material that adds supplemental heat in order to initiate combustion. The MSFC Promoted Ignition-Combustion tester uses a metal promoter to initiate the combustion of a rod of the sample material.

**Prototype:** An original engineering unit/model utilized early in the design process to resolve design issues.

**Real-Time Support:** Level of support that has the personnel, tools, and location necessary for a timely response.

**Risk:** The uncertainty of attaining a performance outcome or result and is the function of the probability and the consequence of failing to attain the performance outcome or result.

**Risk Management:** The processes for identifying, assessing, mitigating, and tracking risks.

**Safety:** Freedom from those conditions that can cause death, injury, occupational illness, damage or loss of equipment or property, or damage to the environment.

**Space Act Agreement (SAA):** Specifically, SAAs are those "agreements whose authority is derived from NASA's "other transaction" authority of the NASA Space Act [of 1958]. It does not include Chiles Act (also known as the Federal Grant and Cooperative Agreement Act) cooperative agreements [31 U.S.C. § 6305] or grants [31 U.S.C. § 6304]. ...these "other transaction" agreements (referred to as SSA) also do not include procurement contracts. Therefore, procurement laws and regulations are not applicable." {"Agreement" defined in the

broadest of contexts includes any agreement concluded under the authority of the NASA Space Act [of 1958] (contracts, leases, cooperative agreements, or other transactions). Generally, agreements establish a set of legally enforceable promises between NASA and another party to the agreement, requiring a commitment of NASA resources (including funding, services, equipment, expertise, information, or facilities to accomplish the objectives of the agreement.”}

**Space Environmental Effects (SEE):** SEE provides valuable information to designers, engineers, and scientists on the behavior of materials in the space environment. Test facilities are utilized to evaluate materials optical, mechanical, and electrical property performance in atomic oxygen, ultraviolet radiation, charged particles, plasma, and thermal vacuum environments. Flight experiments such as those on the Long Duration Exposure Facility, the Passive Optical Sample Assembly, and the Optical Properties Monitor are also used for materials evaluation. The synergistic effects of these aspects of the space environment are still not completely understood and continue to be investigated. The data from these specialized test systems, combined with analytical results from material flight experiments, enable one to determine optimum materials for use on spacecraft.

**Statement of Work (SOW):** A document that expresses the tasks to be performed by the Contractor.

**Structural Test:** Structural strength testing is a simulation of a product's actual service life loads on a test article, the measurement and evaluation of the test article's response parameters, and the correlation of test data with analytical models. It involves imposing and controlling discrete loads, temperatures, and pressures to affect the interactive behavior of test articles to simulate actual service life conditions. Forcing functions are derived with hydraulic actuators, heating and/or cooling systems or fluids, and pressurization systems. Response characteristics are measured in terms of strain, temperature, and displacement. Measured data is processed to determine test article reactions to applied loads, to verify design concepts, and to correlate analytical models. Structural test systems can integrate audio, video, still photography, nondestructive evaluation techniques, and user-supplied measurement types into the overall test system.

A wide range of skills provide the customer with a rapid response for structural testing needs. Test engineers provide overall management and coordination of test activities. Instrumentation and load control engineers support test engineers in accomplishing all test requirements to ensure that all measurement and force loading profiles are properly addressed and performed. Mechanical technicians perform set-ups of mechanical reaction fixtures, hydraulic load application equipment, and test articles. Electrical technicians install and functionally verify (mechanically and electrically) test article instrumentation, strain gauges (including cryogenic applications), and other devices/sensors to measure displacements, loads, pressures, temperatures, etc.

**Test Support:** The diverse skills of the Environmental Test Facility (ETF) personnel can provide the customer with quick turnaround in test setup. Crafts include certified leak-check operators, certified welders, electricians, and machine shop operators. The ETF staff can develop the tooling and fixtures needed for tests such as cold plates and installation of special chamber feedthroughs.

**Thermal Altitude Testing:** Usage of test chambers to subject test articles to temperatures ranging from -70 degrees C to 190 degrees C and altitudes ranging from sea level to 100,000 feet.

**Thermal Humidity Testing:** Usage of test chambers to subject test articles to temperatures ranging from -70 degrees C to 190 degrees C and humidity ranging from 5% to 95%.

**Thermal Vacuum Stability (Outgassing) Test:** A test method used to evaluate the mass loss of materials being subjected to 125°C at a pressure less than  $5 \times 10^{-5}$  psi for 24 hours. The test primarily is used to determine the tendency of a non-metallic material to release volatile compounds.

**Thermal Vacuum Testing:** Usage of test chambers to subject test articles to temperatures ranging from -170 degrees C to 200 degrees C and pressures ranging from ambient to  $5 \times 10^{-8}$  torr.

**Toxic Offgassing (Toxicity) Test:** A test method used to determine the identity and quantity of volatile compounds which are given off from materials and flight hardware. The compounds are then evaluated for their potential impact on human health. The MSFC Toxicity test is conducted at 120°F in order to allow the test material to give off the maximum amount of volatile compounds.

**Vacuum Bakeout Facilities:** Thermal vacuum bakeouts are performed in the Sunspot, V4, V5, V6, V8, V9 and V11 Chambers. Vacuum bakeout cleans components before flights and prior to testing for certification to optical cleanliness specifications MSFC Specification 1238. Instrumentation includes thermocouples and ionization and convection pressure gauges.

**Validation:** Assessment of a set of requirements demonstrating that the requirements are feasible within allowable means (cost/schedule/technical capability), are verifiable, and if fully met, will produce a product that accomplishes the intended objectives. Proof that the product accomplishes the intended purpose. May be determined by a combination of test, analysis, and demonstration

**Verification:** Proof of compliance with specifications. May be determined by a combination of test, analysis, demonstration, and inspection.

**Work Breakdown Structure:** A product-oriented hierarchical division of the hardware, software, services, and data required to produce the program's/projects end product, structured according to the way the work will be performed, and reflective of the way in which program/project costs, schedule, technical and risk data are to be accumulated, summarized and reported.

**Work Year Equivalent (WYE):** Work year equivalent for contractors performing work on NASA contracts.