National Aeronautics and Space Administration
**Langley Research Center**
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January 22, 2013

Reply to Attn of: 12

TO: 12/Research and Development Contracting Branch, Office of Procurement
Attn: C. Lynn Jenkins

FROM: 190/Dawn Jegley, Structural Mechanics and Concepts Branch, Research Directorate

SUBJECT: Justification for Exception to the Fair Opportunity Process (JEFOP) for The Boeing Company, Task Order Modification 5 to NNL11AA68T entitled "HWB Multi-bay Test Article Analysis and Assembly" with The Boeing Company, on Contract NNL10AA05B, Total Estimated Cost $10.4 Million.

In accordance with FAR 16.505, the following information is provided to support this justification:

## I. Recommendation

NASA Langley Research Center (LaRC) intends to modify an existing task order with Boeing under the Structures, Materials, Aerodynamics, Aerothermodynamics, and Acoustics Research and Technology (SMAAART) contract. The purpose of the existing task order is for the analysis and fabrication of a large scale test article representing the center portion of a Hybrid Wing Body (HWB) vehicle. The primary purposes of this proposed task order modification are to increase the task order value and funding as a result of an unexpected cost growth for tooling and assembly of the test article; to add additional work and funding for Boeing's participation at conferences and risk management documentation; and to delete work and reduce task order value for Boeing's support of the testing activity at LaRC. Additionally, this proposed modification adjusts the task order schedule based on delays associated with the complexity of this task order and extends the current task order period of performance (POP) by 17 months from 28 months to 45 months.

As discussed below, this research began as a "collaborative effort" between Boeing and LaRC. Boeing would, at its own expense, fabricate 11 PRSEUS panels under Space Act Agreement (SAA) SAA1-1018, Annex 1 and LaRC, through this task order, would fund the assembly of those panels into the Pultruded Rod Stitched Efficient Unitized Structure (PRSEUS) multi-bay configuration and testing of the configuration [redacted] In order to continue the research effort, LaRC intends to purchase already completed panels under a separate firm-fixed priced (FFP) contract to Boeing. LaRC

then plans to purchase from Boeing the remaining panels required to complete the multi-bay configuration under a new SMAAART task order. All panels will then be given to Boeing as Government Furnished Property (GFP) under this existing task order for the assembly of the multi-bay box. SAA1-1018, Annex 1 will be modified to reflect this plan and the parties' responsibilities.

Boeing is the sole source capable of performing the required effort because it is the only contractor with experience of the stitched structure and the only contractor capable of performing the fabrication of the PRSEUS Panels.

Purchase Request (PR) 4200456686 has been generated to provide incremental funding in the amount of $4M for this modification. The Total Estimated Value for this modification is $10,326,854. The current task order is valued at $5,299,821. The new total estimated Cost Plus Fixed Fee (CPFF) is anticipated to be approximately $15.7M. Although SMAAART is a CPFF type contract, Boeing did not propose a fee amount for this task order and does not plan to propose fee for this planned modification. As such, this task order is a CPFF type with a $0 fee.

## II. Background

Some years ago, LaRC and Boeing joined forces under the NASA Advanced Composites Technology (ACT) Program to make large composite airplane structures a reality. As such, the NASA ACT program was set up in 1989 to improve the efficiency of composite structures and to reduce their manufacturing costs. The ACT Program aims to reduce air travel costs through the use of composite materials on commercial aircraft.

At the time the ACT Program was established, the potential of composites materials to save weight on aircraft primary structure (wing and fuselage) was well-known but the roadblocks to its use were its manufacturing complexity and cost, its brittle nature and sensitivity to damage, a lack of experience with the material systems, and inadequate analysis techniques to reliably predict the behavior of these complex structures.

The Environmentally Responsible Aviation (ERA) Project within the Integrated Systems Research Program (ISRP) of the NASA Aeronautics Research Mission Directorate (ARMD) has the responsibility to develop technologies which will allow future commercial aircraft to simultaneously burn less fuel, produce fewer pollutants, and reduce the amount of noise the community around the airport hears compared to aircraft today. One key component of this effort includes introducing new advanced aircraft configurations such as a hybrid wing body which provides less drag and more lift that the traditional tubular fuselage and wing configuration. Another key factor is lightweight primary structures. To meet these goals, a lightweight composite structure will be developed under this existing task order which will support the loadings associated with the non-tubular shape of the center section of the hybrid wing body and support a higher aspect wing than typically used today.

The structural concept under development in this task order is PRSEUS which is an outgrowth of work begun under the NASA ACT Program in 1990-2000, continued through LaRC-supported trade studies with Boeing in 2004 and continued through an NRA awarded under the Subsonic Fixed Wing Program which ran from 2007-2010.

A summary of the McDonnell Douglas/Boeing involvement through competitively and non-competitively awarded research efforts in resin infusion and stitching technology is shown in the following table and detailed in the narrative below.

| Item | Contract / Task Order | Title | Value | Period of Performance | Type |
|---|---|---|---|---|---|
| 1. | NAS1-18862 | Innovative Composite Aircraft Primary Structures (ICAPS). | $30,382,645 | 3/1989-11/1995 | Competitive |
| 2. | NAS1-20546 | "Technology Verification of Composite Primary Wing Structures for Commercial Transport Aircraft". | $77,787,903 | 9/1995-9/2001 | Competitive |
| 3. | NNL04AA36C | "NASA Maturation of Advanced Aerodynamic and Structures". | $432,034 | 2/2004-8/2004 | Competitive |
| 4. | NNL07AA48C | "Damage Arresting Composites for Shaped Vehicles". | $3,905,015 | 9/2007-10/2010 | Competitive |
| 5. | NNL10AA11B/ NNL10AA99T | "Design, Analysis and Fabrication of Curved PRSEUS Panel" | $596,237 | 2/2010-12/2010 | Non-Competitive |
| 6. | NNL10AA11B/ NNL10AB00T | "HWB Multi-bay Test Article Design and Tooling" | $4,997,767 | 2/2010-3/2011 | Non-Competitive |
| 7. | NNL10AA05B/ NNL11AB68T | "HWB Multi-bay Test Article Analysis and Assembly" | $5,299,821 | 5/2011-9/2013 | Non-Competitive |
| | | TOTAL | $123,401,422 | | |

1. **NAS1-18862:**

In 1989, a NASA Research Announcement (NRA) was issued to solicit innovative ideas that could significantly contribute to development and demonstration of composite technologies to enable composite primary structure for transport aircraft. Out of the 48 proposals submitted, 15 contracts were awarded to industry and university partners. Douglas Aircraft Company's (now part of the Boeing Co.) proposal for the development of stitching technology that would improve damage tolerance, reduce part count, reduce hands-on labor and thereby make composite wing structures 25 percent lighter, and reduce fabrication costs by 20 percent compared to their own aluminum airplanes was 1 of the 15 contracts proposals selected for award. LaRC contract NAS1-18862 was awarded to Douglas to design composite wing structures and develop stitching and resin infusion technology. The technology development under this contract included numerous large stitched panels which were tested either at their facilities or at LaRC. The final phase of that contract was the design and fabrication of a 12-foot long composite box section which was successfully tested at LaRC in 1995.

2. **NAS1-20546:**

In order to further advance the state of the art in composite technology for primary aircraft structure, a new competition was conducted in 1995. That competition was aimed at organizations that had expertise in all the technology areas needed for composite applications to large aircraft structures including the ability to fabricate full-scale aircraft parts. The only proposals LaRC received were from Boeing and McDonnell Douglas. Awards were made from that solicitation to both Boeing and McDonnell Douglas. The Boeing contract (NAS1-20553) was to study the application of composites to fuselage structure and the McDonnell Douglas contract (NAS1-20546) was to develop stitching and resin infusion technology and gain a better understanding of the behavior of composite wings under realistic loading conditions. Under the McDonnell Douglas contract, the contractor fabricated numerous articles, including a stitching and resin infusion 40-foot long wing box with complex curvature representative of the inboard section of the wing of a 220-passenger commercial aircraft. Contracts NAS1-18862 and NAS1-20546 were instrumental to the development of stitching technology and the understanding of resin flow through dry preforms, and the contractor Douglas Aircraft and McDonnell Douglas achieved their goal of 20% cost reduction and 25% weight reduction over metallic structure.

3. **NNL04AA36C:**

At the successful completion of the ACT program in 2001, the former McDonnell Douglas organization (now part of Boeing) continued to privately develop stitched technology and looking for additional applications of this process. In the 2003 to 2004 timeframe, an NRA under the Twenty-first Century Aircraft Technology (TCAT) project competitively sought proposals for structures technology development and Boeing was awarded a contract for trade studies to apply stitched, resin infused technology to a hybrid wing body aircraft and an advanced theater transport under LaRC contract NNL04AA36C entitled "NASA Maturation of Advanced Aerodynamic and Structures." Since the TCAT program was cancelled, the research only included trade studies and did not involve the follow-on task of hardware fabrication.

Boeing's efforts to apply stitched structures on flying aircraft resulted in a contract with the Department of Defense (DOD) to provide stitched resin infused fairings in 2003 and stitched gear doors in 2006 on the C-17. These stitched structures are currently flying on C-17 aircraft. Boeing also worked with the Air Force Research Laboratory (AFRL) to develop aerospace quality parts from out-of-autoclave processing and a more structural efficient stiffener. The concept developed while working with AFRL is PRSEUS. This work was completed in 2006 and is described in the AFRL document "Multi-role Bomber Structural Analysis."

4. **NNL07AA48C:**

In 2007, the NASA Fundamental Aeronautics Program, Subsonic Fixed Wing Project, initiated a competitive NRA to develop technologies related to hybrid wing body vehicles. Fifty two (52) proposals were received. Six (6) of these proposals were in the area of Materials and Structures. Eleven (11) contracts were awarded overall, two in the area of Materials and Structures. The Langley contract (i.e., NNL07AA48C) entitled "Damage Arresting Composites for Shaped Vehicles" was awarded to the Boeing Company. Contract NNL07AA48C consisted of a 1-year phase I effort for trade studies and fabrication of two 80" x 42" PRSEUS panels and a 2-year phase II effort to continue analysis work, improve stitching and resin infusion methodologies, and to fabricate three larger PRSEUS panels and test one and deliver the other two to LaRC for testing. This contract was completed in October 2010 by bringing the Technology Readiness Level of PRSEUS structure for fuselage applications to 4.

5. **NNL10AA99T:**

The application of PRSEUS to traditionally shaped tubular fuselage sections was explored using American Recovery and Reinvestment Act (ARRA) funding under a task which was directed to Boeing under contract in 2010 (i.e., NNL10AA11B/NNL10AB99T). ARRA funding allowed LaRC to support a partnership with the FAA (IA1-1019) wherein LaRC paid for a test article, the FAA paid for conducting a test and Boeing provided test support with its funds. Boeing also used its own tooling which it previously fabricated without government support. Since this activity was not in line with the stated goal of developing HWB structure in ERA, it was kept separate from the HWB development activities. Under this LaRC contract task order NNL10AA99T, Boeing designed and fabricated a 90-inch radius, 10-foot long curved panel to demonstrate the applicability of PRSEUS to traditionally-shaped aircraft fuselage sections. This panel was subsequently tested at the FAA Full-Scale Aircraft Structural Test Evaluation and Research (FASTER) facility, where it met or exceeded all design requirements. This design and fabrication activity proved that high-quality PRSEUS curved panels could be manufactured to meet FAA requirements.

6. **NNL10AB00T and SAA1-1018:**

In 2010 ARRA funding allowed LaRC to move forward with a long term plan for development of PRSEUS structure. A Space Act Agreement (SAA) between Boeing and LaRC (SAA1-1018, Annex 1) was initiated under which Boeing has fabricated and continues to fabricate test articles related to PRSEUS joints, repairs and other PRSEUS features. Some of these test articles have been tested at LaRC. Many of these features support the development of a 30-foot Multi-bay box test article. This SAA has not yet expired.

A non-competitive contract task was initiated with Boeing as part of a collaboration which included the SAA. Under contract with LaRC (i.e., NNL10AA11B/NNL10AB00T) Boeing designed the Multi-bay box test article containing 30-foot long PRSEUS panels. The Multi-bay box test article was designed to fit into the LaRC Combined Loads Test System (COLTS) facility. The subject of this task order and modification is a continuation of this work with PRSEUS structure and moves the research and technology effort forward.

Over the last five years, several research announcements from NASA and the Air Force Research Laboratory have sought advanced aircraft structure designs that save weight, are cost effective, and damage tolerant. The most promising approach identified involves the use of resin infused stitched composites. Through numerous site visits to many commercial and military aircraft original equipment manufacturers (OEMs) and their aerospace supplier companies (small and large), over the last 6 years, we have found that the Boeing Research & Technology (R&T) group in Huntington Beach, CA (formerly Phantom Works) is the only company pursuing this technology at this time. The stitching machine and layup and infusion techniques are unique to Boeing R&T, and enable the realization of a low cost, light weight, and damage tolerant aircraft structure that has the potential to revolutionize the aircraft and spacecraft industry. It is this approach by Boeing R&T that is most consistent with the ERA Project goal of identifying the most promising and realistic technologies, and transitioning these to the aircraft industry over the next three years.

7. **NNL11AA68T:**

The current task order to be modified was awarded in 2011 as a non-competitive task order with LaRC (i.e., NNL10AA05B/NNL11AB68T) to operate in conjunction with SAA1-1018, Annex 1. Under the contract Boeing completed design of a 30-foot-long composite test article and completed the fabrication of the tooling needed to fabricate the PRSEUS panels for the Multi-bay box. This tooling is being used to fabricate the PRSEUS panels to build the Multi-bay box. The assembly of the Multi-bay box is part of this current task order.

## III. Description of Required Supplies/Services

The Environmentally Responsible Aviation (ERA) Program includes the development of lightweight aircraft structures to reduce fuel burn and emissions. The structural concept under development in this task is PRSEUS. As part of current subject task order, the Contactor is required to analyze and assemble a 30-foot long multi-bay test article using the same materials, design methodology, and out-of-autoclave manufacturing approach used in contract NNL07AA48C. [redacted] Boeing has completed stitching and resin infusion of five PRSEUS panels and will complete the infusion of a sixth panel in January 2013. LaRC also will purchase these panels under a separate Firm Fixed Price (FFP) contract and later provide these as GFP under this SMAAART task order to be used for the assembly of the Multi-bay box. LaRC will

purchase the six panels which have not yet been fabricated under a separate SMAAART task order and later provide these as GFP under this SMAAART task order to be used for the assembly of the Multi-bay box.

This modification for additional work fits within the scope of the SMAAART contract. Further, the proposed task order falls within the SMAAART contract performance period and within the maximum contract value.

## IV. Authority Permitting a Fair Opportunity Exception

FAR 16.505(b)(1)(i) requires the Contracting Officer provide each awardee under a multiple award contract, a fair opportunity to be considered for each order exceeding $3,000 unless a statutory exception applies. Specifically, the exception that precludes the fair opportunity process for this acquisition is FAR 16.505(b)(2)(i)(B), which states that "Only one awardee is capable of providing the services or supplies required at the level of quality required because the service or supplies ordered are unique or highly specialized".

As shown in the table above, these contracts represent 20 years of experience and a total of over $123 million invested by LaRC in this technology. The level of quality required cannot be obtained from the other offerors because this work requires use of curved metal tooling owned by Boeing and manufacturing methodologies used by and developed under numerous LaRC Contracts including NNL07AA48C with Boeing. Since no other SMAAART or outside contractor has any experience with PRSEUS technology, a sole source modification to the existing task order as an exception to the Fair Opportunity process is the most appropriate mechanism to continue to move this technology forward.

## V. Demonstration of the Contractor's Unique Qualifications or Nature of the Acquisition Requires the Use of the Authority Cited Above to Provide the Required Supply/Service (Applicability of Authority)

As noted above, Boeing is the only source capable of performing the required additional effort because it is the only contractor capable fabricating PRSEUS structures. The basis for this conclusion is as follows:

This proposed task order modification will build upon work initiated under the subject task order and under SAA1-1018, Annex 1. LaRC has invested in excess of $123M over the past two decades to work with Boeing on stitched structure development.

Under the proposed task order modification for the ERA Project, it is advantageous to the Government to complete the task to deliver the 30-foot multi-bay box. This proposed task order modification, which builds upon the work that Boeing has already accomplished, is in the best interest of the Government because LaRC has invested a substantial amount of money, time, and effort in the above-mentioned PRSEUS development efforts with Boeing; it is not economically feasible to award this task order to a new/different contractor who would not have the facilities, methods, experience, or data available to fabricate these PRSEUS panels. Thirty (30) patents related to various aspects of stitching, resin infusion and PRSEUS have been awarded to Boeing and McDonnell Douglas.

The stitching machine and layup and infusion techniques are unique to Boeing R&T, and enable the realization of low cost, light weight, and damage tolerant aircraft structure that has the potential to revolutionize the aircraft and spacecraft industry. It is this approach by Boeing R&T that is most consistent with the ERA Project goal of identifying the most promising and realistic technologies, and transitioning these to the aircraft industry over the next three years.

## VI. Description of Efforts Made To Ensure Competition Between All Awardees

As mentioned above and below, this proposed task order modification builds upon the work already completed and/or in progress under task order NNL11AA68T. As described above, several research announcements from NASA and the Air Force Research Laboratory have sought advanced aircraft structure designs that save weight, are cost effective, and damage tolerant. The most promising approach identified involves the use of resin infused stitched composite. Through numerous site visits to many commercial and military aircraft original equipment manufacturers (OEMs) and their aerospace supplier companies (small and large), over the last 6 years, we have found that the Boeing Research & Technology (R&T) group in Huntington Beach, CA (formerly Phantom Works) is the only company pursuing this technology at this time.

The ERA program engaged in a series of market research activities to develop its Phase 2 activities, where it seeks to mature technologies from a TRL of 4 to 5 or 6, with an emphasis on those technologies that can be matured to a higher technology maturation level and those that have demonstrated commercial viability in the 2020 to 2025 timeframe. These efforts included publishing a Request for Information (RFI) in FEDBIZOPPS and the NASA Acquisition Internet Site on February 24, 2012 which solicited extensive information including (1) recommendations of technologies associated with the technology focus areas ready for Integrated Technology Demonstrations, and associated test campaigns and test assets to be completed by the end of FY 2015, raising TRL to 5 or 6 and thereby advancing integration readiness level and (2) product focused transition plans associated with the identified technologies. The ERA program also conducted a Meeting of Experts (MOE) on March 29, 2012 to gather additional information to set its Phase 2 Strategy. After the RFI responses and information obtained at the MOE, the ERA Program made the decision to move forward on several Integrated Technology Demonstration (ITD) research efforts. PRSEUS was one of those selected. Only Boeing proposed continuing development of stitched structures or demonstrated, through responses to the RFI, that it has the capability to pursue development of stitched structure.

## VII. Determination by the Contracting Officer That The Anticipated Cost to the Government Will Be Fair and Reasonable

The CPFF amount for this acquisition will be determined fair and reasonable by the Contracting Officer prior to award of the task order modification. Actions anticipated to ensure reasonableness will be accomplished using the procedures and criteria contained in the Federal Acquisition Regulation (FAR), NASA FAR Supplement (NFS), and other regulatory documents as applicable. Detailed documentation and justification of reasonableness will be

disclosed in the Price Negotiation Memorandum (PNM) which will be prepared using the evaluation of the Boeing quoted pricing, compared to the independent Government estimate, and the pricing of previous similar efforts. Certified cost and pricing data will be obtained and used in determining a fair and reasonable cost.

## VIII. Description of Market Research Conducted Among All Awardees and the Results Or A Statement of the Reason Market Research Was Not Conducted

As detailed in paragraph VI., the ERA program engaged in extensive market research and made significant efforts to achieve competition to award the contracts. The Contracting Officer further considered other contracts during the initial award and this modification request to the subject task order, such as the Technical, Engineering, Aerospace Mission Support (TEAMS) and TEAMS II contract which has a similar scope and statement of work as the SMAAART contract. However, the TEAMS II contract provides on or near site engineering support and does not include the capability to provide the necessary facilities. As such, additional market research for this proposed task order was not performed.

## IX. Other Facts Supporting the Justification

None.

## X. List of Any Awardee That Expressed Interest in the Acquisition

None.

## XI. Actions the Agency May Take to Remove or Overcome Any Barriers To Increasing Fair Opportunity Before Any Subsequent Acquisition For the Supplies or Services

LaRC may have future requirements that can only be met by Boeing. However, the Contracting Officer will continue to scrutinize all SOWs received to ensure fair opportunity is appropriately given. LaRC typically looks for proactive steps that can be taken to eliminate barriers to competition for future requirements. Since this is a modification to an existing task order and integral to its completion, combined with Boeing's unique and highly specialized equipment and abilities, it is not advantageous for the Government to release this proposed task order modification as a competitive acquisition when there is no expectation that the other SMAAART contractors will submit a proposal. Additionally, because LaRC's only known future requirements for this technology at this time are also in support of the multi-bay box effort and involve only near-term panel fabrication, LaRC lacks the ability to incentivize the other SMAAART contractors to invest the substantial sums that would be required to establish an alternate source for this service. These other procurement actions to support the multi-bay box test article are being developed at this time and will be evaluated on their merits as we receive proposals.

JEFOP, Task Order Mod 5 to NNL11AA68T

**Technical Certification:**

I certify that to the best of my knowledge and belief, the data furnished above is complete and accurate.

Dawn Jegley — 1/23/13

Dawn Jegley
ERA Integrated Technology Demonstration on Unitized Structures Lead

Date

**Contracting Officer Certification:**

I hereby certify that the above justification is accurate and complete, to the best of my knowledge and belief, and the anticipated cost to the Government will be fair and reasonable.

C. Lynn Jenkins — 1-23-13

C. Lynn Jenkins
Contracting Officer

Date

Concurrence:

Susan E. McClain — 1/23/2013

Susan E. McClain
Head, Research and Development Contracting Branch, Office of Procurement

Date

Michael I. Mark — 23 JAN 13

Michael I. Mark
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Virginia C. Wycoff — 1/24/2013

Virginia C. Wycoff
Procurement Officer

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Approval:

Stephen G. Jurczyk
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1/24/2013
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