Request for Information

Heatshield for Extreme Entry Environment Technology (HEEET) Composite Carrier Structure

HEEET-4007
Revision N/C

Preparation Date: 10/23/2014
Revision Date: N/A

Expiration Date: 12/30/2014

National Aeronautics and Space Administration

Ames Research Center
Moffett Field, California

Latest Revision Version can be validated at http://minx.arc.nasa.gov

Table of Contents

Introduction

This document is a Request For Information (RFI). This RFI defines the anticipated effort required for the process, development, and fabrication of various flat and curved composite panels, tooling, and fittings that is expected to culminate in two composite carrier structure builds for the Heatshield for Extreme Entry Environment Technology (HEEET). This RFI provides the initial framework for a draft Statement of Work (SOW) expected to be released by the HEEET project as a result of this market research. The terms SOW and (Request for Proposal) RFP are used within this RFI document, however, neither document has been finalized. The HEEET project may perform site visits to vendors that have responded to this RFI. Comments and feedback from industry will influence the requirements of the SOW and RFP that are planned to be released near the end of the 2014 calendar year.

Special RFI Response Instructions

Included in the RFI response, the contractor should address the approach and scheduling of the following items:

1. Opportunities For Cost Reduction
2. Contractor Kick-off Meeting
3. Procurement Schedule of all raw materials
4. Design and fabrication of necessary tooling
5. Manufacturing Verification Testing
6. Schedule for Manufacturing Readiness Reviews
7. All Hardware Deliverables
8. Implementing a Quality Management System and Quality Assurance Plan

Special Considerations (not necessarily in order of importance):
Evaluation factors included in a future solicitation may include the following considerations:

1. A company that responds to this RFI, and also accommodates a site visit from several members of the HEEET team prior to the release of the request for proposal.
2. Previous experience: space qualified composite structure design, fabrication, and testing experience.
3. A proposal response which meets all SOW requirements at or in advance of the delivery durations stated in the "Deliverables" section of this SOW.
4. A proposal response which meets all SOW requirements at minimum cost.
5. Facilities, key personnel, and infrastructure of the company
6. Suggestions from industry in the RFI response for other evaluation factors.

The use of innovation to meet the previously stated criteria is strongly encouraged. The Government welcomes responses with alternative work and process approaches in this regard.

1 SCOPE

This Draft Statement of Work (SOW) defines the effort required for the process, development, and fabrication of various flat and curved composite panels, tooling, and fittings that will culminate in two composite carrier structure builds for the Heatshield for Extreme Entry Environment

Technology (HEEET). One carrier structure is for a manufacturing development unit, which will demonstrate manufacturability and TPS bonding processes. The second carrier structure will be the Engineering Test Unit, which will undergo testing with the heatshield material bonded to it. Both the panels and full carrier structures are intended for engineering testing. While the structure will not see spaceflight use, the procedures and processes shall conform to spaceflight processing requirements, except as noted. This document shall describe the scope, background, applicable documents, requirements, and associated program management needed to complete the tasks solicited by the Government.

1.1 BACKGROUND

The HEEET Project, funded by NASA's Space Technology Mission Directorate under the Game Changing Development Program (GCDP) seeks to mature a game changing Woven Thermal Protection System (WTPS) technology to enable in-situ robotic science missions recommended by the NASA Research Council (NRC) Planetary Science Decadal Survey (PSDS) committee. One of the primary deliverables for the HEEET project is an Engineering Test Unit (ETU). The ETU consists of a flight-like woven TPS heat shield that is assembled on a flight-like carrier structure and this integrated system will be put through a series of environmental tests. There are four primary goals associated with the development, manufacturing, and testing of the ETU:

1. Verification of structural performance of ETU and model correlation
2. Demonstration of manufacturability at full scale (full scale is defined as ETU scale that is relevant and demonstrates the capability for future flight articles that may be larger than ETU scale)
3. Demonstration of defect inspection and identification of entire heat shield at full scale
4. Demonstration of NASA's ability to transfer prototype component manufacturing insight to outside partners, levy efficient and effective requirements, and verify that delivered hardware is acceptable

To accomplish these goals, the project is building a 1 meter Engineering Test Unit (ETU). The ETU will consist of a tiled woven TPS system assembled on a representative carrier structure. The ETU will be designed and constructed to satisfy the demanding flight environments of a Saturn probe of this size. It will utilize flight like materials, design practices, and manufacturing rigor where appropriate.

The primary deliverable from this SOW is the carrier structure for the ETU. A representative carrier structure is shown in Figure 1. The assembly is a carbon composite monocoque consisting of carbon fiber composite face sheet over aluminum honeycomb. Two sets of three brackets are bonded and fastened over six regions of densified core.

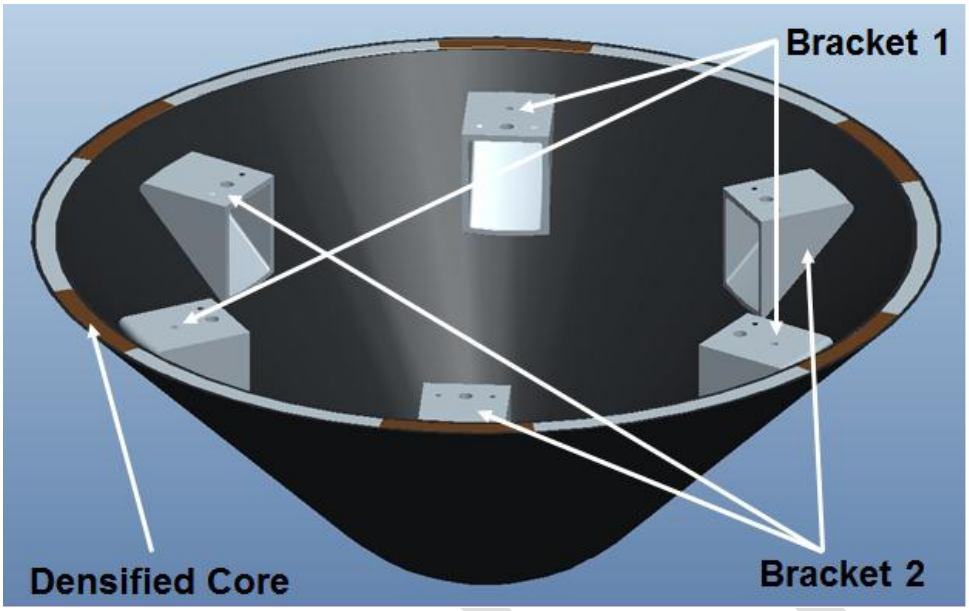

Figure 1: *Composite Carrier Structure*

2 APPLICABLE DOCUMENTS:

Copies of specifications, standards, drawings, and publications required by suppliers in connection with specified procurement functions should be obtained from the contracting agency or as directed by the contracting officer. Documents beginning with the control number "ACB" are program documents controlled by the National Aeronautics and Space Administration (NASA)

2.1 Government Documents

DOCUMENT NUMBER	TITLE	Use
ACB-L-0800A-XR002	Structural Bonding of Composite	Required
ACB-L-0800A-XR010	Composite Material Specification	Required
ACB-L-0800A-XR011	Composite Material Process Specification	Required
ACB-L-080A-XR003	Bushing Installation	Required
ACB-L-080A-XR010	Raw Composite Materials	Required
NPD 8730.5	NASA Quality Assurance Policy	Reference
NPR-8715.3	NASA General Safety Program Requirements	Reference

ASTM E-1495	Standard Guide for Acousto-Ultrasonic Assessment of Composites, Laminates, and Bonded Joints	Optional
AIA/NAS NAS 999	Nondestructive Inspection of Advanced Composite Structures	Reference
ASTM E-2533	Standard Guide for Nondestructive Testing of Polymer Matrix Composites Used in Aerospace Applications	Reference
ASTM E-2662	Standard Practice for Radiologic Examination of Flat Panel Composites and Sandwich Core Materials Used in Aerospace Applications	Optional
ASTM E-2663	Standard Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE) for Ultrasonic Test Methods	Optional
MIL-HDBK-17-2F	Composite Materials Handbook Volume 2. Polymer Matrix Composites Materials Properties	Reference
NPD 8730.5	NASA Quality Assurance Policy	Reference
NPR-8715.3	NASA General Safety Program Requirements	Reference
S-311-M-70	Destructive Physical Analysis. Equivalent	
SAE AS 9100B	Quality Systems Aerospace Model for Quality Assurance in Design, Development	Reference

3 SOW Requirements/Process Specification

This section outlines the SOW requirements and process specifications of the ETU carrier structure.

3.1 Roles and Responsibilities

The contractor may be referred to as the "the supplier", "the vendor", or "the contractor" synonymously within this SOW. The NASA Ames Research Center shall act as the customer performing buyoffs at all levels and phases of the contract. The references to NASA, ARC, NASA ARC, NASA Ames Research Center, and the Government shall be used interchangeably within this document. Quality oversight shall be conducted by NASA. All components shall be fabricated and tested by the contractor per process/SOW specification. NASA shall approve any substitution process proposed by the contractor.

The released mechanical drawing package provided by NASA is the contractual vehicle by which the supplier shall fabricate or assemble all piece parts, components, or subassemblies into the specified deliverables.

In the event that NASA elects to increase the scope of work tasks through the addition of new work tasks, Class I changes to drawings, and/or significant modifications to process specifications herein, advance notice of said changes may be transmitted by email, letters of notification, letters of intent, etc. Any additional scope changes shall be decided jointly between the prospective vendor and NASA with a subsequent SOW for the subsequent scope change. Any subtasks related to this SOW, unless otherwise specified, shall fall under the same contractual obligations specified herein.

All contractual direction correspondence affecting deliverable Contract Line Items (CLINS) shall be captured and revised 10 working days prior to any pre-ship review.

3.2 Material Lot Purchasing

Raw composite materials shall be procured in accordance with ACB-L-080A-XR010. Sufficient material shall be ordered such that All Deliverables listed are fabricated from one lot of carbon fiber reinforced polymer (CFRP) pre-impregnated material. All Excess material (not including scrap) shall be delivered to ARC 30 working days prior to contract closure, contract termination.

3.3 Process Specifications

In all cases where hardware deliverables reference process specifications, compliance with those specifications is mandatory. The following is a list of the key specifications (but not limited to) required to complete the HEEET Composite Carrier Structure Work Task. These processes shall be made available in electronic PDF format with the Request for Proposal when it is issued:

- ACB-L-080A-XR002, Structural Bonding of Composite Materials
- ACB-L-080A-XR003, Bushing Installation
- ACB-L-080A-XR010, Raw Composite Materials
- ACB-L-080A-XR011, Processing Composite Materials

All applicable and reference documentation identified in this document shall apply in the situations where they are specifically referenced. Unless a specific issue or revision is listed, the referenced documents shall be of that issue or revision in effect on the date of Request for Proposal (RFP). In the event of a conflict between the SOW and the specification, the SOW shall take precedence. See Appendix B for a list of referenced documents.

3.4 Substitution/Alternative Work Processes

In the event the contractor selects an Alternative Work process, the contractor shall perform design, analysis, fabrication, and inspection of any additional tooling and or new processes required to produce the Deliverables stated in Section 11. The contractor shall perform complete process and tooling validation concurrently with NASA ARC to finalize all manufacturing process details (beyond that contained in the supplied process specifications) or to resolve any discrepancies between test specimen and/or part design and the specified performance

3.5 Engineering Documentation

The contractor shall document and deliver all analyses of any engineering work tasks associated with section 5 including but not limited to: hand calculations, thermal analysis, tooling process developments, and inspection reports. A contractor selected format is suitable for this documentation, upon approval by NASA, 5 working days prior to the MRR.

3.6 On-site Government Representative

The Government shall reserve the right to maintain continuous representation at the contractor worksite. During this period, the representative shall be onsite for validation of workmanship process, quality control and expedite mandatory inspection points. The representative shall have "stop work" authority.

3.7 Notification

The contractor shall notify the NASA/ARC COTR 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.

3.7.1 Contractor Drawing Packages

The contractor shall provide a drawing package that includes all mechanical detail and assembly drawings and electronic models for manufacturing related components such as shipping containers, tools molds, etc. not already been provided by NASA. All updates or changes to this drawing package shall also be delivered to NASA. This drawing package shall be reviewed during MMR.

3.7.2 Engineering Change Proposals (ECP)

ECP's shall be submitted electronically as required to request changes to any baseline documentation. Class I changes are those which affect form, fit, or function.

The subcontractor shall not incorporate a Class I change without prior written approval of ARC. Class II changes (an engineering change other than a Class I) require ARC notification and written concurrence of the classification. Departures from, or non-compliance with, the product specification shall be requested using an Engineering Change Proposal. All outstanding deviations or waivers will be approved by ARC before the end-item is shipped.

3.7.3 Engineering Drawings/Models

If required during the period of performance and/or proposal phases, electronic versions of drawings and models shall be exchanged in the following formats, listed in order of preference:

1. Pro Engineer Wildfire 3.0
2. STEP 201
3. IGES
4. CATIA V5.0

A released drawing package shall be provided to the prospective vendors at the time of the Request for Proposal (RFP). The drawing package shall contain the following type of drawings and documents:

- Component or piece part drawings
- Ply drawings (composite material specification and geometry)
- Assembly drawings

The naming convention for NASA Ames Research Center engineering drawings in the HEEET project is:

HEEET-6XXX-YYY-Rev.ZZZ

Where XXX is the drawing number and YYY is the part number. Revision level ZZZ is either "-" indicating an initial release, or an alphabetic character.

A CD-ROM of the drawing/documents package shall be provided. All engineering drawings shall be rendered in Adobe Portable Document Format (PDF) at minimum "D" size resolution. The vendor may request alternate file formats.

4 Management and Reporting

The contractor shall establish and maintain management operations that shall include the following areas:

- Reviews and Meetings
- Subcontractor Control
- Schedule and Financial Management
- Data Management
- Management and Accountability for Government Furnished Equipment, Material or Information.

4.1 Reviews and Meetings

The required meetings are outlined below. The NASA/ARC COTR shall have the authority to remove the requirement for meetings. The elimination of reviews and/or meetings shall be captured by written NASA/ARC COTR approval.

Summary Reports shall be submitted for all meetings and reviews and, at a minimum, shall include meeting notice, agenda, attendance, review meeting minutes, action items, action item accomplishment responsibility and agreements. The reports shall be distributed to all meeting attendees at not greater than 5 work days after the meeting, review, or TIM. Electronic PDF format sent by email shall be considered acceptable.

4.1.1 Kick-Off Meeting

The Contractor shall organize and present a Kick-Off meeting to a NASA Review Team at the Contractor's facility, unless otherwise agreed to by the contractor and NASA/ARC COTR, no later

than 10 business days after the contract award. The contractor shall establish that the baseline technical and manufacturing requirements are clearly understood and that procurement definition and manufacturing direction is complete as specified in this document, and the HEEET Carrier Structure Deliverable Items List and Schedule. This review shall also provide an opportunity to review drawings and manufacturing processes.

The contractor shall present a comprehensive presentation which lays out the approach and planning for the HEEET work task. The presentation shall cover but shall not be limited to the following subjects:

- Programmatic structure definition of the HEEET work task including: WBS, personnel roles and responsibilities.
- Key manufacturing requirements which shall be met as defined in the SOW.
- Key manufacturing processes or contractor process which shall be met during the complete fabrication period.
- A Schedule covering all elements of the HEEET work tasks presented in Microsoft Projects form.
- Status on material purchasing: lead time of materials, dates of anticipated purchases, prospective vendors, anticipated shipping methods, etc.
- A Configuration Management Process shall be described at kick-off meeting or a Configuration Management Plan shall be submitted.
- Overview of Quality Assurance Processes used to meet SOW requirements

4.1.2 Technical Interchange Meetings (TIM)

For the purposes of design transition and communication the contractor is permitted to plan informal, face-to-face technical interchange meetings at the contractor facilities. The contractor shall support review and coordination of technical issues including, but not limited to manufacturing approaches, drawing details, engineering change notices/requests (ECN), and reviews of contractor proposed alternative work efforts. TIM's are intended to work out technical details prior to Manufacturing Readiness Reviews. TIM's may be proposed by either party as required.

NASA/ARC or the Contractor may initiate a TIM. The said initiator shall provide notice a minimum of 7 working days prior to the proposed meeting date. The contractor shall budget supporting a minimum of 1 TIMs during the period of performance.

4.1.3 Manufacturing Readiness Reviews (MRRs)

The Contractor shall organize and present a Manufacturing Readiness Review to a NASA Review Team at the Contractor's facility at a minimum of 5 working days PRIOR to each of the following manufacturing phases:

- Phase 1: Flat panel fabrication
- Phase 2: Curved panel fabrication
- Phase 3: Carrier Structure Tool
- Phase 4: MDU fabrication
- Phase 5: ETU fabrication

- Any work task options cited herein
- As required by NASA/ARC, any subdivision of the aforementioned phases relating to the release of "traveler", "work instruction" or contractor specific process

Each review shall demonstrate overall conformance of the requirements for the aforementioned Phases as specified in this Statement of Work.

Review topics shall cover but are not limited to:

- Final approval (by signature) of any contractor derived manufacturing process.
- Final approval (by signature) of any drawing modifications
- Final approval (by signature) of any quality assurance related process
- Review of Manufacturing Schedule for that Phase/Segment
- Review of personnel, manpower supporting that Manufacturing segment.

Upon closure of any open items resulting from the MRR the contractor shall be considered ready to commence production/manufacturing.

4.1.4 Weekly Status Meetings (WSM)

Bi-weekly status meetings shall be held in the lead up to fabrication of the MDU and ETU. During fabrication of the MDU and ETU, weekly status meetings shall be held at 9 A.M. Pacific Time each Monday during the period of performance at the Contractor facility. NASA/ARC COTR will participate in person or via WebEx/Telecom. Minutes of the meeting shall be captured by the contractor in an email Planned vs. Actual progress, shall be presented along with action item tracking and any other programmatic or technical topics will be discussed

4.1.5 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 Contract Line Items (CLIN) to ARC. A PSR shall be held prior to the delivery of each item. The PSR shall include presentation of the EIDP. 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. All discrepancy report documentation shall be discussed and included as part of the EIDP.

At the time of the PSR, documents and analysis to support fulfillment of the requirements of this SOW for the hardware being delivered shall be complete and all actions from previous reviews shall be closed.

4.2 Subcontractor Control

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 employee who shall serve as the point of contact with the NASA/Ames Research Center Contracting Officer's Technical Representative (NASA/ARC COTR) for all technical aspects of the Composite Structures contract.

In the event the Contractor elects to subcontract work tasks, the subcontractor shall conform to the same requirements stated herein to manage all program resources, control schedules, and manage engineering, manufacturing and procurement activities. The subcontractor shall perform all necessary configuration management, Quality Assurance, documentation control, and distribution functions.

4.3 Schedule and Financial Management

The Contractor shall establish a baseline schedule with Work Breakdown Structure (WBS) in accordance with all tasks specified herein. This schedule shall become a key component work weekly and monthly status reporting. The format shall be of a Gantt type using Microsoft® Projects. Financial Reporting shall be in accordance with the Federal Acquisition Regulations. WBS structure shall correspond with Financial Reporting categories. Non recurring engineering and recurring engineering costs shall be separately reported.

4.4 DATA Management (Travelers, Technical Reports, Etc.)

The contractor shall maintain internal documentation to control the flow of work through all manufacturing steps. A "traveler", or "work instruction" is recommend for tracking history of process related steps as applied manufacturing. The contractor shall maintain and deliver all electronic correspondence, CAD models, and related electronic data throughout program life cycle. For each review, the contractor shall provide to ARC a Review Presentation Package including all relevant deliverables no less than 5 work days prior to the review. Electronic PDF format sent by email shall be considered acceptable.

4.4.1 Monthly Progress Reports (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, including:

- A summary of work accomplished
- A summary of problems encountered
- A list of any monthly nonconformance and their resolutions
- Summaries of inspection and test activities
- Copies of written approvals for deviations from approved drawings
- As required by the COTR: copies of material certifications and certificates of conformance for raw materials received that period.
- A snapshot/copy of the current working schedule (Microsoft Projects®)

4.4.2 Configuration Control Plan

The contractor shall deliver a configuration control plan at the kickoff meeting which describes the following:

1. Configuration management organization, methods, procedures, and controls
2. Configuration identification
3. Change control and change management processes
4. Status accounting
5. Configuration control audits

4.4.3 End Item Data Package (EIDP)

The contractor shall provide documentation verifying that each end contract line item deliverable meets the requirements of the specification. This data package shall be approved by contractor Quality Assurance and contain at a minimum, the following items:

1. All documentation per ACB-L-080A-XR002
2. All documentation per ACB-L-080A-XR003
3. All documentation per ACB-L-080A-XR010
4. All documentation per ACB-L-080A-XR011
5. Dimensional Inspection Reports
6. Results of Non-Destructive Examination
7. Certification of Conformance signed by an officer of the company
8. Nonconforming material reports occurring during end-item acceptance tests
9. Contamination Control compliance documentation
10. As built manufacturing processes (contractor specific)
11. Material certifications for all materials in the end item

Contractor format is acceptable upon approval from the Government. The contractor shall deliver two hard copies of each EIDP as described above. One hard copy shall be enclosed with the hardware shipment. An electronic copy of the EIDP (PDF format preferred) shall also be delivered to NASA.

5 Contractor Tasks/Work Phases

The work tasks shall be structured in the following manner:

- Phase1: Flat Panel fabrication
- Phase 2: Curved Panel fabrication
- Phase 3: Carrier structure tooling and Bracket fabrication
- Phase 4: Composite sandwich structural test program
- Phase 5: MDU Carrier Structure Build
- Phase 6: ETU Carrier Structure Build

RFI RESPONSES:

Sets of questions for RFI responses are included below for Phases 1 – 6. Vendors are encouraged to comment on any cost or schedule drivers from the requirements and process control documents listed in previous sections. Additionally, alternatives that reduce the cost and schedule, but still meet the intent are encouraged.

5.1 Phase 1: Flat Composite Test Specimens

Phase 1 of this statement of work is the development of flat composite sandwich material. The flat panels will undergo traditional composite sandwich testing to assess workmanship and provide structural allowables for the processes and materials under this work task. All processes and procedures including documentation should be followed as if panels requested were flight articles. The Contractor shall manufacture one 48x96 in^2 flat panel. Part acceptance will be determined by the following criteria:

- NDE of part
- TTT tensile testing
- Other vendor proposed workmanship tests.

Panel specifications are still TBD, but are anticipated to be near the dimensions specified below.

- **Panel Dimensions:**
  - Total overall dimensions of flat panel shall be 48x96 in^2
- **Core Specifications:**
  - Hexcel 5052 Honeycomb core
  - Thickness between 0.25" and 1.5"
  - Density within 4 to 12 pcf
- **Core Splice:**
  - One core splice running 48" in length across the center of the panel.
- **Core Fill:**
  - A 24x24 in^2 section of the corner of the panel filled with Tencate EX-1541 corefill
- **Composite Skin:**
  - T-300 5HS weave oriented such that it is symmetric across the sandwich
  - 12 to 48 plies (~0.12" to ~0.25") on either side of the aluminum core.
  - Cyanate Ester resin system.

Phase 1 Questions to Vendors:

- What, if any, concerns does the vendor have with this phase?
- What is the most cost effective billet size to request for the various options of core density?
- Is the vendor able to perform acceptance testing on the flat panel?
  - NDE
    - If so, what type of NDE is proposed?
  - Through the thickness tension tests
- What resin system or alternate resin system if different from Cyanate Ester would the vendor propose?
  - What is the shelf life and is this a concern given the schedule in section 11?
- What other workmanship tests would the vendor propose?
- What is an estimated cost and build/test schedule for the following options:
  - One 48x96in^2 panel of 0.25" thick 4 pcf core with 12 plies on either side of the honeycomb, a 2x2ft2 section of corefill and one core splice running down the center of the panel.

- One 48x96in^2 panel of 0.75" thick 4 pcf core with 12 plies on either side of the honeycomb, a 2x2ft2 section of corefill and one core splice running down the center of the panel.
- One 48x96in^2 panel of 0.25" thick 4 pcf core with 12 plies on either side of the honeycomb, a 2x2ft2 section of corefill and one core splice running down the center of the panel, and 4, 0.5" diameter bushings embedded in the corefill region.

5.2 Phase 2: Curved Composite Test Specimens

Phase 2 of this statement of work is the development of curved composite sandwich panels. The panels will undergo traditional composite sandwich testing to assess workmanship and strength allowable testing for the processes and materials under this work task. All manufacturing processes used shall be per ACB-L-080A-XR002, -003, -010 and -011. All processes and procedures including documentation should be followed as if panels requested were flight articles. Tooling shall be developed by the contractor to accommodate this build. A Manufacturing Readiness Review is required both prior to the tool build and the curved panel build. Part acceptance will be determined by the following criteria:

- NDE of part
- TTT tensile testing
- Other vendor proposed workmanship tests.

Curved Panel One:

The first curved panel is expected to fall within the following specifications.

- **Panel Dimensions:**
  - Outer mold line radius shall be 8"
  - Total overall dimensions of flat panel shall be 36x36 in^2
- **Core Specifications:**
  - Hexcel 5052 Honeycomb core
  - Core ribbon direction should be orthogonal to the curvature direction.
  - Thickness between 0.25" and 1.5"
  - Density within 4 to 12 pcf
- **Core Splice:**
  - One core splice running perpendicular to the ribbon direction 12" from the edge of the panel
- **Core Fill:**
  - Up to an 18x18 in^2 section of the corner of the panel filled with Tencate EX-1541 corefill
- **Composite Skin:**
  - T-300 5HS weave oriented such that it is symmetric across the sandwich
  - Cyanate Ester resin system.
  - 12 to 48 plies (~0.12" to ~0.25") on either side of the aluminum core.

Curved Panel Two:

The second curved panel is expected to fall within the following specifications.

- **Panel Dimensions:**

  - Outer mold line radius shall be 16”
  - Total overall dimensions of flat panel shall be 36x36 in^2
- **Core Specifications:**
  - Hexcel 5052 Honeycomb core
  - Core ribbon direction should be orthogonal to the curvature direction.
  - Thickness between 0.25” and 1.5”
  - Density within 4 to 12 pcf
- **Core Splice:**
  - One core splice running perpendicular to the ribbon direction 12” from the edge of the panel
- **Core Fill:**
  - Up to an 18x18 in^2 section of the corner of the panel filled with Tencate EX-1541 corefill
- **Composite Skin:**
  - T-300 5HS weave oriented such that it is symmetric across the sandwich
  - 12 to 48 plies (~0.12” to ~0.25”) on either side of the aluminum core.
  - Cyanate Ester resin system.

Phase 2 Questions to Vendors:

- What, if any, concerns does the vendor have with this phase?
  - Core thickness/density
  - Radius of curvature?
  - Core splice?
- What is the most cost effective billet size for the various core densities?
- Is the vendor able to perform acceptance testing on the flat panel?
  - NDE
    - If so, what type of NDE is proposed?
  - Through the thickness tension tests
- What resin system or alternate resin system if different from Cyanate Ester would the vendor propose?
  - What is the shelf life and is this a concern given the schedule in section 11?
- What other workmanship tests would the vendor propose?
- How will the vendor verify dimensional accuracy of the part?
- What prior experience does the vendor have with:
  - Manufacturing similar panels
  - Manufacturing panels with core splices
  - Manufacturing panels with core splices on compound curvature articles?
- Is the vendor able to perform NDE on the part?
- What is an estimated cost and build/test schedule for the following options:
  - Panel One: 3x3 ft^2 panel with 0.25” thick 4 pcf core with 12 plies on either side of the honeycomb one core splice running parallel with the ribbon direction and offset 24” from the edge of the panel
  - Panel Two: 0.75” thick 12 pcf core with with 18 plies on either side of the honeycomb one core splice running parallel with the ribbon direction and offset

24" from the edge of the panel and completely filled with Tencate EX-1541 corefill.

- Panel Two: 0.75" thick 12 pcf core with with 18 plies on either side of the honeycomb one core splice running parallel with the ribbon direction and offset 24" from the edge of the panel.

5.3 Phase 3: Composite Sandwich B-Basis Testing

Phase 3 is the development of allowables to support the structural analysis. A tentative test matrix is provided in Table 1. Material used in testing will be from phases 1 and 2 of this SOW.

Test	Core	Facesheet	Quantity
Laminate Skin CTE	N/A	12 plies	4
Laminate Skin IP Tension	N/A	12 plies	6
Core shear	12 pcf core	12 plies	6
Core splice shear	12 pcf core w/ corefill	12 plies	6
TTT Tension	8 pcf flex core	12 plies	6
TTT Tension	12 pcf core	12 plies	6
TTT Tension	12 pcf core w/ corefill	12 plies	6
Fastener/bushing pull through	12 pcf core w/ corefill	12 plies	6
Fastener/bushing Bearing	12 pcf core w/ corefill	12 plies	6

Table 1: Minimum structural allowable test program

Phase 3 Questions to Vendors:

- What testing capability and experience does the vendor have in house?
- If no in-house capability is present has the vendor contracted out testing in the past?
- What is the anticipated cost and schedule for each of the tests and quantities shown in Table 1?

5.4 Phase 4: Carrier Structure Tooling

Phase 4 is the development of tooling for the MDU and carrier structure build. A Manufacturing Readiness Review is required prior to the tool build. The tool shall be built to accommodate an outer mold line of the composite sandwich to the surface drawing specifications provided in Figure 2.

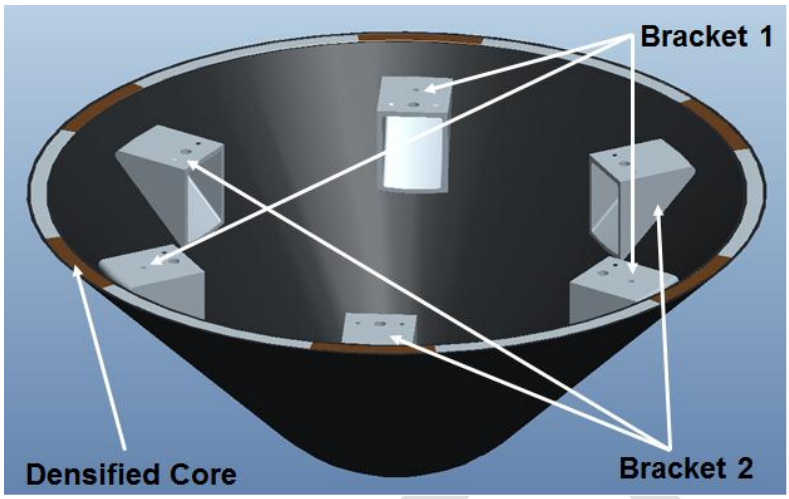

Figure 2: Tooling OML dimensions.

Phase 4 Questions to Vendors:

- What, if any, concerns does the vendor have with this phase?
- What alternative materials to graphite is proposed for the tool?
- How will the vendor verify dimensional accuracy of the part?
- What resin system or alternate resin system if different from Cyanate Ester would the vendor propose?
    - What is the shelf life and is this a concern given the schedule in section 11?
- What is the projected schedule and cost for a graphite tool of the two dimensions provided in Figure 2?
    - 1m
    - 1.5m

5.5 Phase 5: MDU Carrier Structure Build

Phase 5 of this statement of work is the development of an MDU. The MDU will undergo testing to assess workmanship and structural performance. All manufacturing processes used shall be per ACB-L-080A-XR002, -003, -010 and -011. All processes and procedures including documentation should be followed as if the MDU were a flight article. A Manufacturing Readiness Review is required prior to the MDU build. Part acceptance will be determined by the following criteria:

- NDE of part
- TTT tensile testing of tag end articles
- Dimensional tolerance measurements verifying part is within part tolerance
- Other vendor proposed workmanship tests.

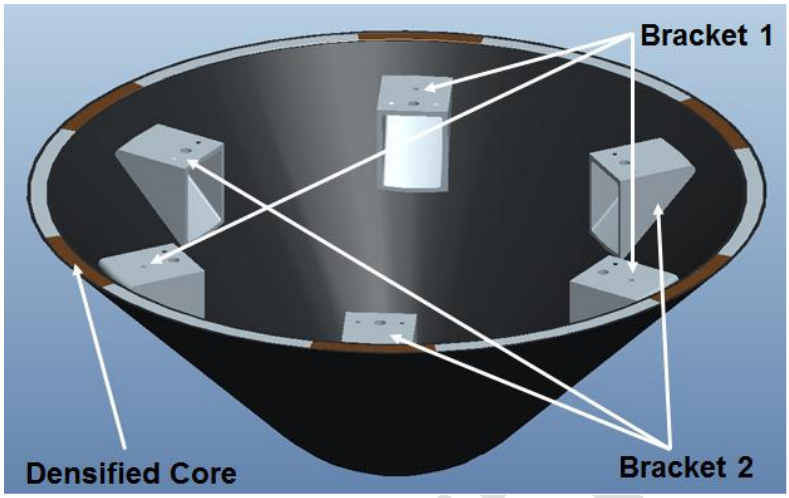

Figure 3: Preliminary Manufacturing Demonstration Unit Concept.,

Phase 5 Questions to Vendors:

- What, if any, concerns does the vendor have with this phase?
- What additional developmental work is recommended or required prior to building the MDU carrier structure?
- How will the vendor verify dimensional accuracy of the part?
- Does the vendor have experience manufacturing and installing brackets?
- What prior experience does the vendor have that is applicable to this build?
- What NDE technique is proposed?
- What, if any, alternative workmanship tests are proposed?
- What resin system or alternate resin system if different from Cyanate Ester would the vendor propose?
    - What is the shelf life and is this a concern given the schedule in section 11?
- What is the projected schedule and cost to build a 1 meter structure assuming the following:
    - 0.75” constant core thickness
    - Al 5052 1/8” cell size 0.003” foil size 12 pcf core along the conical section of the vehicle
    - Al 5052/F80 – 0.0025 foil size 8 pcf flex core along the nosecap of the vehicle.
    - 12 plies of T300 5HS weave stacked in a quasi-isotropic layup on both sides of the aluminum honeycomb
    - 3 heat shield backshell fittings with 4 bushings and corefill underneath each fitting region and extending 1” beyond each edge.
    - 3 heat shield payload fittings with 4 bushings and corefill underneath each fitting region and extending 1” beyond each edge.

5.6 Phase 6: ETU Carrier Structure Build

Phase 6 of this statement of work is the development of an ETU. The ETU will undergo testing to assess workmanship and structural performance. All manufacturing processes used shall be per ACB-L-080A-XR002, -003, -010 and -011. All processes and procedures including

documentation should be followed as if the ETU were a flight article. A Manufacturing Readiness Review is required prior to the ETU build. Part acceptance will be determined by the following criteria:

- NDE of part
- TTT tensile testing of tag end articles
- Dimensional tolerance measurements verifying part is within part tolerance
- Other vendor proposed workmanship tests.
- Detailed document outlining

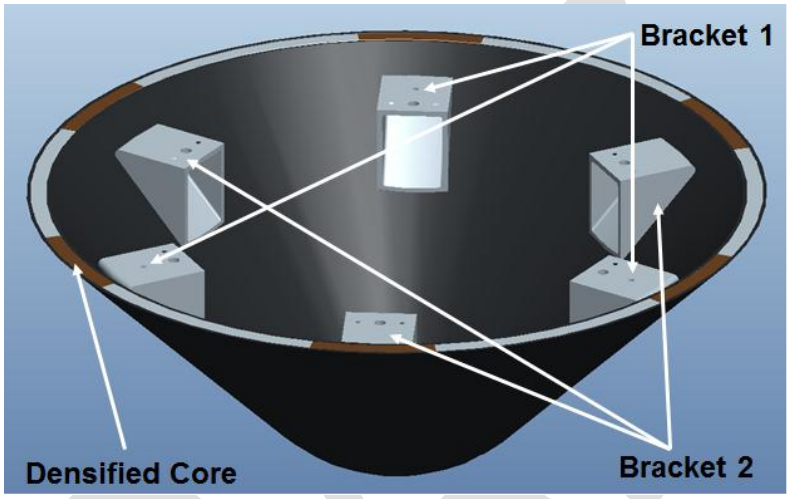

Figure 4: Manufacturing Demonstration Unit.

Phase 6 Questions to Vendors:

- What, if any, concerns does the vendor have with this phase?
- What additional developmental work is recommended or required prior to building the ETU carrier structure.
- How will the vendor verify dimensional accuracy of the part?
- What type of NDE is proposed?
- What other workmanship tests are proposed by the vendor?
- What prior experience does the vendor have that is applicable to this build?
- Does the vendor have experience manufacturing and installing brackets?
- What is the projected schedule and cost to build a 1 meter structure assuming the following:
    - 0.75” constant core thickness
    - Al 5052 1/8” cell size 0.003” foil size 12 pcf core along the conical section of the vehicle
    - Al 5052/F80 – 0.0025 foil size 8 pcf flex core along the nosecap of the vehicle.
    - 12 plies of T300 5HS weave stacked in a quasi-isotropic layup on both sides of the aluminum honeycomb
    - 3 heat shield backshell fittings with 4 bushings and corefill underneath each fitting region and extending 1” beyond each edge.

- 3 heat shield payload fittings with 4 bushings and corefill underneath each fitting region and extending 1" beyond each edge.

5.7 Government Furnished Equipment (GFE)

Inspection reports of this equipment are provided in the data package for this SOW. Contractors electing to not use the existing GFE shall itemize the non-recurring and recurring engineering costs in the response to this statement of work.

5.8 Tooling Hardware Deliverables

All tooling designed, fabricated and used for the manufacture of the HEEET related hardware in this SOW shall be delivered to NASA upon completion of Phase 5. Final award shall not be released prior to acceptance of said deliverables.

5.9 Manufacturing Process

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 requires written approval from the NASA/ARC COTR prior to their usage. This package will be reviewed at the Manufacturing Readiness Review meeting. Approval of contractor processes and procedures shall be obtained at the conclusion of a successful MRR.

5.10 Process Control

The contractor shall manufacture the deliverable hardware using documentation that lists the detailed manufacturing and processing steps required to manufacture and or test each deliverable item. The contractor shall use this documentation to list any deviations, changes, anomalies, and/or repairs that occur during the manufacturing process and certify that each step has been performed as specified. ARC reserves the right to inspect all process and documentation upon request.

The subcontractor's processes shall be certified to or compliant with AS9100 (or equivalent as approved by NASA).

6 Quality Assurance

6.1 General Requirements

6.1.1 Quality Management System

The contractor shall implement product assurance efforts sufficient to assure the delivered product meets all contractual requirements. Certification to AS9100 is strongly recommended. The contractor shall provide both a Quality Management System Manual and a preliminary Quality Assurance Plan in the response to SOW / RFQ. A final Quality Assurance Plan at kick-off meeting.

The Quality Assurance Plan shall define the general polices, controls, procedures, and approaches to be followed in implementing all phases of the end item product assurance program. This plan shall address the following product assurance related functions:

- Hardware Quality Assurance

Contractor format is acceptable.

ARC CSO or their representative reserves the right to conduct inspections, process review, perform audits, and witness testing at the contractor or any lower-tier subcontractor, with prior notification.

6.1.2 Government Source Inspection

The Government may elect to perform inspections. 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 representative shall also be notified 48 hours in advance of the time that articles or materials are ready for inspection or test.

6.1.3 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.

6.1.4 Government Mandatory Inspection Points (MIPs)

The ARC CSO or designee will perform MIPs defined by procedures or processes specified herein. The government may impose additional MIPs if a new process or specification is proposed by the contractor.

6.2 Nonconformance

The contractor shall implement a nonconformance control system that documents, segregates, and dispositions any material or product that does not conform to the requirements of the applicable drawing, specification, or contract.

Any nonconformance (discrepancy), regardless of nature or where discovered, shall be documented. The NASA COTR has authority to initiate an MRB. The material shall be positively identified. The contractor should perform a preliminary review of such item(s) and make a disposition as follows:

(a) *Scrap* — If the item(s) are determined unfit for use, they should be scrapped.

(b) *Return to subcontractor* — If procured item(s) are unacceptable, they should be returned to the subcontractor.

(c) *Complete or rework to specification* — If the item(s) can be completed or reworked to drawing and/or specification requirements.

All finalized nonconformance reports shall be included in the EIDP, and shall be available for review by ARC at the contractor's facility. The contractor shall not ship any nonconforming articles unless authorized by ARC.

6.2.1 Disposition of Nonconformance's

Nonconformances shall be dispositioned as follows:

a) The contractor shall submit all dispositioned non-conformance reports (repair, use-as-is, and acceptance and qualification test dispositions) to ARC for approval. Nonconformance reports may be in the contractor's format.

b) Each interim disposition of a nonconformance shall be separately approved by ARC.

c) ARC shall be notified and a formal nonconformance report shall be submitted within two (2) calendar days of a non-conformance. ARC will respond within five (5) work days of receiving the request.

d) In urgent situations, where time does not permit mailing the nonconformance report, the contractor shall notify the appropriate ARC COTR by telephone, followed within 24 hours by a confirming facsimile or e-mail. The contract administrator shall receive the non-conformance from the contractor and submit it to the ARC Material Review Board (MRB) for immediate action. The appropriate ARC COTR will notify the contractor by facsimile, email message, or telephone of MRB action and will mail formal disposition instructions for the nonconformance to the contractor.

e) The contractor's nonconforming materials report shall cross-reference the applicable nonconformance report.

6.2.2 Material Review Board (MRB)

In the event of a discrepancy, an MRB shall be formed. The MRB will investigate root causes and identify corrective actions. The board shall consist of contract and NASA members.

6.3 Certification and Calibration of Test Equipment

The contractor shall only perform testing with equipment that has been calibrated and/or certified.

6.4 Workmanship Standards and Processes

The vendor shall provide documentation of the workmanship standards on all structures. The workmanship standard shall be presented at the MRR(s). The standard shall define the minimum acceptance criteria applied to flight hardware produced by the contractor. This shall include, as a minimum:

1. A list of the manufacturing processes to be verified.
2. The pass/fail criteria for the processes
3. The inspection methods used to verify the processes

6.5 Materials & Processes

The contractor's selection of materials and processes used in manufacture and test of the deliverables shall be in compliance with the requirements of this document and the associated specification. It is important that all organic materials, solvents, etc. used during manufacture, processing, cleaning, and packaging be carefully controlled to eliminate sources of outgassing or contamination. A list of all materials and processes to be used in the deliverable items shall be provided to ARC for approval. The material list shall contain as a minimum:

Organics:

1. Per ACB-L-080A-XR010 and –XR011

Inorganics:

1. Material and Temper
2. Material Specification
3. Material Finish and Specification

Processes:

1. Process specification Number and Title

Contractor format is acceptable.

The contractor shall assure the implementation of a system to review GIDEP Alerts and customer furnished NASA Advisories for materials and processes, take appropriate action, and notify BATC of impacts or significant problems. This activity shall continue throughout the contract lifecycle. The subcontractor will provide a review matrix of all applicable Alerts and Advisories that impact furnished hardware along with actions taken.

6.5.1 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 Carbon Fiber Reinforced Polymer and related adhesives. All limited life items such as these shall have detailed logs tracking their storage and use per ACB-L-080A-XR010.

7 Contamination Control Requirements

The Contractor shall maintain cleanliness during manufacture of all hardware in accordance with NASA Ames Research Center Document Specifications:

- ACB-L-080A-XR010
- ACB-L-080A-XR011

8 Additional Acceptance Criteria

In addition to compliance with all drawings requirements, specifications, and contractual elements stated herein; all deliverables shall, where applicable, demonstrate compliance IAW ACB-080A-XR014. A certification of compliance shall be generated by the Vendor at the time of compliance/acceptance and countersigned by a NASA/ARC quality assurance witness. The general scope of the aforementioned documents shall be as follows:

- A Go/No-Go fit check with the following specified Tool/Gauge Assemblies:
  - HEEET-XXX-YYY-ZZZ
  - HEEET-XXX-YYY-ZZZ

- Transmittal of the certification of compliance with ACB-L-080A-XR014 to the NASA/ARTS COTR, including all contractual elements in this document shall of constitute release of payment or commencement of the next manufacturing phase or completion of contract phase.

9 Deliverables

Delivery schedule of all deliverables shall be in accordance with schedule document "HEEET Carrier Structure Sched Rev(X).mpp"
(Where X is recognized as the latest published version of the document)

A tentative schedule is provided below. Vendors are encouraged to provide feedback.

Schedule Tasks	10/1/2014	11/1/2014	12/1/2014	1/1/2015	2/1/2015	3/1/2015	4/1/2015	5/1/2015	6/1/2015	7/1/2015	8/1/2015	9/1/2015	10/1/2015	11/1/2015	12/1/2015
Carrier Structure RFI Relsease															
RFI Responses															
Vendor Site Visit															
Carrier Structure RFP Relsease															
RFP Responses															
RFP Evaluation + Write up															
Contracting Award															
Flat Panel Fabrication (Phase 1)															
Curved Panel Fabrication (Phase 2)															
Carrier Structure Tooling (Phase 4)															
MDU Fabrication (Phase 5)															
MDU Shipping															
ETU Fabrication (Phase 6)															
ETU Shipping															

10 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
CFRP	Carbon Fiber Reinforced Polymer
CLIN	Contract Line Item

ABBREVIATION/ ACRONYM	DEFINITION
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
HEEET	Heatshield for Extreme Entry Environment Technology
ICD	Interface Control Document
IML	Inner Mold Line
IRT	Infrared Thermography
MAR	Mission Assurance Requirements
MDU	Manufacturing Demonstration Unit
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
OML	Outer Mold Line
PER	Pre-Environmental Review
PIL	Parts Identification List
PM	Propulsion Module
PSR	Pre-Ship Review
PWB	Printed Wiring Board
QA	Quality Assurance
QCM	Quartz Crystal Microbalance
ROM	Rough Order of Magnitude

ABBREVIATION/ ACRONYM	DEFINITION
R&QA	Reliability and Quality Assurance
SCC	Stress Corrosion Cracking
S/C	Spacecraft
SMA	System Safety and Mission Assurance
SOW	Statement of Work
TML	Total Mass Loss
TIM	Technical Interchange Meeting
TO	Technical Officer
TQCM	Temperature Controlled Quartz Crystal Microbalance
TRL	Technology Readiness Level
UT	Ultrasonic Test
WVR	Waiver

11 N/A

12 APPENDIX B: 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
541-PG-8072.1.2	GSFC Fastener Integrity Requirements
AIA/NAS NAS 999	Nondestructive Inspection of Advanced Composite Structures
APR 7120.8	Program/Project Reviews for Space Flight Systems
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
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
ASTM E-2662	Standard Practice for Radiologic Examination of Flat Panel Composites and Sandwich Core Materials Used in Aerospace Applications
ASTM E-2663	Standard Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE) for Ultrasonic Test Methods
ASTM E-595	Standard test method for total mass loss and collected volatile condensable materials from outgassing in a vacuum environment
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
MSFC-STD-3029	Multiprogram/project common-use document guidelines for the selection of metallic materials for stress corrosion cracking resistance in sodium chloride environments
NASA-STD-6001	Flammability, odor, off-gassing and compatibility requirements & test procedures for materials in environments that support combustion
NASA-STD-8739.7	Electrostatic Discharge Control
NPD 8730.5	NASA Quality Assurance Policy
NPR-8715.3	NASA General Safety Program Requirements
RSM 2002B	Range Safety Manual, WFF; Revision B
S-311-M-70	Destructive Physical Analysis. Equivalent

13 Appendix C: Government Furnished Equipment List

N/A

14 Appendix D: HEEET Carrier Structure Related Drawings

Carrier Structure

Line Item	Part Number	Rev	Part Description
1			
2			
3			
4			
5