Statement of Work

for the

Lunar Atmosphere and Dust Environment Explorer (LADEE) Project

Fabrication of the Spacecraft Composite Structure

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Revision DRAFT

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Ames Research Center
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National Aeronautics and
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TO VERIFY THAT THIS IS THE CORRECT VERSION PRIOR TO USE.

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1.0 Introduction

1.1 General Information

The National Aeronautics and Space Administration (NASA), the Science Mission Directorate (SMD) and the Lunar Quest Program (LQP) have the stated mission to design, develop, integrate, launch, and operate the Lunar Atmosphere and Dust Environment Explorer (LADEE).

LADEE is a strategic lunar science mission with several objectives:

- Address the NRC Scientific Context for Exploration of the Moon goal of determining the global density, composition, and time variability of the fragile lunar atmosphere before it is further perturbed by future human activity,
- Demonstrate the ability to utilize optical laser communications equipment to provide high bandwidth communication from the Moon,
- Demonstrate a low-cost reusable spacecraft bus architecture for future Planetary Science missions, and
- Demonstrate the use of a small class expendable launch vehicle (e.g. Minotaur IV+) for lunar missions from the Wallops Flight Facility.

A small, modular spacecraft which contains bus electronics and communications equipment, solar arrays and batteries, pointing and control hardware, LADEE accommodates three scientific instruments and one technology demonstration payload.

This document defines the work to be performed for Contractor fabrication and delivery of the LADEE modular spacecraft composite structure, from here on referred to as the composite structure, structure, or module(s).

1.2 General Requirements

The Contractor shall provide the personnel, facilities, and raw materials necessary to fabricate, test, and deliver:

1) Test coupons fabricated from the materials and processes to be utilized in the flight spacecraft structure.
2) The flight structure for the LADEE spacecraft.
3) A second spacecraft structure that will be tested to qualification levels or used as a flight spare structure.

Each of the two structures are comprised of four (4) monocoque modules, a propulsion structure, internal cruciform panels, a radiator structural panel and thirty-four (30 flight + 4 spare) solar cell substrate panels.

Included in the response, the contractor shall address the detailed approach and scheduling of the following items:

1. Opportunities For Cost Reduction

2. Contractor Kick-off Meeting
3. Procurement of all raw materials
4. Design and fabrication of necessary tooling beyond that supplied by NASA
5. Material Verification Testing
6. Manufacturing Verification Testing
7. Product Assurance Implementation Plan
8. Schedule for Manufacturing Readiness Reviews
9. Detailed schedule for delivery of all items

Option 1- The contractor shall address the option of performing coupon testing to define a database of material properties. This shall be based on a quantity of 700 individual coupon load tests. Witness coupon testing of 150 individual coupon load tests shall also be addressed. See section 8.1 for details.

Option 2 – The contractor shall address a contract option of adding a task to apply the aluminum foil spacecraft grounding system to the spacecraft module structure. See Section 8.2 for details.

1.3 Applicable Documents

All applicable and reference documentation identified in this document shall apply in the situations where they are specifically referenced. In the event of a conflict between the SOW and the specification, the SOW shall take precedence. See Appendix C for a list of referenced documents.

1.4 Government Furnished Equipment (GFE)

NASA will offer existing molds and basic tooling that the Contractor is encouraged to use or investigate using for manufacturing of the LADEE structure. A complete listing of the GFE available is contained in section *4.6 GFE Available*. Inspection reports are also available of this equipment upon request. Contractors electing to not use the existing GFE are encouraged to show the cost implications in their proposal submittal as a separate option for any molds and tooling that would be used instead of the existing GFE.

1.5 On-site Government Representative

The Government plans to have continuous onsite representation at the contractor. The representative will be onsite for quality control oversight and to expedite closure of mandatory government inspection points designed into the manufacturing process. Contractors should plan accordingly.

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2.0 Management, Reporting, Documentation and Reviews

2.1 Management and Reporting

The contractor shall designate personnel who will be given full responsibility and authority to manage and administer all phases of the work specified by the contract and ensure that all objectives are accomplished within schedule and cost constraints.

The contractor shall designate and identify by name a single individual who shall serve as a point of contact with the ARC Contracting Officer's Technical Representative (COTR) for all technical aspects of the Composite Structures contract.

The contractor shall perform all necessary functions to manage program resources, control schedules, and manage engineering, manufacturing and procurement activities. The contractor shall perform all necessary configuration management, Quality Assurance, documentation control, and distribution functions.

The contractor shall prepare and present to the NASA/ARC COTR monthly status via telecon and a written report. The report shall contain a summary of work accomplished, a summary of problems encountered, nonconformance's and their resolution, summaries of inspection and test activities, copies of written approvals for deviations from approved drawings, copies of material certifications and certificates of conformance for raw materials received that period, and a discussion of issues that might affect schedule.
The contractor shall also generate a list of significant milestones that will enable the NASA/ARC COTR to ascertain program progress.

2.2 Documentation

The contractor shall ensure the generation and delivery of all documentation as called for in the Contract.

In addition to that documentation specifically called for in the Contract, upon request by the NASA/ARC COTR, the contractor shall make available a copy of any document or data generated during this contract performance for review by the ARC at either the contractor's facility or via the internet. This includes, but is not limited to, technical reports and memorandums, drawings, schematics, studies, analyses, parts and materials data, test data, alerts, etc. Reference section 3.2.4 for data delivery package details.

2.3 Reviews and Meetings

The required meetings are outlined below. The NASA/ARC COTR shall have the authority to remove the requirement for meetings as the production develops.

The following reviews shall be performed-

2.3.1 Contractor Kick-Off Meeting

The Contractor shall organize and present a Kick-Off meeting to an ARC Review Team at the Contractor's facility, unless otherwise agreed to by the contractor and NASA/ARC COTR, on a date defined in the contract. This review shall establish that the baseline manufacturing

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requirements are clearly understood and that procurement definition is complete as specified in this document, and the LADEE Structure Deliverable Items List and Schedule. This review shall also provide an opportunity to review drawings and processes.

This Kick-Off Meeting shall cover programmatic, technical, test and verification, and quality assurance topics. The Kick-Off meeting shall demonstrate that planning for the remaining project activities is adequate and that there are reasonable expectations that the project will accommodate any imposed constraints and meet its success criteria within the allocated resources.

The contractor shall provide to ARC a Kick-Off meeting presentation package and all other required deliverable data one week prior to the review.

Review minutes shall be prepared and, as a minimum, shall include attendance, action items, action item accomplishment responsibility and agreements. All items shall be in sufficient detail to be self-explanatory. A Review Report shall be prepared following the Kick-Off meeting and, as a minimum, contain meeting notice, agenda, review meeting minutes described above and responses to all recommendations and action items.

2.3.2 Manufacturing Readiness Reviews (MRRs)

The Contractor shall organize and present a Manufacturing readiness Review to an ARC Review Team at the Contractor's facility prior to each of the three main manufacturing phases:

1. Coupons
2. Flight Structure
3. Flight Spare Structure

This review shall demonstrate overall conformance of the requirements specified in this Statement of Work. This review shall cover programmatic, technical, test and verification, and quality assurance topics. This review shall also provide an opportunity to review drawings and all analyses required to be approved before the start of fabrication. Drawings and analyses should be released or ready for final review and approval. This review shall cover programmatic, technical, test and verification, quality assurance topics, and overall status.

The contractor shall provide to ARC a Manufacturing Readiness Review Presentation Package and all other required deliverable data one week prior to the review. Refer to section 3.2.3 for the list of required deliverable data.

Review minutes shall be prepared and, as a minimum, shall include attendance, action items, action item accomplishment responsibility and agreements. All items shall be in sufficient detail to be self-explanatory. A Manufacturing Readiness Review Report shall be prepared and delivered following the review and, as a minimum, contain meeting notice, agenda, review meeting minutes described above and responses to all recommendations and action items. These items will be tracked at the weekly status telecoms (WSMs).

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2.3.3 Weekly Status Meetings (WSM)

Weekly status meetings will be held at an agreed upon time at the Contractor facility. NASA/ARC COTR will participate in person or via WebEx/Telecom. Planned vs. Actual progress will be presented along with action item tracking and any other programmatic or technical topics will be discussed

2.3.4 Monthly Progress Reports (MPR)

The contractor shall produce a Monthly Progress Report (MPR). This report shall cover programmatic, technical, test and verification, and quality assurance progress and status. This report shall also include a review of all tooling design, test plans and procedures and all analyses required to convey project status. This report shall demonstrate continued conformance to the requirements specified in this SOW appropriate to the fabrication phase.

2.3.5 Pre-Ship Review (PSR)

The Contractor shall hold a Pre-Ship Review at the contractor's plant at the completion of verification tests and prior to shipment of the hardware to ARC. A PSR shall be held prior to the delivery of each hardware item. Any differences between the hardware to be delivered and the drawings or specifications shall be listed and acceptance justifications presented. Any differences between the Flight Structure and the Flight Spare Structure shall be presented if necessary. At the time of the PSR, documents and analysis to support satisfaction of the requirements of this SOW for the hardware being delivered shall be complete and all actions from previous reviews for the hardware being delivered shall be closed.

A Data Delivery Package (reference 3.2.4) shall be presented for review at each PSR. The contractor shall deliver objective evidence with the hardware, showing product assurance acceptance of in-process workmanship processes, and final inspection. The contractor must implement all corrective actions necessary to remedy, before final acceptance, any nonconformance with respect to this SOW or the specifications noted on the design drawings. A government source inspection shall be required prior to shipment. ARC or its representative shall have final approval authority over all tests, verification, and documentation.

2.3.6 Technical Interchange Meetings (TIM)

The contractor shall plan for informal, face-to-face technical interchange meetings to be held at the contractor facilities. These TIMs shall support review and coordination of technical issues including, but not limited to, parts, test plans, test procedures, design modifications, and design analyses. The TIM meeting notice shall be seven (7) calendar days in advance of each meeting. ARC or the Contractor can initiate TIMs.

2.4 Notification to NASA/ARC Contracting Officer (CO) and Contracting Officer's Technical Representative (COTR)

The contractor shall notify the NASA/ARC Contracting Officer's Technical Representative at least seven (7) calendar days in advance of all mandatory hardware inspections, test activities,

and deliveries at either the Contractor's or a sub-Contractor's facility to allow timely participation by the NASA/ARC Quality Assurance personnel.

3.0 Engineering

3.1 General Requirements

The contractor shall perform design, analysis, fabrication, and inspection of any additional tooling or processes required, to produce the deliverable hardware beyond that provided by NASA. The contractor shall participate in concurrent engineering with ARC throughout the program to resolve any discrepancies between coupon and/or part design and their specified performance.

3.2 Engineering Documentation

The contractor shall perform engineering analyses of the detail design and assembly drawings and subsequent fabrication process documentation, test, and inspection reports of the tooling that is used in the fabrication process. Contractor format is suitable for this documentation upon approval at the MRR.

3.2.2 Drawing Package

The contractor shall provide a drawing package that includes, but is not limited, to all mechanical detail and assembly drawings for all tooling required for manufacturing that has not already been provided by NASA.

3.2.4 Manufacturing Process Package

The contractor shall prepare a Manufacturing Processes Package that contains any contractor specific manufacturing processes that will be utilized during fabrication of the delivered hardware. This package must describe any deviations from the NASA supplied process specifications, and obtain NASA/ARC COTR approval prior to their usage. This package will be previewed at the Manufacturing Readiness Review meeting. Approval of contractor processes and procedures will be obtained by a successful MRR.

3.2.5 Data Delivery Package

The Data Delivery Package shall be made available for review during mandatory inspections and pre-ship reviews for each of the different hardware deliverables. This package shall also be delivered with each end item with the level of detail required of that item. The package shall be comprised of, but not limited to, the following data:

- As-Built vs. As Designed drawings (with appropriately dispositioned non-conformance reports)
- Final Drawing Package (including rework instructions, if any)
- Problem/anomaly reporting (complete copies of report)
- Deviations/Waivers/open items/non-conformances and their dispositions,
- Class I (?) MRBs (complete copies of reports)
- List of Materials, including lot and expiration data, when applicable, and certifications, and list of Processes used

- Log of total material out- time for all life limited materials
- List and status of all identified Life-Limited Items
- Dimensional Inspection Reports for all deliverable hardware
- Photographic or Video Documentation of all critical manufacturing steps and procedures
- Results of the Non-Destructive Examination (such as Ultrasonic Test)
- List of Open Items with reason for item(s) being open and proposed closure date
- Contamination Control compliance documentation
- Tooling drawings and tooling inspection reports
- Manufacturing Processes (contractor specific)
- Autoclave or press log books and recorded cure profiles
- Traceable Time and location details of all material (ie. epoxy) lots used
- Any data packages (checklists) specifically called out from process and manufacturing procedures
- Temperature and humidity logs of all controlled storage and manufacturing facilities
- Assembly travelers of the module level and above
- Certification logs for all hardware and fabricated piece parts.
- As-run test plans and test reports.

3.2.5 Verification Plan

A Verification Plan shall be generated and delivered by the contractor to demonstrate planned hardware conformance to the drawings, processes and procedures. This plan shall include procedures for non-destructive examination (NDE) of the finished parts. The verification Plan shall identify required inspections, tests (such as NDE), fit checks, etc. as required to ensure proper manufacturing and assembly meet design specifications, and that no outstanding non-conformances due to workmanship or material problems exist.

The plan shall state the purpose of each test, state acceptance criteria, describe in detail the test method, instrumentation, and any limitations of the test. The verification test sequence shall be provided. The plan should include a test matrix summarizing all tests that will be performed on the deliverables.

The test organization shall be defined, including definition of personnel authority and responsibility. Key facilities that are required for each test shall be identified, with particular attention paid to special facilities that ma be resource constrained or only available at a subcontractor's facility. Contractor format is acceptable.

This plan shall be a contractor controlled document and shall indicate all changes made after the initial approval by the NASA/ARC COTR. After verification test plan approval, no changes shall be made without written NASA/ARC COTR approval. The NDE test must conform to AIA/NAS NAS 999, Nondestructive Inspection of Advanced Composite Structures.

3.2.6 Verification Test Procedures

The contractor shall generate Verification Test Procedures. The verification procedures shall be step-by-step instructions for performing tests outlined by the Verification Test Plan. The

procedures shall define the environmental conditions for the tests, required equipment and facilities, test constraints, use of diagnostic or performance test software, operating conditions, tolerance on all input stimuli, data to be recorded and pass/fail limits. Test procedures shall also include details with respect to any GSE required.

Verification test procedures shall be contractor controlled documents and shall indicate all changes made after the initial release for review to NASA. The finalized as-run/redlined document shall be transmitted to NASA as part of the deliverables.

3.2.7 Contamination Control Plan

The Contractor shall provide a Contamination Control Plan to ARC for review. All delivered hardware should be delivered visibly clean, contain no particulate from manufacturing, and all surfaces should be wiped with IPA. No silicon adhesives or machining oils etc. are allowed during any processing of the material or structure components as specified in the LADEE Contamination Control Plan (C35.LADEE.CCP). The contractor shall establish the specific cleanliness requirements to minimize degradation.

4.0 Hardware Manufacture

4.1 Contamination Control Requirements

The contractor shall establish the specific cleanliness requirements to minimize performance degradation and delineate the approaches to meet the LADEE Project requirements as specified in the LADEE Contamination Control Plan (C35.LADEE.CCP).

4.2 Limited-Life Items

The contractor shall identify, procure, and manage limited-life items. Limited-life items include all materials that are subject to degradation because of limited shelf life or freezer out-time. This includes all CFRP prepreg and adhesives. All limited life items such as these shall have detailed logs tracking their storage and use per ACB-L-080A-XR010.

4.3 Composite Test Coupons

The Contractor shall manufacture test coupons, detail specimens and element specimens per drawings ACB-L-080K-M100 thru 150. All manufacturing processes used shall be per ACB-L-080A-XR002, -003, -010 and -011. These coupons will be tested to develop the B-Basis statistically developed property database. All processes and procedures including documentation should be followed as if these were the flight article. MRR is required. Shipping multiple batches of coupons to NASA/ARC as they are manufactured is encouraged. All bonded bushings, inserts, and brackets shall be fabricated, inspected, and installed by the contractor.

Note: Testing of these coupons and developing the B-Basis database is offered as option 1 in this SOW.

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4.4 Spacecraft Flight Structure

All manufacturing processes used shall be per ACB-L-080A-XR002, -XR003, -XR004, -XR010 and -XR011. All bonded bushings, inserts, and brackets shall be fabricated, inspected, and installed by the contractor.

Contractor shall manufacture and inspect a spacecraft qualification structure per drawings:

File Name	Drawing	Description
ACB-L-080A-M150_PRE_12-21-09.pdf	ACB-L-080A-M150	LADEE STRUCTURE
ACB-L-080B-M001_PRE_12-2-09.pdf	ACB-L-080B-M001	BUS MODULE
ACB-L-080B-M004_PRE_12-15-09.pdf	ACB-L-080B-M004	RADIATOR PANEL
ACB-L-080B-M010_PRE_12-9-09.pdf	ACB-L-080B-M010	BUS MODULE SOLAR PANEL
ACB-L-080C-M001_PRE_12-3-09.pdf	ACB-L-080C-M001	EXTENSION MODULE
ACB-L-080C-M008_PRE_12-8-09.pdf	ACB-L-080C-M008	EXTENSION MODULE SOLAR PANEL
ACB-L-080D-M043_PRE_12-14-09.pdf	ACB-L-080D-M043	PROPULSION DECK
ACB-L-080D-M044_PRE_12-14-09.pdf	ACB-L-080D-M044	PROPULSION WEB 1
ACB-L-080D-M045_PRE_12-14-09.pdf	ACB-L-080D-M045	PROPULSION WEB 2
ACB-L-080D-M049_PRE_12-14-09.pdf	ACB-L-080D-M049	PROPULSION CRUCIFORM
ACB-L-080D-M050_PRE_12-14-09.pdf	ACB-L-080D-M050	PROPULSION WEB 3
ACB-L-080F-M001_PRE_2-24-09.pdf	ACB-L-080F-M001	PAYLOAD MODULE
ACB-L-080F-M005_PRE_12-9-09.pdf	ACB-L-080F-M005	PAYLOAD CRUCIFORM
ACB-L-080F-M007_PRE_12-14-09.pdf	ACB-L-080F-M007	PAYLOAD MONOCOQUE
ACB-L-080F-M120_PRE_12-9-09.pdf	ACB-L-080F-M120	PAYLOAD MODULE CRUCIFORM PANEL 1
ACB-L-080F-M121_PRE_12-9-09.pdf	ACB-L-080F-M121	PAYLOAD MODULE CRUCIFORM PANEL 2
ACB-L-080F-M122_PRE_12-9-09.pdf	ACB-L-080F-M122	PAYLOAD MODULE CRUCIFORM PANEL 3
ACB-L-081A-M001_PRE_07-08-09.pdf	ACB-L-081A-M001	LADEE DATUMS
ACB-L-081B-M023_PRE_12-3-09.pdf	ACB-L-081B-M023	BUS MODULE SIDE CORE
ACB-L-081B-M024_PRE_12-3-09.pdf	ACB-L-081B-M024	BUS MODULE TOP CORE
ACB-L-081B-M025_PRE_12-3-09.pdf	ACB-L-081B-M025	BUS MODULE BOTTOM CORE
ACB-L-081B-M101_PRE_12-3-09.pdf	ACB-L-081B-M101	PLY 1, BUS MODULE
ACB-L-081B-M102_PRE_12-3-09.pdf	ACB-L-081B-M102	PLY 2, BUS MODULE
ACB-L-081B-M103_PRE_12-3-09.pdf	ACB-L-081B-M103	PLY 3, BUS MODULE
ACB-L-081B-M104_PRE_12-3-09.pdf	ACB-L-081B-M104	PLY 4, BUS MODULE
ACB-L-081B-M105_PRE_12-3-09.pdf	ACB-L-081B-M105	PLY 5, BUS MODULE
ACB-L-081B-M106_PRE_12-3-09.pdf	ACB-L-081B-M106	PLY 6, BUS MODULE
ACB-L-081B-M107_PRE_12-3-09.pdf	ACB-L-081B-M107	PLY 7, BUS MODULE
ACB-L-081B-M108_PRE_12-3-09.pdf	ACB-L-081B-M108	PLY 8, BUS MODULE
ACB-L-081B-M109_PRE_12-3-09.pdf	ACB-L-081B-M109	PLY 9, BUS MODULE
ACB-L-081B-M110_PRE_12-3-09.pdf	ACB-L-081B-M110	PLY 10, BUS MODULE
ACB-L-081B-M111_PRE_12-3-09.pdf	ACB-L-081B-M111	PLY 11, BUS MODULE
ACB-L-081B-M112_PRE_12-3-09.pdf	ACB-L-081B-M112	PLY 12, BUS MODULE
ACB-L-081B-M113_PRE_12-3-09.pdf	ACB-L-081B-M113	PLY 13, BUS MODULE
ACB-L-081B-M114_PRE_12-3-09.pdf	ACB-L-081B-M114	PLY 14, BUS MODULE
ACB-L-081B-M115_PRE_12-3-09.pdf	ACB-L-081B-M115	PLY 15, BUS MODULE
ACB-L-081B-M116_PRE_12-3-09.pdf	ACB-L-081B-M116	PLY 16, BUS MODULE
ACB-L-081B-M120_PRE_12-9-09.pdf	ACB-L-081B-M120	KAPTON LAYER, BUS MODULE
ACB-L-081C-M015_PRE_12-4-09.pdf	ACB-L-081C-M015	EXTENSION MODULE BOTTOM CORE
ACB-L-081C-M027_PRE_12-4-09.pdf	ACB-L-081C-M027	EXTENSION MODULE TOP CORE
ACB-L-081C-M028_PRE_12-4-09.pdf	ACB-L-081C-M028	EXTENSION MODULE SIDE CORE
ACB-L-081C-M033_PRE_12-16-09.pdf	ACB-L-081C-M033	DOUBLE SIDED BUSHING, #10 CUP
ACB-L-081C-M034_PRE_12-16-09.pdf	ACB-L-081C-M034	DOUBLE SIDED BUSHING, #10 THRU PLUG
ACB-L-081C-M101_PRE_12-4-09.pdf	ACB-L-081C-M101	PLY 1, EXTENSION MODULE
ACB-L-081C-M102_PRE_12-4-09.pdf	ACB-L-081C-M102	PLY 2, EXTENSION MODULE
ACB-L-081C-M103_PRE_12-4-09.pdf	ACB-L-081C-M103	PLY 3, EXTENSION MODULE
ACB-L-081C-M104_PRE_12-4-09.pdf	ACB-L-081C-M104	PLY 4, EXTENSION MODULE
ACB-L-081C-M105_PRE_12-4-09.pdf	ACB-L-081C-M105	PLY 5, EXTENSION MODULE
ACB-L-081C-M106_PRE_12-4-09.pdf	ACB-L-081C-M106	PLY 6, EXTENSION MODULE
ACB-L-081C-M107_PRE_12-4-09.pdf	ACB-L-081C-M107	PLY 7, EXTENSION MODULE
ACB-L-081C-M108_PRE_12-4-09.pdf	ACB-L-081C-M108	PLY 8, EXTENSION MODULE
ACB-L-081C-M109_PRE_12-4-09.pdf	ACB-L-081C-M109	PLY 9, EXTENSION MODULE
ACB-L-081C-M110_PRE_12-4-09.pdf	ACB-L-081C-M110	PLY 10, EXTENSION MODULE
ACB-L-081C-M111_PRE_12-4-09.pdf	ACB-L-081C-M111	PLY 11, EXTENSION MODULE
ACB-L-081C-M112_PRE_12-4-09.pdf	ACB-L-081C-M112	PLY 12, EXTENSION MODULE
ACB-L-081C-M113_PRE_12-4-09.pdf	ACB-L-081C-M113	PLY 13, EXTENSION MODULE
ACB-L-081C-M114_PRE_12-4-09.pdf	ACB-L-081C-M114	PLY 14, EXTENSION MODULE

ACB-L-081C-M115_PRE_12-4-09.pdf	ACB-L-081C-M115	PLY 15, EXTENSION MODULE
ACB-L-081C-M116_PRE_12-4-09.pdf	ACB-L-081C-M116	PLY 16, EXTENSION MODULE
ACB-L-081C-M120_PRE_12-8-09.pdf	ACB-L-081C-M120	KAPTON LAYER, EXTENSION MODULE SOLAR PANEL
ACB-L-080D-M016_PRE_12-4-09.pdf	ACB-L-080D-M016	SINGLE STAGE MODULE
ACB-L-081D-M198_PRE_12-14-09.pdf	ACB-L-081D-M198	MLB PATTER FITTING
ACB-L-081E-M137_PRE_12-16-09.pdf	ACB-L-081E-M137	GROUND BUSHING
ACB-L-081F-M011_PRE_12-14-09.pdf	ACB-L-081F-M011	PAYLOAD CRUCIFORM END BRACKET
ACB-L-081F-M086_PRE_12-16-09.pdf	ACB-L-081F-M086	LDEX BUSHING, MALE
ACB-L-081F-M087_PRE_12-16-09.pdf	ACB-L-081F-M087	LDEX BUSHING, FEMALE
ACB-L-081F-M099_PRE_12-16-09.pdf	ACB-L-081F-M099	DOUBLE SIDED BUSHING, #8 THREADED PLUG
ACB-L-081F-M111_PRE_12-16-09.pdf	ACB-L-081F-M111	DOUBLE SIDED BUSHING, #8 CUP
ACB-L-081F-M112_PRE_12-16-09.pdf	ACB-L-081F-M112	DOUBLE SIDED BUSHINGS, .25 DIA. PIN CUP
ACB-L-081F-M118_PRE_12-14-09.pdf	ACB-L-081F-M118	PAYLOAD CRUCIFORM BOLT PATTER 2 FITTING
ACB-L-081F-M119_PRE_12-11-09.pdf	ACB-L-081F-M119	CRUCIFORM PANELS COMMON FITTING

Witness specimens shall be provided as deliverable items to be manufactured from drop areas of modules or panels (coupon and detail samples, 3 of each type) or cured concurrently with module ('L'-element samples, 3 each) or bonded concurrently with panel fittings (fitting element samples (3 each) (all TBS/TBR).

4.5 Spacecraft Flight Spare Structure

All manufacturing processes used shall be per ACB-L-080A-XR002, -003, -004, -010 and -011. All bonded bushings, inserts, and brackets shall be fabricated, inspected, and installed by the contractor.

Contractor shall manufacture test a spacecraft flight structure per drawings:

File Name	Drawing	Description
ACB-L-080A-M150_PRE_12-21-09.pdf	ACB-L-080A-M150	LADEE STRUCTURE
ACB-L-080B-M001_PRE_12-2-09.pdf	ACB-L-080B-M001	BUS MODULE
ACB-L-080B-M004_PRE_12-15-09.pdf	ACB-L-080B-M004	RADIATOR PANEL
ACB-L-080B-M010_PRE_12-9-09.pdf	ACB-L-080B-M010	BUS MODULE SOLAR PANEL
ACB-L-080C-M001_PRE_12-3-09.pdf	ACB-L-080C-M001	EXTENSION MODULE
ACB-L-080C-M008_PRE_12-8-09.pdf	ACB-L-080C-M008	EXTENSION MODULE SOLAR PANEL
ACB-L-080D-M043_PRE_12-14-09.pdf	ACB-L-080D-M043	PROPULSION DECK
ACB-L-080D-M044_PRE_12-14-09.pdf	ACB-L-080D-M044	PROPULSION WEB 1
ACB-L-080D-M045_PRE_12-14-09.pdf	ACB-L-080D-M045	PROPULSION WEB 2
ACB-L-080D-M049_PRE_12-14-09.pdf	ACB-L-080D-M049	PROPULSION CRUCIFORM
ACB-L-080D-M050_PRE_12-14-09.pdf	ACB-L-080D-M050	PROPULSION WEB 3
ACB-L-080F-M001_PRE_2-24-09.pdf	ACB-L-080F-M001	PAYLOAD MODULE
ACB-L-080F-M005_PRE_12-9-09.pdf	ACB-L-080F-M005	PAYLOAD CRUCIFORM
ACB-L-080F-M007_PRE_12-14-09.pdf	ACB-L-080F-M007	PAYLOAD MONOCOQUE
ACB-L-080F-M120_PRE_12-9-09.pdf	ACB-L-080F-M120	PAYLOAD MODULE CRUCIFORM PANEL 1
ACB-L-080F-M121_PRE_12-9-09.pdf	ACB-L-080F-M121	PAYLOAD MODULE CRUCIFORM PANEL 2
ACB-L-080F-M122_PRE_12-9-09.pdf	ACB-L-080F-M122	PAYLOAD MODULE CRUCIFORM PANEL 3
ACB-L-081A-M001_PRE_07-08-09.pdf	ACB-L-081A-M001	LADEE DATUMS
ACB-L-081B-M023_PRE_12-3-09.pdf	ACB-L-081B-M023	BUS MODULE SIDE CORE
ACB-L-081B-M024_PRE_12-3-09.pdf	ACB-L-081B-M024	BUS MODULE TOP CORE
ACB-L-081B-M025_PRE_12-3-09.pdf	ACB-L-081B-M025	BUS MODULE BOTTOM CORE
ACB-L-081B-M101_PRE_12-3-09.pdf	ACB-L-081B-M101	PLY 1, BUS MODULE
ACB-L-081B-M102_PRE_12-3-09.pdf	ACB-L-081B-M102	PLY 2, BUS MODULE
ACB-L-081B-M103_PRE_12-3-09.pdf	ACB-L-081B-M103	PLY 3, BUS MODULE
ACB-L-081B-M104_PRE_12-3-09.pdf	ACB-L-081B-M104	PLY 4, BUS MODULE
ACB-L-081B-M105_PRE_12-3-09.pdf	ACB-L-081B-M105	PLY 5, BUS MODULE
ACB-L-081B-M106_PRE_12-3-09.pdf	ACB-L-081B-M106	PLY 6, BUS MODULE
ACB-L-081B-M107_PRE_12-3-09.pdf	ACB-L-081B-M107	PLY 7, BUS MODULE
ACB-L-081B-M108_PRE_12-3-09.pdf	ACB-L-081B-M108	PLY 8, BUS MODULE
ACB-L-081B-M109_PRE_12-3-09.pdf	ACB-L-081B-M109	PLY 9, BUS MODULE
ACB-L-081B-M110_PRE_12-3-09.pdf	ACB-L-081B-M110	PLY 10, BUS MODULE
ACB-L-081B-M111_PRE_12-3-09.pdf	ACB-L-081B-M111	PLY 11, BUS MODULE

ACB-L-081B-M112_PRE_12-3-09.pdf	ACB-L-081B-M112	PLY 12, BUS MODULE
ACB-L-081B-M113_PRE_12-3-09.pdf	ACB-L-081B-M113	PLY 13, BUS MODULE
ACB-L-081B-M114_PRE_12-3-09.pdf	ACB-L-081B-M114	PLY 14, BUS MODULE
ACB-L-081B-M115_PRE_12-3-09.pdf	ACB-L-081B-M115	PLY 15, BUS MODULE
ACB-L-081B-M116_PRE_12-3-09.pdf	ACB-L-081B-M116	PLY 16, BUS MODULE
ACB-L-081B-M120_PRE_12-9-09.pdf	ACB-L-081B-M120	KAPTON LAYER, BUS MODULE
ACB-L-081C-M015_PRE_12-4-09.pdf	ACB-L-081C-M015	EXTENSION MODULE BOTTOM CORE
ACB-L-081C-M027_PRE_12-4-09.pdf	ACB-L-081C-M027	EXTENSION MODULE TOP CORE
ACB-L-081C-M028_PRE_12-4-09.pdf	ACB-L-081C-M028	EXTENSION MODULE SIDE CORE
ACB-L-081C-M033_PRE_12-16-09.pdf	ACB-L-081C-M033	DOUBLE SIDED BUSHING, #10 CUP
ACB-L-081C-M034_PRE_12-16-09.pdf	ACB-L-081C-M034	DOUBLE SIDED BUSHING, #10 THRU PLUG
ACB-L-081C-M101_PRE_12-4-09.pdf	ACB-L-081C-M101	PLY 1, EXTENSION MODULE
ACB-L-081C-M102_PRE_12-4-09.pdf	ACB-L-081C-M102	PLY 2, EXTENSION MODULE
ACB-L-081C-M103_PRE_12-4-09.pdf	ACB-L-081C-M103	PLY 3, EXTENSION MODULE
ACB-L-081C-M104_PRE_12-4-09.pdf	ACB-L-081C-M104	PLY 4, EXTENSION MODULE
ACB-L-081C-M105_PRE_12-4-09.pdf	ACB-L-081C-M105	PLY 5, EXTENSION MODULE
ACB-L-081C-M106_PRE_12-4-09.pdf	ACB-L-081C-M106	PLY 6, EXTENSION MODULE
ACB-L-081C-M107_PRE_12-4-09.pdf	ACB-L-081C-M107	PLY 7, EXTENSION MODULE
ACB-L-081C-M108_PRE_12-4-09.pdf	ACB-L-081C-M108	PLY 8, EXTENSION MODULE
ACB-L-081C-M109_PRE_12-4-09.pdf	ACB-L-081C-M109	PLY 9, EXTENSION MODULE
ACB-L-081C-M110_PRE_12-4-09.pdf	ACB-L-081C-M110	PLY 10, EXTENSION MODULE
ACB-L-081C-M111_PRE_12-4-09.pdf	ACB-L-081C-M111	PLY 11, EXTENSION MODULE
ACB-L-081C-M112_PRE_12-4-09.pdf	ACB-L-081C-M112	PLY 12, EXTENSION MODULE
ACB-L-081C-M113_PRE_12-4-09.pdf	ACB-L-081C-M113	PLY 13, EXTENSION MODULE
ACB-L-081C-M114_PRE_12-4-09.pdf	ACB-L-081C-M114	PLY 14, EXTENSION MODULE
ACB-L-081C-M115_PRE_12-4-09.pdf	ACB-L-081C-M115	PLY 15, EXTENSION MODULE
ACB-L-081C-M116_PRE_12-4-09.pdf	ACB-L-081C-M116	PLY 16, EXTENSION MODULE
ACB-L-081C-M120_PRE_12-8-09.pdf	ACB-L-081C-M120	KAPTON LAYER, EXTENSION MODULE SOLAR PANEL
ACB-L-080D-M016_PRE_12-4-09.pdf	ACB-L-080D-M016	SINGLE STAGE MODULE
ACB-L-081D-M198_PRE_12-14-09.pdf	ACB-L-081D-M198	MLB PATTER FITTING
ACB-L-081E-M137_PRE_12-16-09.pdf	ACB-L-081E-M137	GROUND BUSHING
ACB-L-081F-M011_PRE_12-14-09.pdf	ACB-L-081F-M011	PAYLOAD CRUCIFORM END BRACKET
ACB-L-081F-M086_PRE_12-16-09.pdf	ACB-L-081F-M086	LDEX BUSHING, MALE
ACB-L-081F-M087_PRE_12-16-09.pdf	ACB-L-081F-M087	LDEX BUSHING, FEMALE
ACB-L-081F-M099_PRE_12-16-09.pdf	ACB-L-081F-M099	DOUBLE SIDED BUSHING, #8 THREADED PLUG
ACB-L-081F-M111_PRE_12-16-09.pdf	ACB-L-081F-M111	DOUBLE SIDED BUSHING, #8 CUP
ACB-L-081F-M112_PRE_12-16-09.pdf	ACB-L-081F-M112	DOUBLE SIDED BUSHINGS, .25 DIA. PIN CUP
ACB-L-081F-M118_PRE_12-14-09.pdf	ACB-L-081F-M118	PAYLOAD CRUCIFORM BOLT PATTER 2 FITTING
ACB-L-081F-M119_PRE_12-11-09.pdf	ACB-L-081F-M119	CRUCIFORM PANELS COMMON FITTING

Witness specimens shall be provided as deliverable items to be manufactured from drop areas of modules or panels (coupon and detail samples, 3 of each type) or cured concurrently with module ('L'-element samples, 3 each) or bonded concurrently with panel fittings (fitting element samples (3 each) (all TBS/TBR).

4.6 Government Furnished Equipment Available

The Government Furnished Equipment consists of 1 mold for each monocoque module type and the basic tooling needed for bushing installation and panel machining. The GFE is not expected to be the only tooling necessary for manufacturing. It is offered as a schedule and cost savings option for the Contractor. Inspection reports of all molds and tooling is available upon request. A Complete list of the GFE is in the table below:

Mold/Tooling Assembly	**Sub-assembly**	**Part #**
Straight-sided Module Mold		
	Left Half	
	Right Half	
	Top	

Bus Module Mold		
	Bottom	
	Top	
Straight-sided Module Tooling		
	Drill Tool, FWD, PLD & EXT Modules	
	Bonding Tool, Payload & Extension Mod	
	Drill Tool, Payload Access Door	
	Spacer, Bushing, Door	
	Drill Tool, AFT, PLD & EXT Modules	
	Alignment Block, Drill Tool	
	Bonding Tool, Module Inboard	
Bus Module Tooling		
	Drill Tool, Bus Module	
	Dill Tool, Module Aft Interface	
	Bonding Tool, Aft Inboard	
	Alignment Block	
	Bonding Tool, FWD Inboard	

5.0 Reserved.

6.0 Quality Assurance

6.1 General Requirements

6.1.1 Quality Assurance Plan/Manual

The contractor shall implement a Quality Management System that meets the intent of the requirements of American National Standards Institute (ANSI)/ISO/ American Society for Quality (ASQ) Q9001 (1994 or 2000 version) or equivalent. The QA manual/plan shall identify the supplier's management, policies, standard practices, job instructions, and work instructions. The manual shall describe requirements for quality, including failure reporting, throughout all areas of contract performance, including fabrication, processing, assembly, inspection, test, packaging, storage, and shipping. The manual shall detail the complete flow of material from receipt to final shipment and may include flowcharts if available. If workmanship standards and/or manufacturing process differences exist between flight and non-flight hardware, the Quality Manual shall clearly identify these differences. The contractor shall submit a Quality Management Plan to ARC. NASA/ARC COTR shall be notified of any changes to the QA program.

6.1.2 Surveillance of the Contractor

The work activities and operations of the contractor, subcontractors, and suppliers are subject to evaluation, review, survey, and inspection by NASA/ARC COTR and representative(s).

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The contractor shall provide the NASA representative(s) with documents, records, and access to workings areas within the contractor facilities that are required by the representative to perform the overview activities.

6.1.2.1 Government Source Inspection

The Government may elect to perform inspections at a supplier's plant. The following statement shall be included on all procurement documents: "All work on this order is subject to inspection and test by the Government at any time and place”.

The Government quality representative who has been delegated NASA quality assurance functions on this procurement shall be notified immediately upon contractor receipt of any supplier / subcontractor orders. The Government representative shall also be notified 48 hours in advance of the time that articles or materials are ready for inspection or test.

6.1.2.2 Contractor Source Inspection

The contractor shall ensure that its procurement documents impose the applicable requirements on subcontractors and other suppliers. The subcontractor and other suppliers shall in turn impose the requirements on their procurement sources.

The contractor shall perform source inspection at the subcontractor's or supplier's facilities in accordance with the contract or subcontract documentation or when one or more of the following conditions exist:

- In process, end item controls, or tests that are destructive in nature prevent the developer from verifying quality after delivery to the developer's facility.
- It is not feasible or economical for the contractor to determine the quality of procured articles solely by inspections or tests performed at the contractor’s facility.
- Qualification tests are to be performed by the subcontractor or supplier.
- Products are shipped directly from the source to NASA, by-passing the contractor's inspection facilities.

6.1.2.3 Government Mandatory Inspection Points (MIPs)

The NASA/ARC COTR will perform the following MIPs listed below. The government may request additional MIPs if a specific process prohibits inspection at a later time or if a new process or specification is proposed by the contractor.

- Inspection and photographic documentation of OML ply layup, core ply layup, and IML ply layup prior to bagging and autoclave cure cycle for each module
- Inspection and photographic documentation of OML ply layup, core ply layup, and IML ply layup prior to bagging and autoclave cure cycle for the Composite Test Coupons
- Rework Inspection
- Post Cure/Pre machining
- Post machining of composite
- All Post Cure/Pre bonding per ACB-L-080A-XR003
- Pre-Ship Inspection / Data Review

NASA reserves the right, after review of the contractor's planned inspection points, to add mandatory inspection points to the manufacture of the composite structure.

6.1.3 Configuration Management

The contractor's Configuration Management (CM) system (available for review on request) shall control the design and hardware by means of drawings, specifications, and other documents and shall ensure all applicable changes are reviewed in a systematic manner to determine the validity and impact on performance, schedule and cost. The contractor's CM system shall have a change classification and impact assessment process that ensures Class I changes are forwarded to the NASA/ARC COTR for approval prior to release/incorporation. Class I changes are defined as changes that affect form, fit, function, or requirements as stated within this document

All other changes are considered to be Class II changes and shall be controlled and dispositioned by the contractor. All Class II changes shall be provided monthly to the COTR for review purposes. NASA/ARC reserves the right to review all Class II changes for technical content to ensure the proper classification has been assigned. Any flight item that is found to be non-compliant with the quality, workmanship and performance requirements of the contract shall be dispositioned via a waiver or MRB, unless the affected item is reworked to restore compliance or is replaced with a fully compliant item. The contractor shall submit Waivers and MRB's to the COTR for final approval.

A Contractor QA representative shall lead the Configuration Control Board (CCB). The QA activities shall be defined in the Configuration Management Plan and described in detail in the QA Plan. Related portions of the plans shall be cross-referenced.

All Contractor's CM related activities and deliveries shall be done in accordance to the LADEE Project Configuration Management Procedure (C04.LADEE.CM).

Part numbering and a traveler system shall be proposed.

6.1.4 Anomaly Reporting

All hardware anomalies shall be reported to the NASA/ARC COTR. The NASA ARC COTR shall be notified within 24 hours of each anomaly.

The Contractor's processes for review, disposition and approval of anomaly reports shall be described in their quality plan/manual or provided as a supplement document. In addition, the contractor's anomaly reporting document shall describe the members of the Material Review Board (MRB) and Failure Review Board (FRB). The MRB and FRB shall include NASA participation. These processes shall ensure that positive corrective action has been taken to preclude recurrence and that appropriate audits and tests are performed to verify the implementation of the corrective action.

The contractor shall routinely inform the LADEE Project of MRB and FRB meeting schedules and agendas with sufficient notice to permit LADEE Project participation if desired by LADEE.

At the contractor's facility, NASA/Government representatives may participate in MRB/FRB activities as deemed appropriate by Government management or contract.

The NASA/ARC COTR reserves disapproval rights on MRB and FRB decisions. To assure process consistency, the contractor shall provide the LADEE Project on-line access to their LADEE anomaly-reporting database.

The Contractor shall provide, as part of the monthly report, a list of all open anomaly reports and a separate list of the anomaly reports closed during the month. For each reported anomaly or nonconformance, there shall be a report that documents the investigation and engineering analysis needed to determine the cause and corrective actions to disposition the nonconformance, and identify any closed problem reports that do not have a definitive cause or corrective action. Reports shall be submitted to the NASA/ARC COTR for review and approval of the disposition.

The supplier shall establish and maintain documented procedures to ensure products or components that do not conform to specific requirements are prevented from unintended use or installation. This control shall provide for identification, documentation, evaluation, segregation (when practical), disposition of nonconforming product, and for notification to the functions concerned.

6.2 System Safety Requirements

The contractor shall supply detailed descriptions of the test and inspection requirements for all flight hardware and materials, ground support equipment (GSE), and their interfaces necessary for a valid identification, assessment, control and mitigation of documented hazards. This includes technical information concerning hazardous and safety critical equipment, systems, operations, handling and materials. For all identified hazards, the contractor shall also document hazard controls, verifications and tracking methods.

The contractor shall provide technical support to the LADEE Project for safety working group and technical meetings as necessary in conjunction with TIMs.

6.3 Reliability Requirements

6.3.1 Limited-Life Items

The contractor shall identify and manage limited-life items. Limited-life items include all materials that are subject to degradation because of limited shelf life or freezer out-time. This includes all CFRP prepreg and adhesives. All limited life items such as these shall have detailed logs tracking their storage and use. Preliminary and final reports of limited-life items shall be provided in accordance with the LADEE Deliverable Items List and Schedule.

The NASA/ARC COTR shall approve the use of all limited-life items.

6.4 Ground Support Equipment (GSE)

Ground Support Equipment (GSE) that directly interfaces with flight deliverable items shall be assembled and maintained to mitigate potential risk to flight hardware. Parts and materials selection and reporting requirements are exempted as long as deliverable flight item contamination requirements are not compromised. However, all GSE interfaces to flight hardware shall be flight quality (e.g. drill templates, fixtures, baseplates, etc.) materials, cleanliness per appropriate specification.

6.5 Fabrication Verification Requirements

6.5.1 Verification Requirements

The Contractor shall implement a program to verify all requirements specified in the LADEE Composite Structure Drawing Package and all the other controlling documents.

The Contractor shall provide a verification matrix defining the method of verification for each specific requirement of this contract. Verification methods shall include:

> Inspection: Designated as (I) and represents inspection of the physical hardware by a customer appointed qualified inspector for compliance.
>
> Analysis: Designated as (A) and represents documentation of performance or function through detailed analysis using all applicable tools and techniques.
>
> Test: Designated as (T) and represents a detailed test of performance and/or functionality throughout a properly configured test setup where all critical data taken during the test period is captured for review.

In-process production evaluation tests and environmental stress screening tests shall also be considered to be verification tests.

6.5.2 Analysis / Trending / Reporting Of Test Data

The Contractor shall properly record, maintain and analyze test information during the normal test program to assess performance and flight worthiness and to aid in the identification and analysis of flight hardware verification, failures, and problems. Selected parameters shall be monitored for trends starting at component acceptance testing and continuing through the system integration and test (I&T) phases. These parameters will be compiled in a Trended Parameters List (TPL).

The contractor shall analyze collected test data to verify performance and document the data and analysis in a test report or trend analysis report that is delivered as part of the Data Delivery Package and presented at formal technical reviews as appropriate.

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6.6 Workmanship Standards and Processes

6.6.1 Workmanship: Use of Alternate Workmanship Standards

NASA/ARC COTR recognizes that the contractor may have an established workmanship program equivalent to the specific standards cited herein. In these instances, the contractor may use existing standards upon review and approval by the NASA/ARC COTR. It must be established that the developer's workmanship program fully encompasses the specific requirements of this program. It is the contractor's responsibility to list all deviations from the baseline workmanship standards and to provide data supporting their position/rationale. In instances where differences exist, the developer shall provide the details and rationale for their approach.

6.6.2 Training and Certification of Contractor Personnel

All personnel performing work on flight hardware requiring a prerequisite set of skills and competency shall be certified as having completed the required training, appropriate to their involvement.

6.6.3 Hardware Handling, Cleaning And Packaging

The handling of flight hardware shall be performed by qualified personnel in accordance with approved procedures that address cleaning, handling, packaging, tent enclosures, shipping containers, bagging, and purging. Compatible packaging shall be selected so that hardware is not contaminated or otherwise degraded during shipping or storage. All personnel working on flight hardware shall be certified as having completed the required training and competency certifications prior to handling any flight hardware. This includes, but is not limited to, workmanship, clean room and ESD awareness courses.

Products shall be stored, preserved, marked, labeled, packaged, and packed to prevent loss of marking, deterioration, contamination, excessive condensation and moisture, or damage during all phases of the program. Stored and stocked items shall be controlled in accordance with documented procedures and be subject to quality. A certification log or traveler with all data from the assembly to delivery shall be delivered as part of Deliverable Items List and Schedule package. The material certifications shall also be a part of the Deliverable Items List and Schedule. A DD-250 form is required, which documents the official delivery of hardware, with QA signatures to formally accept the delivery.

The completed parts shall be marked in accordance with MIL-STD-130L, and shall include but not be limited to the following:

1) Vendor Part Number
2) Vendor Name
3) Vendor Serial Number
4) Contract Number
5) Unit Name
6) Weight

6.6.3.1 Shipping

Contractor is responsible for providing an acceptable shipping container that protects the hardware appropriately for all environments the hardware may encounter.

While in a shipping container, each structure shall be wrapped in a non-ESD-generating vapor barrier with redundant maximum humidity indicators. Mounting surfaces and ports shall be protected with pads that shall not cause structure deterioration.. Each structure shall be wrapped in a clean non-static bag retained in place by pressure-sensitive tape applied only to the bag surface itself. A second sealed plastic bag shall be placed over the inner bag. A legible structure identification card shall be taped to the outer surface of the inner bag so that the card is readable without opening the outer bag.

The shipping container shall also include shock and humidity indicators and shall be capable of prolonged shipping conditions. The Contractor shall document what action NASA ARC is to take if the sensors are tripped when hardware arrives at the NASA ARC receiving area. A copy of this document shall be included with shipping documentation.

By executing the act of product shipment, the supplier certifies that the product complies with all contract requirements. Prior to shipping, quality assurance personnel shall ensure that:

- Fabrication, inspection, and test operations have been completed and accepted.
- All products are identified and marked in accordance with requirements.
- The accompanying documentation (developer's shipping and property accountable form) has been reviewed for completeness, identification, and quality approvals.
- Evidence exists that preservation and packaging are in compliance with requirements.
- Packaging and marking of products, as a minimum comply with Interstate Commerce Commission rules and regulations and are adequate to ensure safe arrival and ready identification at their destinations.
- The loading and transporting methods are in compliance with those designated in the shipping documents.
- Integrity seals are on shipping containers and externally observable shock or humidity monitors do not show excessive environmental exposure.
- In the event of unscheduled removal of a product from its container, the extent of re-inspection and retest shall be as authorized by NASA or its representative.
- Special handling instructions for receiving activities, including observation and recording requirements for shipping-environment monitors are provided where appropriate.

The contractor’s quality assurance organization shall verify prior to shipment that the above requirements have been met and shall sign off appropriate shipping documents to provide evidence of this verification. The contractor shall ship Freight On Board (F.O.B.) Destination. The contractor has the responsibility for any damage incurred during shipment.

6.7.6 GIDEP Alerts and Problem Advisories

Contractors shall keep sufficient selection and usage records for all flight parts and materials adequate to determine applicability of any issued Government Industry Data Exchange

Program (GIDEP) alerts relevant to items used on LADEE. The contractor shall review and disposition all GIDEP Alerts for relevancy and impact. In addition, the contractor shall review and disposition any NASA Alerts and Advisories provided to the developer by the NASA/ARC COTR or designee. Alert applicability, impact, and corrective actions shall be documented and status provided to the NASA/ARC COTR on a monthly basis.

6.8 Materials, Processes and Lubrication Requirements

6.8.1 Materials Selection Requirements

To qualify material for flight use, the material must have a satisfactory flight heritage relevant to LADEE requirements or meet the following applicable selection criteria as defined herein for:

- Vacuum outgassing
- Stress Corrosion Cracking (SCC)
- Lubrication requirements
- Manufacturing process selection
- Fastener integrity

The selection and use of material with hazardous properties (such as flammability and toxicity) shall meet the requirements specified in NASA-STD-6001. A material that has limited space flight heritage or does not meet the applicable selection requirements shall be considered non-compliant. If there are no alternatives available to select a compliant material, the material's usage will be justified and approved prior to use for the desired application on the basis of test, similarity, analyses, inspection, existing data, or a combination of those data. A Materials Usage Agreement (MUA) shall be submitted to NASA/ARC COTR for approval for use of the proposed non-compliant material. Refer to Appendix B for an example of the LADEE MUA form. The Contractor may use their own forms provided they contain sufficient information and justification.

The contractor shall create and maintain a Materials and Processes Identification List (MIL) and shall review proposed materials and processes with the NASA/ARC COTR. The MIL shall be available for review of proposed materials and processes by the NASA/ARC COTR. An As-Built Materials List (ABML) shall be included as part of the end item data package. Preliminary and final reports shall be provided in accordance with the Deliverable Items List and Schedule.

Pure Tin, Zinc, and Cadmium are not acceptable for flight use. Silicon adhesives are not acceptable for flight risk.

6.8.2 Vacuum Outgassing of Polymeric Materials

Only materials that have a total mass loss (TML) less than 1.00% and a collected volatile condensable mass (CVCM) less than 0.10% shall be approved for use in a vacuum environment. Material vacuum outgassing shall be determined in accordance with ASTM E-595. If a material exceeds these maximum limits, the contractor shall be required to either replace with a compliant material or bring it into compliance via a vacuum bakeout, or to

submit a Material Usage Agreement (MUA) for its usage. Preliminary and final reports shall be provided in accordance with the Deliverable Items List and Schedule.

6.8.5 Process Selection Requirements

Manufacturing processes shall be carefully selected to preclude unacceptable material property changes during exposure to flight environments that could cause adverse effects to the material and/or to the intended applications. Materials and manufacturing process information shall be provided on the material list.

6.8.6 Fasteners

The contractor shall comply with the procurement and test requirements for flight hardware and critical ground support equipment fasteners contained in 541-PG-8072.1.2, Goddard Space Flight Center Fastener Integrity Requirements. Traceability shall be maintained for every fastener lot.

6.8.7 Materials Procurement Requirements

Raw materials purchased by the contractor and its developers shall be accompanied by a Certificate of Compliance and, where applicable, the results of nondestructive, chemical and physical tests. This information shall be made available to the NASA/ARC COTR for review. Materials used shall be bought according the drawing package specifications. Any deviations of material types must be approved by the government.

6.8.8 Dissimilar Metals

N/A.

6.8 Heat Treatment

Metal parts of the structure shall be heat treated in accordance with NASA approved procedure.

6.8.9 Welding

N/A

6.8.10 Fungus Inert Material

N/A

6.8.11 Corrosive Metals

N/A

6.8.12 Interchangeability

N/A

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7.0 Contamination Control Requirements

The contractor shall establish the specific cleanliness requirements to minimize performance degradation and delineate the approaches to meet the LADEE Contamination Control Plan (C35.LADEE.CCP). Reference the contamination and control plan

7.1 Thermal Vacuum Bakeouts

Thermal vacuum bake-out of the hardware deliverables shall be performed before delivery. The parameters of such bakeouts (e.g., temperature, duration, outgassing requirements, and pressure) are specified in the LADEE Environmental Verification Specification (T05.LADEE.EVS) and the LADEE Thermal Control Subsystem Requirements Document (T01-007.LADEE.TCSR).

A quartz crystal microbalance (QCM) or temperature controlled quartz crystal microbalance (TQCM) shall be incorporated during all thermal vacuum bakeouts. The QCM shall provide the outgassing rate data during the bakeout. This data shall be recorded and provided in the data package.

Although the thermal vacuum test is normally used for a final bakeout opportunity [usually in the last hot cycle], the individual components should be fully cured and baked out before thermal vacuum testing to minimize the length of time spent in the chamber.

7.2 External Cleanliness

All exterior hardware cleanliness shall be verified to be 450A, as described in IEST-STD-CC1246D, upon delivery to ARC.

8.0 Contractor Options

8.1 Option 1: Coupon Testing for B-basis and witness samples

TBD, details to follow upon RFP release

8.2 Option 2: EMI/EMC Film application

TBD, details to follow upon RFP release

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APPENDIX A: Abbreviations and Acronyms

ABBREVIATION/ ACRONYM	DEFINITION
ABML	As-Built Materials List
ABPL	As-Built Parts List
ADC	After Date of Contract
AIP	Assurance Implementation Plan
ANSI	American National Standards Institute
ARC	Ames Research Center
CAD	Computer Aided Design
CAGE	Commercial and Government Entity
C&DH	Command and Data Handling
CCB	Configuration Control Board
CDR	Critical Design Review
CFD	Computational Fluid Dynamics
CFRP	Carbon Fiber Reinforced Plastic
CM	Configuration Management
CO	Contracting Officer
COTR	Contracting Officer's Technical Representative
CVCM	Collected Volatile Condensable Mass
DCR	Design Conformance Review
DPA	Destructive Physical Analysis
EO	Engineering Order
ESD	Electrostatic-Discharge
ETU	Engineering Test Unit
FEM	Finite Element Model
FMEA	Failure Modes and Effects Analysis
FOB	Freight On Board
FRB	Failure Review Board
FU	Flight Unit
GFE	Government Furnished Equipment
GIDEP	Government/Industry Data Exchange Program
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
GSI	Government Source Inspection
ICD	Interface Control Document
LADEE	Lunar Atmosphere and Dust Environment Explorer
MAR	Mission Assurance Requirements
MIL	Materials Identification List
MIP	Mandatory Inspection Point
MGSE	Mechanical Ground Support Equipment
MRB	Material Review Board
MRR	Manufacturing Readiness Review
MUA	Materials Usage Agreement
NDE	Non-destructive Examination
NSPAR	Non Standard Parts Approval Request
PER	Pre-Environmental Review
PIL	Parts Identification List

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ABBREVIATION/ ACRONYM	DEFINITION
PM	Propulsion Module
PSR	Pre-Ship Review
PWB	Printed Wiring Board
QA	Quality Assurance
ROM	Rough Order of Magnitude
R&QA	Reliability and Quality Assurance
SCC	Stress Corrosion Cracking
S/C	Spacecraft
SEE	Single-Event Effects
SOW	Statement of Work
TML	Total Mass Loss
TID	Total Ionizing Dose
TIM	Technical Interchange Meeting
TO	Technical Officer
TRL	Technology Readiness Level
UT	Ultrasonic Test
WVR	Waiver

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APPENDIX B: LADEE Material Usage Agreement Form

MATERIAL USAGE AGREEMENT (MUA)		USAGE AGREEMENT NO.:	PAGE OF
PROJECT:	:	ORIGINATOR:	ORGANIZATION:

DETAIL DRAWING	NOMENCLATURE	USING ASSEMBLY	NOMENCLATURE

MATERIAL & SPECIFICATION	MANUFACTURER & TRADE NAME

USAGE	THICKNESS	WEIGHT	EXPOSED AREA	ENVIRONMENT		
				PRESSURE	TEMPERATURE	MEDIA

APPLICATION:
RATIONALE:

ORIGINATOR:	PROJECT MANAGER:	DATE:

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APPENDIX C: List of Referenced Documents

Applicable Documents

All referenced documentation identified in the SOW shall apply in the situations where they are specifically referenced.

DOCUMENT NUMBER	TITLE	Revision/Date
541-PG-8072.1.2	GSFC Fastener Integrity Requirements	03/05/01
ACB-L-0800A-XR002	LADEE Bonding Specification	Rev. Draft Dec. 2009
ACB-L-0800A-XR003	Bushing Installation Specification	Rev. Draft Dec. 2009
ACB-L-0800A-XR004	LADEE Module Layup Specification	Rev. Draft Dec. 2009
ACB-L-0800A-XR010	Composite Material Specification	Rev. Draft Dec. 2009
ACB-L-0800A-XR011	Composite Material Process Specification	Rev. Draft Dec. 2009
AFSPCMAN 91-710	Air Force Range Safety User Requirements Manual	
AIA/NAS NAS 999	Nondestructive Inspection of Advanced Composite Structures	
ANSI/ASQ9001-2000	Model for Quality Assurance Design, Development, Production, Installation, and Servicing	Aug 1991
APR 7120.8	Program/Project Reviews for Space Flight Systems	
APR 8070.1	Engineering Design Requirements For Space Flight Systems	
APR 8070.2	Class D Spacecraft Design and Environmental Test	
ANSI/ESD S20.20	Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)	
ASTM E-1495	Standard Guide for Acousto-Ultrasonic Assessment of Composites, Laminates, and Bonded Joints	7/10/02
ASTM E-1556	Standard Specification for Epoxy Resin System for Composite Skin, Honeycomb Sandwich Panel Repair	
ASTM E-2533	Standard Guide for Nondestructive Testing of Polymer Matrix Composites Used in Aerospace Applications	5/15/09

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ASTM E-2662	Standard Practice for Radiologic Examination of Flat Panel Composites and Sandwich Core Materials Used in Aerospace Applications	6/1/09
ASTM E-2663	Standard Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE) for Ultrasonic Test Methods	12/15/08
ASTM E-595	Standard test method for total mass loss and collected volatile condensable materials from outgassing in a vacuum environment	10/1/03
AWS D17.1	Specification for Fusion Welding for Aerospace Applications	1/1/01
C01.LADEE.SMAIP	LADEE System Safety and Mission Implementation Plan	Rev - Draft
C03.LADEE.SEMP	Systems Engineering Management Plan	Rev - Draft
C14.LADEE.EMI/EMC	LADEE Electromagnetic Interference And Compatibility Control Plan	Rev - Draft
C35.LADEE.CCP	LADEE Contamination Control Plan	Rev - Draft
C35.LADEE.RCP	LADEE Radiation Control Plan	Rev - Draft
EWR-127-1	Eastern and Western Range Safety Requirements	10/23/2000
MIL-HDBK-17-2F	Composite Materials Handbook Volume 2. Polymer Matrix Composites Materials Properties	
MIL-STD-882	Standard Practice for System Safety	
MIL-STD-889	Dissimilar Materials	
MIL-STD-1629	Procedures for Performing an FMEA	11/24/1980
MSFC-STD-3029	Multiprogram/project common-use document guidelines for the selection of metallic materials for stress corrosion cracking resistance in sodium chloride environments	5/22/00
NASA-STD-6001	Flammability, odor, off-gassing and compatibility requirements & test procedures for materials in environments that support combustion	2/9/1998
NASA-STD-8739.7	Electrostatic Discharge Control	12/15/97
NPR-8715.3	NASA General Safety Program Requirements	
RSM 2002B	Range Safety Manual, WFF; Revision B	
S-311-M-70	Destructive Physical Analysis. Equivalent	1/7/1990

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SAE AS 9100	Quality Systems Aerospace Model for Quality Assurance in Design, Development	
T01-004.LADEE.MSRD-L4	LADEE Mechanical Systems Requirements Document	
T01-006. LADEE. SMAR	LADEE Project System Safety and Mission Assurance Requirements	
T01-007.LADEE.TCSR	LADEE Thermal Control Subsystem Requirements Document	
T05.LADEE.EVS	LADEE Environmental Verification Specification (Tailored APR 8070.2)	

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