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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GEORGE C. MARSHALL SPACE FLIGHT CENTER

JUSTIFICATION FOR OTHER THAN FULL AND OPEN COMPETITION

1. **Agency and Contracting Activity**. The procuring agency is the National Aeronautics and Space Administration (NASA), and the contracting activity is NASA's George C. Marshall Space Flight Center (MSFC).

2. **Description of Action**. NASA's MSFC proposes to procure the Interim Cryogenic Propulsion System (ICPS) from The Boeing Company for use in the Space Launch System (SLS). This effort is from authority to proceed through hardware modification and qualification. The effort includes the manufacture and flight support for two flight units, including flight spares, in support of Exploration Missions 1 and 2 (EM-1 and EM-2) launching in late Fiscal Year (FY) 2017 and 2021 respectively. Although EM-1 is not a crewed mission, all modifications to and qualification efforts for the ICPS are to be completed prior to flight of EM-1 in order to obtain flight performance data prior to its use on a crewed mission (EM-2). Because the ICPS may be required for additional SLS flights, this effort also includes two options to manufacture a total of two additional flight units, including flight support and flight spares, for use on the third and fourth Exploration Missions (EM-3 and EM-4). Additional commercial in-space stages are currently in development and could support EM-3 and EM-4, but availability of flight data to validate their use on crewed missions is uncertain. The options to procure two additional ICPS will ensure hardware availability for EM-3 and EM-4. The development efforts of the additional commercial in-space stages will be monitored and assessed for SLS needs prior to a decision to execute the two options in accordance with NFS 1817.207-70, Analysis to Support Exercise of Options. The total estimated cost of this effort is approximately $175M for the base contract ($307M including all options), and the estimated period of performance is approximately 8 years for the base contract (12 years including all options).

3. **Description of Supplies/Services Being Acquired.**

3(a) SLS Architecture: Consistent with the NASA Authorization Act of 2010 (S.3729) NASA has developed a set of reference missions that rely on evolving a set of development and operational space launch capabilities over a period of time to support increasingly ambitious exploration missions to increasingly more challenging destinations. (Reference missions define missions that NASA intends to perform, including the means of launching those missions, leading directly to a set of launch vehicle needs.) A key early capability required by NASA's reference missions is the Orion Multipurpose Crew Vehicle (MPCV) and a human-rated Space Launch System. MPCV development began in 2005 in support of the Constellation Program and will provide crew accommodations, propulsion, and communication for extended exploration missions. For the first two missions, SLS will

launch the MPCV for an un-crewed circumlunar flight around the moon with free lunar return and for a crewed high lunar orbit around the moon (Refer to Figure 1.0). The SLS vehicle lift capability for these flights is approximately 70 metric tons (mT).

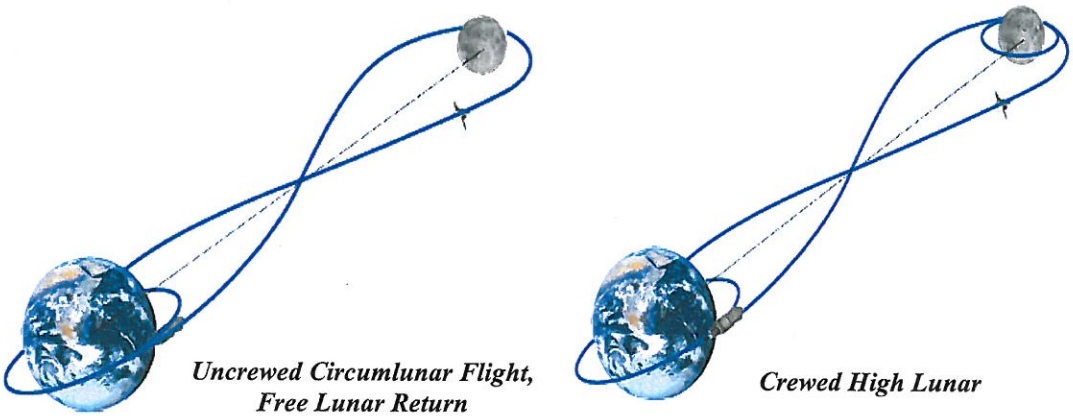

FIGURE 1.0 First and Second NASA Reference Missions

NASA's reference missions also require a launch system capable of lifting up to 130 metric tons of payloads to Low Earth orbit (LEO) for more ambitious exploration missions. The larger payloads enable placement of significant exploration hardware in space and enable potential science missions to Near Earth Objects, such as asteroids and Mars.

The SLS Program Office has developed launch system architecture to meet an evolving capability strategy consistent with the reference missions and at a pace prescribed by the available budget (Refer to Figure 2.0). NASA selected a launch system that incorporates Liquid Oxygen (LOX) and Liquid Hydrogen (LH2) propulsion technology for the Core Stage, Space Shuttle heritage RS-25 engine as the Core Stage main engine, and matures five segment solid rocket motor technologies for the boost on the initial flights. The vehicle uses a "stage and a half" configuration that ignites the Core Stage engines seconds before liftoff and then ignites the solid motors at liftoff. The boosters burn out approximately two minutes into the flight while the Core Stage engines continue to burn until the desired cutoff point is achieved. The basic configuration is flexible for both 70 metric ton launch capability and for evolving to a 130 metric ton capability, with the incorporation of an Upper Stage powered by J-2X engines. The J-2X development began in 2007 in support of the Constellation Program.

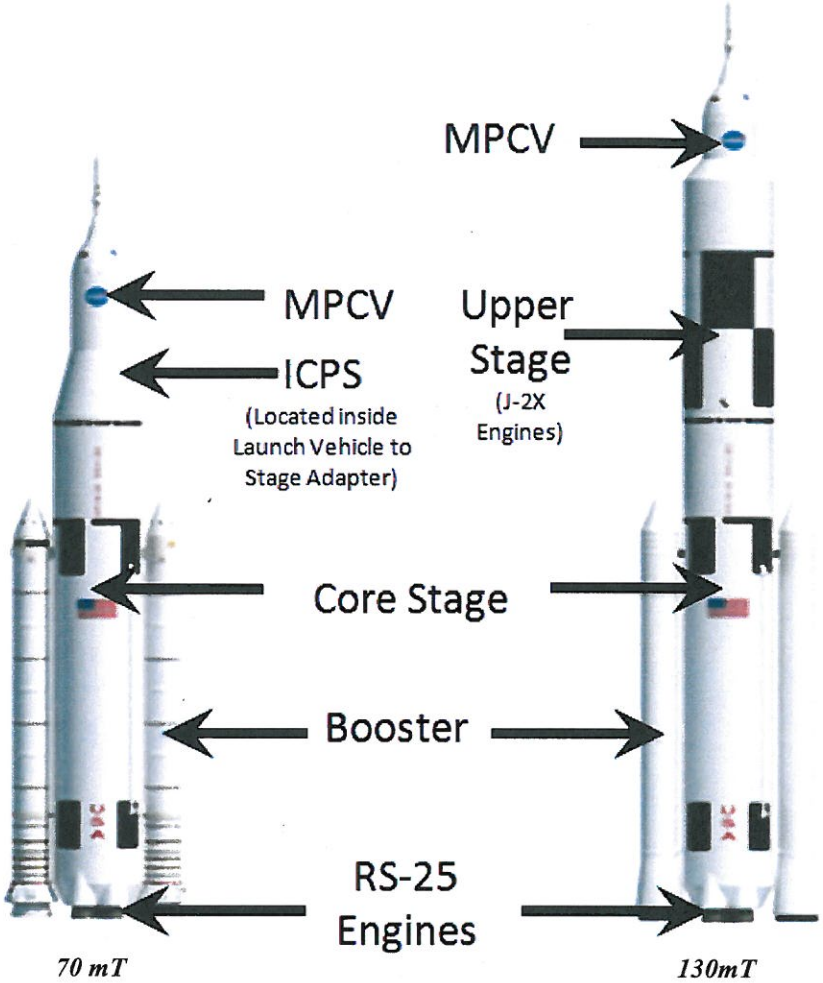

Figure 2.0 Evolvable SLS Architecture

3(b) Description of Supplies/Services: Following the announcement of the SLS vehicle architecture, the first two reference missions (un-crewed EM-1 and crewed EM-2) were defined by NASA as the initial steps to be taken in support of NASA's long term goal to expand human presence beyond low-Earth orbit. Subsequently, an integrated, technical assessment of the SLS vehicle and designed MPCV was performed to assess the ability to achieve these reference missions. This assessment identified that the propulsion system of the SLS vehicle could only deliver the MPCV, at its current weight with service module and crew, into a lower earth orbit. The need for additional delta velocity to perform a propulsive maneuver, with multiple engine starts, was identified in order to set the spacecraft on a trajectory toward the moon. This maneuver could not be accomplished with the use of the MPCV service module propulsion system.

Pursuant to this need, NASA's MSFC identified the requirement for a cryogenic propulsion stage as an interim solution pending development of the Upper Stage for the evolved SLS architecture. The ICPS design parameters and performance characteristics are as follows:

1) Human Rating in accordance with NPR 87205.2B, "Human-Rating for Space Systems"
2) Lift Capability on Orbit of approximately 53,400 lbs
3) Mass of 71,400 lbs
4) Length as stacked within 500 inches
5) Delta-V greater than 3,050 m/s with three engine ignitions (third ignition for disposal)
6) Stage Functionality to perform a separation event and three-axis control after insertion, but before MPCV separation
7) Axial Acceleration, not to exceed 2g
8) Reference Missions
   a. Support MPCV free lunar return missions
   b. Support MPCV High Lunar Orbit (HLO) missions

The contractor will be responsible for providing, which includes modification, qualification, and manufacture of, up to four ICPS units compliant with the specified design parameters and performance characteristics and compatible with the SLS vehicle. In addition, the contractor will be responsible for providing flight spares and flight support. The first ICPS unit must be delivered by the fourth quarter of fiscal year 2016 in support of the first exploration mission in 2017.

4. **Statutory Authority.** The statutory authority permitting other than full and open competition is 10 U.S.C. § 2304(c) (1), as implemented by FAR Part 6.302-1, "Only one responsible source and no other supplies or services will satisfy agency requirements".

5. **Rationale Supporting Use of the Authority.** The rationale supporting use of 10 U.S.C. § 2304(c)(1) is there is a sound basis to conclude that the agency's minimum needs can only be satisfied by unique design parameters and performance characteristics that are available from only one source.

   a) Boeing's 5-meter Delta Cryogenic Second Stage (DCSS) is the only in-space propulsion stage capable of meeting the ICPS design parameters and performance characteristics (considering SLS schedule constraints) with relatively minor modifications. As currently designed, the DCSS meets all requirements noted above with the exception of Human Rating and delta-V. Modifications to the hardware would be required to meet failure tolerance requirements, including design margins and redundancy, as required per NPR 8705.2B. The current capability of the DCSS provides a delta-V just under the required 3,050 m/s. The additional delta-V can be obtained by stretching the LH2 tank inches in length to accommodate additional fuel. A simpler alternative to be assessed is utilizing the altitude control system (ACS) to perform the final, third burn for disposal. The DCSS has completed both an extensive development program as well as qualification program including full scale testing. In addition, the DCSS has proven flight history data and validation. No other in-space propulsion stage (either existing with proven flight performance or planned) requires such relatively minor modifications to be made fully compliant with the ICPS design parameters and performance characteristics. These modifications can be qualified with minimal structure and component testing, which builds upon the testing described above.

b) Boeing maintains the data rights to the DCSS. Boeing maintains the unique and specific design and testing knowledge/skills required to effect the types of modifications to the DCSS necessary to enable full compliance with the ICPS design parameters and performance characteristics.

6. **Market Research/Potential Sources**. Market research was conducted via a number of manners. First, the Government undertook an extensive in-house review of the available in-space propulsion capabilities within the United States, Europe, and Japan. That review considered variants of the Delta and Atlas vehicles from the United States, the Ariane vehicle from Europe, and the H-IIB vehicle from Japan. When the design parameters and performance characteristics submitted by the potential sources were compared against ICPS design parameters and performance characteristics, only the 5-meter variant of the DCSS was capable (with relatively minor modifications) of meeting the requirements of the Government. A sources sought synopsis was later published January 9, 2012 on the NASA Acquisition Internet Site (NAIS) and in FedBizOpps as a means of validating the in-house assessment. In response to the sources sought synopsis, three vendors submitted statements of capability. Upon Governmental review of the three responses, it was determined that only Boeing could meet the design parameters and performance characteristics with minimum modifications. The other two vendors proposed modifications to hardware that is either existing or under-development. These modifications would require full scale development and testing to qualify the stages described for flight. Full scale testing is a lengthy process and creates unacceptable schedule risk to the SLS Program. One vendor further proposed a change to the NASA reference missions to minimize hardware modifications, which is also an unacceptable approach to meeting the requirements of the SLS Program. While these two vendors may be positioned in the future to support the required design parameters and performance characteristics, neither company at the present maintains an existing capability or a capability requiring relatively minor modifications that can be available for use on EM-1 and EM-2 in time to support the mission flight dates.

On May 3, 2012, the ICPS acquisition pre-solicitation synopsis was published on NAIS and in FedBizOpps. A response was received from one of the vendors who responded to the sources sought synopsis in January 2012. The vendor submitted the same information regarding the design parameters and performance characteristics as previously provided which is still under-development. As found before, the modifications would require full scale development/testing to qualify the stage for flight. The submittal described the use of results from sub-scale testing conducted for a stage currently under development (larger than the ICPS described in the two synopses) to develop a modified version of that stage sized to meet the ICPS envelope described in the two synopses. Sub-scale testing in the manner described is not an acceptable approach to development/qualification due to the difficulties and uncertainties associated with scaling test results from sub-scale to full scale, especially when associated with engine performance. A response was also received from a vendor making reference to an unsolicited proposal submitted to Goddard Space Flight Center in 2011 for an unrelated activity. That response was a single page e-mail without any attempt to address the ICPS requirement described in the pre-solicitation synopsis, so it is referenced in this justification only to fully describe responses to the pre-solicitation synopsis. Collectively, all research demonstrates that the effort required by this acquisition is not

available from any source other than Boeing. It was determined that the 5-meter variant of the DCSS is the only means of satisfying the ICPS design parameters and performance characteristics necessary to support the early NASA reference missions.

7. **Determination of Fair and Reasonable Cost**. A cost analysis will be performed as described in FAR Part 15.4. Boeing will submit a proposal that will be evaluated and negotiated by the Government. All sources such as Contracting Officers, Cost and Price Analysts, The Defense Contract Audit Agency (DCAA), and Government technical representatives will be utilized in the determination of a fair and reasonable cost.

8. **Barriers to Competition.** No known actions exist which the Agency may take to remove or overcome barriers to competition before any subsequent acquisition for this activity.

For the above reasons, full and open competition is not feasible. Therefore, purchase of the requirement described herein from Boeing is the only approach that will meet the Government's minimum needs for EM-1 and EM-2.

Pursuant to NFS Part 1804.570, this proposed contract action will be published on the NASA Acquisition Internet Service (NAIS) and pursuant to FAR Part 5.201; this proposed contract action will be synopsized in the Federal Business Opportunities.

I hereby certify the facts in this justification and any supporting data used for this justification are accurate and complete to the best of my knowledge.

David E. Beaman — 6/7/12

David E. Beaman
Manager, Spacecraft Payload Integration Office

Date

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

G. Earl Pendley — 6/6/12

George E. Pendley
Contracting Officer

Date

Concurrence:

Kim E. Whitson
Procurement Officer

6/19/2012
Date

Robin N. Henderson
Center Competition Advocate

Date June 21, 2012

William H. Gerstenmaier
Associate Administrator for Space Operations
Mission Directorate

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Date

William P. McNally
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7/12/12
Date

Approved:

William P. McNally
Assistant Administrator for Procurement

Date 7/12/12