INTRODUCTION – The National Aeronautical and Space Administration (NASA) Langley Research Center (LaRC) pioneers the future in space exploration, scientific discovery, and aeronautics through research and development of technology, scientific instruments and investigations, and exploration systems. The Fabrication Technology Development Branch (FTDB) and the Metal Applications Development Branch (MATB) support the Engineering Directorate (ED) in meeting the vision and mission of LaRC and NASA as an Agency. The mission is met by both civil servants and a Contractor support team who cooperatively work to see our Nation's goals are reached.

GENERAL SCOPE - This Performance Work Statement (PWS) covers the general requirements for Electronic, Mechanical and Composite Hardware Fabrication Support Services (EMCHFSS) II. The Contractor shall fabricate research-oriented, one of a kind flight test articles and assemblies for ground support equipment, aircraft, spaceflight, laboratory, science, research facilities and instrumentation requirements in Government provided facilities on-site at NASA Langley Research Center. These services shall encompass three functional fabrication work areas with support services provided for: Electronics Fabrication, Mechanical Fabrication and Composite Fabrication of research oriented hardware. The Contractor shall, except as otherwise specified, furnish all personnel, training, transportation and on-site management necessary to perform the work. On a regular basis, the contractor will be required to transport material, equipment, and parts from one building to another on-site at LaRC. The Contractor shall perform work in accordance with task orders that shall include performance standards and fabrication specifications in the form of schematics, assembly drawings, sketches, wiring diagrams, and/or written requirements describing the work to be performed along with any special fabrication operations, procedures, and techniques required to satisfactorily complete the task. The Contractor shall follow and provide documentation in accordance with the task order. Such documentation may include, but is not limited to, documentation required by NASA LaRC LMS-CP-5640, and LMS-CP-5646, as well as redlined fabrication drawings that reflect the 'as built' configuration of the final hardware.

1.0 ELECTRONICS FABRICATION SUPPORT

The Contractor shall fabricate research-oriented electronics circuitry which includes, but is not limited to, circuit assemblies for ground support equipment, aircraft, space-flight, laboratory, and research test facilities. The Contractor shall support four functional work areas: General Electronics, Aircraft Electronics, Microelectronics, and Special Fabrication Processes. The Contractor shall provide electronics support including, but not limited to, printed circuit board layout and design, layout of components and parts, population of printed circuit boards, wiring of cables and connectors, functional checkouts, packaging and installation, and modification of electronic circuitry and cables as well as Quality Control (QC) inspections for each task order deliverable prior to final NASA LaRC QA acceptance.

1.1 General Electronics - The Contractor shall provide support for general electronics circuitry and hardware including, but not limited to, the fabrication and assembly of printed circuit boards, cable assemblies, wiring harnesses, and electronics chassis, installation and wiring of research test facilities; and fabrication and assembly of electronics hardware components, subsystems, and systems.

1.2 Aircraft Electronics - The Contractor shall provide support for aircraft electronics circuitry including, but not limited to, data acquisition systems and instrumentation, telemetry, laser, lidar, and optical systems; electronic display units, and a variety of ground support equipment.

1.3 Microelectronics - The Contractor shall provide support for microelectronics circuitry. This support shall include, but is not limited to, vacuum deposition of materials, lithography, photochemical patterning of circuitry, electrodes, and sensor fabrication; interconnections, mounting of micro-miniature components and cables, chip scale packaging; and other functions such as testing and electrical verifications.

1.4 Special Fabrication Processes - The Contractor shall provide support for special fabrication processes including, but not limited to:

1.4.1 The Contractor shall provide photo plotting, photographing, and processing of printed circuit board electronic artwork. The Contractor shall fabricate Printed Circuit Board (PCB) from government-provided schematics and/or artwork. The Contractor shall meet the quality certification standards as identified in Institute of Printed Circuits (IPC) - 6012, Qualification and Performance Specification for Rigid Printed Boards, for all PCBs.

1.4.2 The Contractor shall provide graphics-related processes including, but not limited to, computerized vinyl cutting; screen-printing; decaling; transfer lettering, electronic labeling, metal-photo printing, and graphics artwork layout. The Contractor shall utilize these processes to support the fabrication and installation of hardware including, but not limited to, miscellaneous chassis faceplates; label/identify instrumentation panels, chassis, cabinets, printed circuit boards, and cables. Historically, these graphics-related special fabrication processes have only been required 1 or 2 times per year and no government property or resources are available.

1.4.3 The Contractor shall provide coatings application processes including conformal coating, staking, bonding, potting, encapsulating, and other processes related to the application of protective coatings to printed circuit boards, electronic assemblies, and cables. The Contractor shall provide brazing in support of instrumentation for wind tunnel models and test articles.

1.5 The Contractor shall comply with the following NASA Workmanship Standards for all flight project work (non-aircraft) which are located at http://standards.nasa.gov/documents/nasa, or as directed by the LaRC project's product assurance plan as identified in the task order:

NASA Standard	**TITLE**
NASA-STD-8739.1	Workmanship Standard for Polymeric Application on Electronic Assemblies
IPC J-STD-001ES	Joint Industry Standard, Space Applications Electronic Hardware Addendum to J-STD-001E Requirements for Soldering Electrical and Electronic Assemblies, December 2010 (Chapter 10 of IPC J-STD-001ES does not apply)
NASA-STD-8739.4	Crimping, Interconnecting Cables, Harnesses, and Wiring
NASA-STD-8739.5	Fiber Optics Terminations, Cable Assemblies, and Installation
NASA-STD-8739.6	Implementation Requirements for NASA Workmanship Standards
LPR 8739.21	~~Langley Research Center (~~LaRC~~)~~ Procedures and Guidelines

	for Electrostatic Discharge (ESD) Control ESD-Sensitive (ESDS) Devices Program

2.0 MECHANICAL FABRICATION SUPPORT

The Contractor shall fabricate research-oriented mechanical hardware including, but not limited to, hardware for aircraft instrumentation, ground support equipment, spaceflight applications, and research hardware within test facilities. The Contractor shall support three functional work areas: Metallic Machining, Welding and Metal Fabrication. The Contractor shall fabricate hardware including, but not limited to, aircraft structural modifications, aircraft flight test hardware, simulator modifications, modification to commercial off-the-shelf (COTS) equipment, structural test articles, and research instrumentation. The Contractor shall fabricate device hardware, such as panels, chassis, equipment racks, instrumentation pallets, and cabinets. The Contractor shall provide corrosion control, surface preparation and application of coatings in accordance with common industry standards or as specified in the task order. The Contractor shall perform corrosion control including, but not limited to, preparing metal surfaces using abrasives in the form of wire brushing, sanding, and other methods recommended by coating manufacturers. The Contractor shall design and fabricate special unique tools and fixtures, and develop techniques and processes applicable to metal fabrication technologies. The Contractor shall support the development, fabrication, and testing of unique precision metal wind tunnel models, precision flight and space flight hardware including related ground support hardware, facility components, and laboratory test apparatus. The Contractor shall utilize a variety of specialized machining such as numerically controlled milling, high-speed machining, and wire electrical discharge machining. The Contractor shall operate heavy lift equipment and cranes, such as, 18 Ton mobile crane, high reach man lift, forklifts, 5 and 10 Ton overhead cranes. The Contractor shall support the development of precision models for wind tunnel tests, high-reliability instruments for space flight experiments, and intricate fixtures and support apparatus for research facilities. The Contractor shall provide support for assembly, repair, and testing of mechanical components/systems. The Contractor shall perform a full range of metals fabrication functions such as cutting, bending, precision forming, rolling, braking, and welding. The Contractor shall manage fastener and metal warehouse inventories. The Contractor shall provide metal distribution to various locations on Center, as needed. These tasks are usually required 2-3 times per week for less than one hour duration for each occurrence.

2.1 Metallic Machining – The Contractor shall perform specialized machining processes and program and operate a range of equipment, including but not limited to, programing and operating 3 axis and 5 axis Computer Numerically Controlled (CNC) mills and lathes, 4 axis wire Electrical Discharge Machining (EDM) and, multi-axis abrasive waterjets. The Contractor shall also operate conventional mills and lathes. The Contractor shall design and fabricate special unique tools and fixtures, and develop techniques and processes applicable to machining of metal alloys (primarily aluminum and stainless steel), polymers, and composites.

2.2 Welding – The Contractor shall perform welding techniques and processes including, but not limited to, arc welding such as Flux Cored Arc Welding (FCAW), Gas Metal Arc Welding (GMAW) also known as Metal Inert Gas (MIG), Gas Tungsten Arc Welding (GTAW) also known as Tungsten Inert Gas (TIG), and Shielded Metal Arc Welding (SHAW). The Contractor shall utilize personnel with the appropriate welding certifications, in accordance with American Welding Society (AWS) B2.1 or as specified in the task order. Additionally, the Contractor shall utilize personnel with appropriate silver soldering and brazing certifications in accordance with American Society of Mechanical Engineers (ASME) Section IX, if applicable or as specified in

the task order. The Contractor shall utilize these processes to fabricate and develop precision flight and space flight hardware including related ground support hardware, facility components, and laboratory test apparatus.

2.3 Metal Fabrication – The Contractor shall perform a variety of metal fabrication processes, including but not limited to, aviation metal-smithing; conventional and specialized machining; hand tooling and fitting; metal cutting, aligning, shearing, punching, drilling, grinding, sawing, welding, torch-cutting, forming, bending, rolling, braking, and fastening utilizing riveting, and bolt/screw applications.

3.0 COMPOSITE FABRICATION SUPPORT

The Contractor shall fabricate research-oriented composite hardware including, but not limited to, the development, fabrication, instrumentation, and testing of precision flight and space flight composite aero-elastic and force test wind tunnel test articles. The Contractor shall provide composite fabrication support including, but not limited to, exploration hardware and test articles, free-flight, spin and dynamically scaled remotely piloted articles; planetary and lunar rovers, flight and ground support hardware, tunnel blades, display articles, crates, facility components and laboratory testing apparatus. The Contractor shall support three functional work areas: Composite Model Making, Composite Fabrication, and Instrumentation. The Contractor shall develop one-of-a-kind test specimens utilizing special fabrication techniques applicable to plastics, polymers, composites and additive manufacturing including, but not limited to, application and development of fabrication techniques in ceramics processing and foundry operations to cast and mold non-metallic models and components. The Contractor shall support real time proof-of-concept engineering model development and experimental application techniques utilizing a variety of both plastic and metallic additive manufacturing systems.

3.1 Composite Model Maker – The Contractor shall perform composite model making. The Contractor shall utilize unique processes in composites technology including, but not limited to, model making, patternmaking, mold fabrication, vacuum bagging techniques, material lay-up, polymeric applications and resin infusion. The Contractor shall utilize specialized laboratory equipment including, but not limited to, numerically controlled milling machines, high-speed routers, ply cutters, vacuum pumps, heated paint rooms, conventional wood working equipment and autoclave systems. The Contractor shall support the development and instrumentation of precision models and related structures and hardware for aerospace research. The Contractor shall provide composite surface preparation and application of coatings in accordance with common industry standards or as specified in the task order. The Contractor shall follow proper coatings applications and environmental standards.

3.2 Composite Fabricator – The Contractor shall perform composite fabrication. The Contractor shall utilize laboratory equipment including, but not limited to, laser trackers, CAD design systems, additive manufacturing systems, numerically controlled milling machines, high-speed routers, ply cutters, advanced robotic fiber placement systems, heated paint rooms, conventional wood working equipment and autoclave systems to develop and instrument precision test articles and related structures, test specimens, and hardware for aerospace research applications. The Contractor shall work with a wide range of materials including, but not limited to, pre-preg, dry fabric cloths and unidirectional carbon fiber and fiberglass, release agents, and other room temperature, oven cure and autoclave processing materials. The Contractor shall perform ceramics processing and foundry operations to cast and mold non-metallic models and components. The Contractor shall utilize additive manufacturing technologies including stereolithography, fused deposition modeling, selective laser melting,

and wax patterns. In addition, the Contractor shall develop laser ablation techniques for processing unique materials not suitable for conventional processes.

3.3 Instrumentation – The Contractor shall install instrumentation in models and flight test articles ranging from plastics to ceramics to hybrid metals. The Contractor shall install components including, but not limited to, transducers, static pressure tubes and thermocouples. The Contractor shall utilize methods of instrumentation installation including, but not limited to, bonding, brazing, soldering, molding in place, spot welding and other physical attachment techniques. The Contractor shall advise as an expert authority on a wide variety of production materials and methods related to the organization's work in instrumentation applications technology including, but not limited to, metallic test article development; composite test article development; polymeric applications; electrostatic discharge brazing and soldering; general machining, woodworking and composite fabrication applications; various surface treatments; hardware quality assurance; and other related manufacturing and processing methods used in the production of research-oriented hardware for aerospace applications.

4.0 GENERAL MANAGEMENT

The Contractor shall interface with NASA and Contractor research scientists, engineers, and technicians, including Quality Assurance personnel. The only positions authorized to change contractual agreements or give technical direction are the contracting officer (CO) and contracting officer's representative (COR) to the extent of the delegation from the CO.

4.1 Task Order Control System- The Contractor shall establish, implement and maintain a task order control system required for planning, organization and controlling task order activities. The Contractor shall provide an automated system that establishes the task flow process to ensure flexibility, responsiveness, accuracy, and archiving of the task orders. The task order automated system shall allow for the electronic initiation, receiving, review, approval, issuance, and modification of task order(s). The task order automated system shall have password security for the designated Government officials with initiator editing and re-routing by each approver as needed, and with automatic notification to the approvers. The Contractor shall track and generate end user reports to include, but not limited to, individual task order's estimated cost, funded costs and fee, cumulative task orders estimated cost and fee; fabrication areas tasked, start, stop and completion dates, total task hours (ordered and used), and a completed task quality standard metric for customer feedback with comment input field. The system shall provide security levels to ensure it is secured and only viewable to authorized users. The Contractor shall provide all archived information from the automated task order system within 30 days of contract completion date.

4.2 Response – The Contractor shall be responsive to both routine and rapid response work order requests.

4.2.1 Routine Response – See Contract Section H.3 Task Ordering Procedures.

4.2.2 Rapid Response - The Contractor shall respond to LaRC rapid response request by the Contracting Officer (CO), or COR as needed. Upon receipt of a rapid response task order request, the Contractor shall provide a task order proposal for the requirement within 2 hours. Historically, there have been 5-6 rapid response requests per year with the total average of 8 hours of effort provided per request.

4.3 Progress/Program Meetings – The Contractor shall participate in reviews with the CO and NASA Engineering Directorate management to discuss cost planning, phasing and performance and the overall progress of the Contractor, subcontractors and vendors, on a daily basis, or as required by the CO. These reviews may include both formal and informal discussions with multiple customers requiring multiple products/reports, sometimes due concurrently.

4.4 Employee Certification & Training - The Contractor shall maintain certification and training records on all Contractor employees working on the contract. The Contractor shall ensure that all employees maintain required training and certifications as required by the NASA workmanship standards in PWS section 1.5 and welding, silver soldering, and brazing standards listed in PWS section 2.2.

4.5 Government Provided Training – The Government may require the Contractor to attend training and performance certifications on specific equipment or applications of particular unique procedures that are not commercially available. This additional training must be coordinated by the CO and/or COR.

In accordance with NPR 3410-2G, with the authorization of the cognizant CO or COR, the organization may permit NASA LaRC contractor personnel to attend authorized and scheduled NASA training, provided that space is available and such attendance does not deny civil service employees training. The training must be necessary for Government purposes.

Workmanship standards recertification training NASA LaRC provides:

NASA Standard	TITLE
NASA-STD-8739.1	Workmanship Standard for Polymeric Application on Electronic Assemblies
IPC J-STD-001ES	Joint Industry Standard, Space Applications Electronic Hardware Addendum to J-STD-001E Requirements for Soldering Electrical and Electronic Assemblies, December 2010 (Chapter 10 of IPC J-STD-001ES does not apply)
NASA-STD-8739.4	Crimping, Interconnecting Cables, Harnesses, and Wiring
~~NASA-STD-8739.5~~	~~Fiber Optics Terminations, Cable Assemblies, and Installation~~
LPR 8739.21	Langley Research Center (LaRC) Procedures and Guidelines for Electrostatic Discharge (ESD) Control ESD-Sensitive (ESDS) Devices Program

5.0 PLACE OF PERFORMANCE

The majority of work will be performed at LaRC.

5.1 Government Facilities On-Site - The Government facilities have equipment available for contract performance as listed below. The Government may modify, change, reconfigure or relocate on-site performance locations as needed without

notification to the Contractor. Currently the LaRC work sites are: Flight Test Article Laboratory - building 1232A, Advanced Machining Facility - building 1225, Composite Machining Lab/Material Casting Laboratory – building 1237, Hangar Annex - building 1244, Metal Warehouse – building 1245, Composite Model Development Laboratory - building 1238B, Research Lab, building 1202, Electronics Lab, building 1238A, and various research facilities, and on-board the various research aircraft.

5.2 Other Facilities– The Contractor shall provide support for Electronic, Mechanical and Composite Hardware Fabrication Support Services at other NASA Centers and at locations outside of NASA LaRC, on an as needed basis.

6.0 PHASE-IN

The contractor shall adhere to the approved Phase-In Plan. Any changes to the plan after contract award will be approved by the CO.

6.1 Access to Facilities – The contractor will be authorized access to Government facilities during the phase-in. Access shall not interfere with the work efforts of current contractor or Government personnel. The COR will assist in coordination of access to facilities. Office space will be provided during phase-in for up to two people.

7.0 APPLICABLE DOCUMENTS -

NASA LaRC LMS- CP-5640	Requesting, Performing, and Closing Fabrication Services Request
NASA LaRC LMS-CP-5646	Requesting, Performing, and Closing Non-Formal Fabrication Requests
Langley Form (LF) 133	Fabrication Work Request
LF 211	Heat Treatment Record
LF 213	Verification for QA Inspection
LF 214	Verification for PWB Layout
LF 248	Materials Analysis and Quality Assurance Laboratory (MAQAL) Work Request
LPR 1440.7	LaRC Records Management Procedural Requirements
LMS-CP-4501	Procurement Process Overview
LMS-CP-4892	Bonded Storage
LMS-CP-5507	Reporting and Disposition of Nonconforming Aerospace Hardware Items and Products
LMS-CP-5514	Controlled Stores
LMS-OP-5641	Contractual Resource Management for Fabrication
LMS-CP-5698	Welding
LF 34	Welder's Concurrency Log Entry
LF 471	Weld Procedure Specification (WPS)
LF 472	Welder Performance Qualification (WPQ)
LF 473	Procedure Qualification Record (PQR)
LMS-OP-5642	NDE Procedures
NPR 4200.1	Equipment Management

NPR 8735.2	Management of Government Quality Assurance Functions for NASA Contracts
LMS-BP-8737	FTDB Identification and Traceability of Products Policy
LMS-BP-8738	MATB Identification and Traceability of Products Policy
LPR 1440.7	Records Management
Institute of Printed Circuits IPC-6012	Qualification and Performance Specification for Rigid Printed Boards
AWS B2.1	Base Metal Grouping for Welding Procedure and Performance Qualification
ASME Section IX	Welding and Brazing Qualifications
NASA-STD-8739.1	Workmanship Standard for Polymeric Application on Electronic Assemblies
IPC J-STD-001ES	Joint Industry Standard, Space Applications Electronic Hardware Addendum to J-STD-001E Requirements for Soldering Electrical and Electronic Assemblies, December 2010 (Chapter 10 of IPC J-STD-001ES does not apply)
NASA-STD-8739.4	Crimping, Interconnecting Cables, Harnesses, and Wiring
NASA-STD-8739.5	Fiber Optics Terminations, Cable Assemblies, and Installation
NASA-STD-8739.6	Implementation Requirements for NASA Workmanship Standards
LPR 8739.21	Langley Research Center (LaRC) Procedures and Guidelines for Electrostatic Discharge (ESD) Control ESD-Sensitive (ESDS) Devices Program

APPENDIX A
Definitions, Abbreviations, and Acronyms

Term	Definition
ASME	American Society of Mechanical Engineers
AWS	American Welding Society
CNC	Computer Numerically Controlled
CO	Contracting Officer
COR	Contracting Officer's Representative
COTS	Commercial Off The Shelf
CP	Center Procedure
EMCHFSS	Electronic, Mechanical, Composite, Hardware Fabrication Support Services
ED	Engineering Directorate
EDM	Electrical Discharge machining
FCAW	Flux Cored Arc Welding
FTDB	Fabrication Technology Development Branch
GMAW	Gas Metal Arc Welding
IPC	Institute of Printed Circuits
IPC-6012	Qualification and Performance Specification of Rigid Printed Boards
LaRC	Langley Research Center
LF	Langley Form
LMS	Langley Management System
LPR	Langley Procedural Requirement
MATB	Metal Applications Technology Branch
MIG	Metal Inert Gas
NASA	National Aeronautics and Space Administration
NPR	NASA Procedural Requirement
On-Site	Langley Research Center (LaRC) or other NASA Centers
PWS	Performance Work Statement similar to a Statement of Work and used synonymously
Response	Having Contractor personnel working on-site at the NASA LaRC facility
Rapid Response	An unexpected occurrence or set of circumstances demanding immediate action at the discretion of the CO or COR outside the normal work hours (Monday thru Friday 7:00 am – 5:30 p.m.)
RFQ	Request for Quote
SHAW	Shielded Metal Arc Welding
TIG	Tungsten Inert Gas