PROGRAM SOLICITATION

DARPA-PS-16-03

for

EXPERIMENTAL SPACEPLANE (XS-1)

PHASE II/III

23 MAY 2016

Defense Advanced Research Projects Agency
DARPA/TTO
675 N. Randolph St.
Arlington, VA 22203-1714

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DARPA-PS-16-03 OVERVIEW INFORMATION

- **Federal Agency Name** – Defense Advanced Research Projects Agency (DARPA)
- **Funding Opportunity Title –** XS-1 Phase II/III
- **Announcement Type –** Initial announcement
- **Funding Opportunity Number –** DARPA-PS-16-03
- **NAICS Code:** 541712; Small Business Size: 1500
- **Catalog of Federal Domestic Assistance Numbers (CFDA)** –Not applicable
- **Dates**
  - **Questions Due Date:** Tuesday, June 7, 2016, 14:00 PM Eastern Daylight Time
  - **Proposal Due Date:** Friday, July 22, 2016, 14:00 PM Eastern Daylight Time

- **Concise description of the funding opportunity:** The overall objective of the XS-1 Phase II/III program is to design, build, and flight test a reusable booster system prototype to support an upper stage capable of inserting a minimum of 3,000 pounds to orbit, with a design goal of less than $5M cost per launch for an operational system. The program will demonstrate on-demand and routine flight operations by flying the booster ten times in ten days and launch a demonstration payload greater than 900 pounds to orbit.

  Current space launch vehicles are very expensive, have no surge capability and must be contracted years in advance (i.e., long call up times). For example, the U.S. Air Force's Evolved Expendable Launch Vehicle (EELV) and Minotaur IV launch vehicles have dramatically increased in cost since the inception of those programs. In an era of proliferating foreign threats to U.S. air and space assets, the need for responsive, low cost access to space is increasingly critical. XS-1 will directly address the need for small to medium payloads launched using low cost and operationally efficient concepts of employment (CONEMPs) based on a "clean pad" approach; i.e., limited facilities and ground support equipment.

  It is also envisioned that the XS-1 program will mature many of the key technologies and operational processes needed to enable future space access vehicles. Moreover, it will provide a foundation to build upon for larger launch systems in the future. Missions performed by such follow-on vehicles range from technology maturation to routine space access sortie aircraft enabling a wide range of military applications.

- **Total amount of money to be awarded:** $ 140M
- **Anticipated individual awards** – One award is anticipated.
- **Types of instruments that may be awarded** -- Other Transaction for Prototype Project
- **Any cost sharing requirements:** Cost sharing may be required under applicable statutory regulations for other transactions for prototype projects awarded under the authority of 10 U.S.C. § 2371b.
- **Agency contact**
  - Points of Contact:

    Defense Advanced Research Projects Agency (DARPA)

XS-1 Program
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1.0 INTRODUCTION

The XS-1 is a reusable high speed booster that deploys an expendable upper stage able to insert small payloads to orbit. The program vision is to: 1) leverage the industrial and commercial sectors to break the cycle of escalating space system launch costs and enable lower cost satellite architectures both for the commercial sector and Department of Defense (DoD), 2) prove that a routine and reliable space access vehicle can be built and flown at order of magnitude lower costs than today's launch systems, and 3) enable the transition to a responsive capability for launch and rapid reconstitution of payloads of at least 3,000 lbs. The reusable XS-1 will demonstrate the potential for low cost and "aircraft-like" high ops tempo payload delivery to orbit, enabling responsive next generation space access. The motivation for developing this new launch architecture is to drive down the "cost to space" and "time to space" for fielding a responsive operational capability.

Phase I of the XS-1 program was conducted via DARPA-BAA-14-01. This solicitation addresses Phase II (XS-1 Final Design; Fabrication; and Integration, Assembly, and Ground Test) and Phase III (Flight Test Campaign). During Phase I, several concepts were designed to a level of maturity that ensured the feasibility of the program requirements, and mitigated technical and business risks to an acceptable level. Phases II and III will proceed to detailed design, fabrication, and flight testing, culminating in a demonstration of the full-scale reusable booster prototype, including the insertion of at least 900 pounds of payload into orbit. Full-scale booster flight testing will prove the feasibility of a launch vehicle designed for aircraft-like operations and provide the data and confidence necessary for the system to be transitioned to routine commercial operations.

DARPA anticipates awarding an other transaction (OT) for prototype project to a single performer under DARPA's authority to award an OT for prototype projects under 10 U.S.C. § 2371b. The Government intends to fund a proposer for work performed by means of incremental milestone payments based on the successful accomplishment of specific tasks or delivery of products. However, the Government reserves the right to select for negotiation all, some, one, or none of the proposals received in response to this solicitation, and to make awards without discussions with proposers.

2.0 PROGRAM DESCRIPTION

The Government seeks to finalize a design, fabricate, assemble, and fly the XS-1 through a series of test campaigns that will validate critical technologies and capabilities necessary to drive down cost and time-to-space by an order of magnitude.

2.1 XS-1 Performance Goals

The XS-1 Phase II/III Performance Goals are clarified as compared with those provided in DARPA-BAA-14-01 and are included in Table 1 below. Proposed performance against these metrics (Objective and Threshold) listed in Table 1 will be evaluated as part of the scientific/technical review of each conforming proposal.

Table 1: XS-1 Performance Goals

XS-1 PRIORITIZED GOALS	OBJECTIVE	THRESHOLD
Design a reusable booster system with launch costs traceable to <$5M/flight[1,2,4]	Payload: ≥3,000 lbs to 90° inclination, 100 nm circular (reference orbit)	Payload: ≥3,000 lbs to 28.5° inclination, 100 nm circular (reference orbit)
Fly booster 10 times in 10 days[3]	Sequential calendar days	Allow weather, range, and emergency delays
Demonstrate an immediate payload to orbit capability with cost traceability to the Operational System[2,4]	Payload: ≥1,500 lbs to 100 nm, 28.5° due east	Payload: ≥900 lbs to 100 nm, 28.5° due east
Enable routine, low cost space access	Fly XS-1 to Mach 10+ at least once and stage at high Mach to minimize the size and cost of the upper stage	Fly XS-1 to Mach 3+ at least once, with Mach 2+ staging of a low cost upper stage

NOTES:

[1]The full system (reusable and expendable components) capable of launching these payload masses will be referred to as the "Operational System." This must include performance capabilities for the booster and upper stage, whether reusable or expendable.

[2]Showing traceability requires rigorous tracking of both recurring and non-recurring costs. These must be incorporated into a cost model that includes flight rates, learning curve efficiencies, demonstrated versus Operational System capabilities, required research and development (R&D), and amortization. Under the cost model assumptions, the number of flights and the annual flight rate required to achieve the flight cost goal (can assume BY 2016$) must be identified. The cost model traceability must include both the booster and upper stage for the Operational System capability. This requires assessments/assumptions for low to medium risk upper stage availability. Section 4.1.4 explains how the per-flight costs are to be addressed in any proposal to this solicitation.

[3]The goal is for the 10 flights to be accomplished at any time during a 10 consecutive day period. If range delays are incurred when the vehicle is fully flight-ready, the delays will not be counted against the performance of this goal. The Threshold for this goal will be met if, after subtracting range, weather, and emergency delays, 10 flights have taken place within a net period of 10 calendar days. The flight campaign may consist of 10+ flights and should be representative of the operational system flight envelope for altitude, dynamic pressure, and Mach number.

[4]Smaller payloads to alternative altitude and inclination orbits of equivalent energy states are acceptable.

Successful demonstration of these goals will provide a proof-of-concept for responsive space launch capabilities. Flying ten times in ten days will demonstrate aircraft-like operability using a

"clean pad" concept of employment (CONEMP) along with rapid turnaround and reconstitution of space assets, thus creating a new paradigm for routine space operations. The ability to launch a payload to orbit at a cost of less than $5M will represent approximately a 10X cost reduction compared to today's Minotaur IV capabilities. Demonstrating a launch capability for payloads greater than 900 pounds will provide an immediate operational benefit to military, civil, and commercial stakeholders.

2.2 Program Plan

DARPA will procure Phases II and III of the XS-1 program using an OT agreement with a design-to-cost goal of $140M (Phase II - $123M, Phase III - $17M).

- Phase II: Final Design; Fabrication; and Integration, Assembly, and Ground Test
- Phase III: Flight Test Campaign

This program solicitation solicits proposals that either, 1) propose a system at a preliminary design review level of rigor tailored for a demonstration rather than an acquisition program, or 2) propose a preliminary design derived from vehicle hardware the proposer has developed and tested. Phase III is expected to begin no later than sometime during Government fiscal year FY20. Submission of proposals to Phases II/III is optional, and associated proposal preparation costs will not be reimbursed.

In order to complete detailed design, fabrication, and flight test within the planned schedule and budget, proposals for Phases II and III must contain designs of sufficient engineering maturity and fidelity. This includes the incorporation of propulsion systems that will be ready for flight test by Phase III.

DARPA intends for the hardware, software, and technologies developed under the XS-1 program to be transitioned from Phase III to the commercial sector. Customers for launch services on these XS-1 and derived systems may include civil and military Government agencies.

2.3 Management Approach

DARPA will employ a streamlined systems engineering approach in Phase II/III. Likewise, DARPA is committed to facilitating a rapid and affordable Phase III flight test program. Proposers may propose a civil flight safety and licensing approach, or an approach where the Phase III flight safety/licensing will occur under the auspices of DoD authority with civil transition afterward. In accordance with the approach chosen, proposers are expected to work within the applicable flight safety and licensing frameworks, such as AFSPCMAN 91-710, MIL-HDBK-516C, FAA AST 14 CFR Part 400 series regulations, and FAA airworthiness certifications if required for air-launch approaches. To the maximum extent possible, DARPA will work with the responsible agencies to tailor these documents to the requirements of the program. While DoD airworthiness certification is not a baseline requirement, appropriately tailored compliance with the intent of MIL-HDBK-516C for reusable aircraft is encouraged regardless of the flight safety/licensing approach. Should DoD airworthiness certification be undertaken, DARPA will retain airworthiness approval authority consistent with DoD policies.

Use of DARPA's authority under 10 U.S.C. § 2371b provides significant potential for innovative and streamlined program management and a unique opportunity for collaboration between Government and industry. The Government remains committed to its vision of working with the performer as a partner on a unified team, facilitating the best technical development and program outcome within program constraints. DARPA seeks to continue its streamlined approach to program management, employing a technical support team leveraging contracted and other Government subject matter experts. DARPA encourages proposers to offer a management approach that will enable the most efficient and cost effective program.

Collaborative efforts/teaming are encouraged. Specific content, communications, networking, and team formation are the sole responsibility of the participants.

2.4 Data Rights

DARPA requires sufficient Government rights to intellectual property developed to enable the Government to: 1) flexibly brief Government stakeholders regarding technical progress and accomplishments, 2) allow validation of technical performance, capabilities, and accomplishments by independent technical (potentially non-Government) experts, 3) facilitate discussion of technical challenges and applications with the broader technical community, 4) support wargaming and analyses of alternatives, and 5) support transition opportunities, including design and performance data required to support other acquisition activities. It is anticipated that these latter activities will require the Government to conduct an independent performance analysis; therefore, it will be desirable to have Government Purpose Rights (GPR), as defined in section 4.1.11, to basic architectural, behavioral, and performance characteristics, including dimensions, mass properties, aerodynamics, propulsion, material and structural limitations, and other major subsystem data substantiating performance.

In order to enable transition of XS-1 technologies and concepts to the commercial sector, certain data items will need to be provided with Unlimited Rights, as defined in section 4.1.11. In general, the Government desires Unlimited Rights, on high-level XS-1 system, subsystem, and operational data, including top-level mass properties (flight system with and without propellants, overall subsystem masses), system-level performance (including payloads, average thrust, and average Isp for all stages), subsystem operating principles, concepts of employment (launch base facilities and processing), mission support data (trajectories that support specific missions, types of payloads, capabilities enabled, etc.), and operations data (type and number of personnel required to operate system, nominal time to integrate and launch an encapsulated payload, nominal time to turn around the system). Similar Unlimited Rights for the high-level data requested above should be retained by the Government for any transition or derived vehicles the performer investigates for civil and military applications, including more capable launch, sortie, or point-to-point transport vehicles. Additionally, top-level information on ground support equipment, mission support systems, and operations/remote-monitoring centers should be provided with Unlimited Rights.

3.0 PROGRAM OBJECTIVES

3.1 Phase II: Final Design; Fabrication; and Integration, Assembly, and Ground Test

Phase II is estimated to be a 30-month effort during which the performer shall complete detailed design, fabrication, assembly, and ground testing of the XS-1 booster, demonstration upper stage and ground systems. A systematic approach will be followed with sufficient intermediate reviews to periodically assess progress towards flight demonstration. The Integrated Master Schedule (IMS) will include a critical path analysis that addresses all major events associated with the development and verification of each element of the XS-1 system. Details will be provided on critical activities such as software development, fabrication and integration, and risk reduction. This analysis will assess the key processes, developments, or activities that will pace the development schedule. The performer is expected to hold a tailored Critical Design Review (tCDR) prior to vehicle integration. Long lead items may begin fabrication prior to the tCDR, and fabrication, assembly, and test of components such as the upper stage may extend into Phase III. The performer is expected to fabricate, integrate, assemble, and ground test the various hardware components, including shipment to the launch site and launch preparation. A Flight Test Campaign Readiness Review will be held at the end of Phase II to ensure the program is ready to enter Phase III.

3.1.1. Primary Objectives

1. Develop a detailed design for the XS-1 demonstration system (booster, ground systems, and demonstration upper stage capable of inserting greater than 900 pounds into orbit) and ensure the envelope of system requirements and interfaces necessary to accommodate the operational upper stage are incorporated into the design.
2. Develop and execute a tailored Test and Evaluation Master Plan (TEMP); the TEMP shall include the Phase III flight testing.
3. Develop a Flight Safety/Licensing Plan, addressing FAA and applicable launch and landing range requirements.
4. Conduct risk reduction activities.
5. Conduct tailored Critical Design Review(s) for the XS-1 system, including the demonstration upper stage.
6. Fabricate the XS-1 booster vehicle and ground systems.
7. Design an upper stage for the demonstration system. Fabrication and integration may extend into Phase III.
8. Conduct Integration, Assembly, Ground Test and Qualification
9. Complete 10 propulsion ground tests in 10 consecutive days
10. Conduct a factory to launch site pre-ship review
11. Conduct a Flight Test Campaign Readiness Review

3.1.2. Key Milestones

The Government has defined the minimum content of several key Phase II/III milestones in this section and section 3.2.2. The performer should supplement these milestones as well as their own milestone schedule based on key events and activities, as appropriate, from their TMP and XS-1 development schedule (reference section 3.3.1).

Phase II/III Kick-off Milestone: Immediately following Authority to Proceed

The objective of the kick-off meeting will be to conduct in-depth technical discussions on the performer's preliminary design, address any questions and issues, and set the baseline for proceeding in Phase II.

Minimum Accomplishment Criteria:

- A Phase II program plan review that addresses:
    - Delineation of functional and flowed-down requirements
    - Schedule of milestones and events leading up to milestones
    - Baseline for the IMS, ensuring it is fully populated, includes all task dependencies, and properly displays the critical path
    - Critical path analysis and risk assessment
    - Technology maturation plan, including outline of development activities and testing
    - tCDR approach and long lead plan
    - Demonstration schedule, including airworthiness approval plan and key risk areas
    - Software development schedule
    - Management tools
    - Draft ground test plan
    - Facilities planned to be used or developed

Tailored XS-1 Critical Design Review Milestone

The XS-1 tCDR will be conducted prior to fabrication of the booster, demonstration upper stage, and ground systems to ensure that the detailed design solution satisfies the requirements derived from XS-1 demonstration objectives. To achieve the aggressive schedule and enable long lead purchases, the performer may provide rolling subsystem reviews leading up to tCDR for the full system. Success criteria for tCDR are encompassed in Appendix B.

Minimum Accomplishment Criteria:

- All aspects of tCDR must be complete in accordance with Appendix B – Tailored CDR Success Criteria
- Sufficient progress must be made to merit proceeding to the next milestone

Tailored Demonstration Upper Stage Integration Review Milestone

The Demonstration Upper Stage (DUS) Integration Review will ensure that the design of the upper stage to be used for the orbital launch demonstration within Phase III is capable of doing so safely and that it is compatible with the XS-1 system definition. The performer is expected to tailor the tCDR criteria contained in Appendix B as relevant to their DUS concept.

Minimum Accomplishment Criteria:

- All aspects of DUS Integration Review are complete
- Sufficient progress has been made to merit proceeding to the next milestone

Ten Propulsion Ground Tests in Ten Days Milestone

The objective of the propulsion ground test encompassing 10 firings within 10 consecutive days is to validate the suitability of either a single engine or an integrated propulsion system on XS-1 to accomplish the high ops tempo flight tests. Test duration should support ramp-up to steady state thrust and/or integrated performance of the flight system. A non-exhaustive list of potential options may include:

- During qualification or acceptance testing, the performer may fire a single engine 10 times in 10 consecutive days on a rocket engine test stand.
- Ten firings of the integrated propulsion system on XS-1 may be accomplished in 10 consecutive days on the launch stand.
- The performer may propose alternative approaches that meet the Government's intent to reduce the risk of the Phase III flight test program.

Minimum Accomplishment Criteria:

- Demonstration of sufficiently low propulsion risk to proceed to the next milestone.
- 10 ground engine test firings in 10 consecutive days.

Flight Test Campaign Readiness Review (FTCRR) Milestone

The Flight Test Campaign Readiness Review is a multi-disciplined review to ensure the system and the performer team is ready to proceed into the formal flight testing and demonstration phase.

Minimum Accomplishment Criteria:

- Approval from all Government approval authorities to proceed into Phase III
- Verified readiness of the ground system, flight operations control center (FOCC), range interfaces/support, and flight system to support initial flight testing
- Verified readiness to support the orbital flight demo or identify the orbital flight demo status and schedule a subsequent flight test campaign readiness review for the orbital demo.

3.1.3. Key Deliverables

Test and Evaluation Master Plan that includes all ground and flight test events, and associated reviews. During program execution, the TEMP may be tailored and shall be regularly updated, and will serve as both a plan for future tests as well as a record of completed tests and key outcomes. Coordination with the Government is expected for each significant revision of the TEMP. The performer may choose to incorporate their Technology Maturation Plan (TMP) and/or Qualification Plan content into their TEMP to form a unified testing, risk management, technology maturation, and qualification/verification plan. In such a case, a separate TMP and/or Qualification Plan will not be required during program execution.

Vehicle Overview Document (VOD), or System Overview Document, to be updated at significant design iterations, will capture key system characteristics as the design increases in maturity. It is anticipated an updated VOD will be available at major milestone reviews.

System Design Document (SDD) provides additional details on all aspects of the system design and is a significant program deliverable. The performer shall maintain this document, or its

equivalent, over the course of program execution such that it is current and accurate at major system reviews including tCDR.

Flight Safety and Licensing Plan (FSLP) provides the schedule, processes, and tasks required to verify compliance with flight safety requirements and guidelines prior to execution of the XS-1 flight test program. This includes FAA licensing or experimental permits under 14 C.F.R. 400 series and any applicable FAA airworthiness certifications prior to commercial operations. The proposer is encouraged to baseline and document in the FSLP an Autonomous Flight Safety/Termination Systems (AFSS/AFTS) as part of any orbital launch system design constituted by autonomous vehicles or stages. DoD reusable aircraft design guidance from MIL-HDBK-516C shall be appropriately tailored and incorporated in coordination with the Government team. The contractor shall provide a plan that develops one data set supporting DoD and FAA requirements.

Operational Upper Stage Development Plan supports transition efforts and provides planning information to the commercial sector and Government. The performer shall develop and maintain a high-level plan for maturing the operational upper stage (OUS) design(s) as well as ongoing cost traceability analysis. The performer shall update their OUS development plan at major reviews to reflect the results of risk reduction activities as the focus shifts from a demonstration program to an operational system.

Draft Payload User's Guide: The Payload User's Guide is a publicly-releasable planning document for prospective customers of launch services provided by a commercially-transitioned XS-1 system. The user's guide will include information necessary for pre-contract mission planning and for understanding the system's standard services, interfaces, capabilities, environments, and expectations of the payload.

Commercialization Plan and Corporate Decision Gates:
Includes the performer's near- and long-term plans for the transition of the XS-1 demonstrator system, plus subsequent operational systems, to a sustainable business model. The U.S. Government's objectives in requiring the following information are to ensure that the performer is on a path to build and sustain a market competitive business, based initially on the XS-1 system, and ownership is clearly established for demonstration and operations phases.

This plan shall clearly identify what elements of the Phase II/III programs are transitioned, what new elements must be developed, the bases of operation, mission capabilities, and expected timeline. The plan shall, at a minimum, address the deliverables listed below. These deliverables should be timed in coordination with the performer's corporate decision gates. The performer's corporate decision gates shall be described, including the analysis required at each gate, the metrics by which decisions are made to move from gate to gate, and the position of the deciding executive who approves movement from gate to gate. The performer shall also identify two to three (2-3) payment milestones associated with the commercialization plan and corporate decision gates such as upper stage design reviews/investment gates, launch site design reviews/investment gates, procurement of additional vehicles, etc.

Deliverables should include, but are not limited to, the following:

- Market Analysis: Identification of key market segments, customers within each segment, historic and projected demand, key drivers of demand growth rates, characterization of low, medium and high growth scenarios to be used in Return on Investment (ROI) calculations.
- Customer and Channel Analysis: Conduct customer interviews as required within each market segment. Develop understanding of how each market segment ranks the value of each product attribute (responsiveness, launch cost, control over orbit/inclination, other). Quantitatively estimate customer's willingness to pay for these attributes. Identify the channels through which each customer segment prefers to purchase launch services (for example, direct, through brokerage service, etc.).
- Competitive Analysis: Map out the landscape of expected competing launch services for each major market segment at the time of XS-1's first flight and in the future. For the major product attributes (responsiveness, price to orbit, control, reliability, payload capacity to orbit, etc.), describe competitor's offerings today and their expected future offerings.
- Business Plan: Describe the planned business structure, partnerships with key organizations, and sources of financing. Include a plan to compete and capture target market segments, bases of operation and mission capabilities, expected pricing structure, channels to access customer segments, and how the business plan will evolve over time as additional vehicles are built. Describe required legal, operational, and financial hurdles. Develop a timeline associated with executing the business plan.
- ROI Calculations and Financial Planning: Update the business case developed in Phase I. Run ROI calculations to low, medium, and high demand scenarios for each market segment. Perform a sensitivity analysis and identify key variables affecting profitability and potential risk areas.
- Management Team Development: Identify the market/financial management key personnel for this effort, their skill sets, and a description of the reporting structure and timeline for securing the team.

Phase II Final Report and Engineering Data includes a full report that details all of the Phase II activities, capturing the top-level results of all technology trade studies, design performance analyses, development tests, and the design evolution of the first stage, upper stage, and component technologies. The performer is encouraged to the use the SDD as a foundation for the Final Report. Engineering data consists of data files in the performer's preferred formats that are necessary to understand and model the vehicle system. The engineering data is expected to include, to a subsystem level of definition, the XS-1 booster design, demonstration and operational upper stage design, system layout, and critical component drawings. This encompasses the full booster and DUS external geometry ("outer mold lines"), the aerodynamic and aerothermal databases used to design the system, finite element models, mass properties, load cases, thermal protection system characteristics, propulsion system characteristics, and control laws. System performance estimates shall also be substantiated, including bases of analysis (e.g., empirical data, simulation codes, handbook methods) and methods used. Additionally, an updated $5M/Flight traceability analysis shall also be included in the Final Report.

3.2 Phase III: Flight Test Campaign

Phase III will focus on booster envelope expansion, demonstration of 10 flights in 10 days of the booster, demonstration of any booster-only high-speed flights the performer intends to conduct, and the delivery of a 900+ lb payload into Low Earth Orbit. The 10 flights in 10 days refers to the period from the first lift off to the tenth landing.

Phase III: Flight Test Campaign

3.2.1. Primary Objectives:

1. Complete envelope expansion of the XS-1 booster prototype
2. Conduct any high-speed booster-only demonstration flight(s)
3. Fly XS-1 booster 10 times in 10 days
4. Launch a payload of greater than 900 pounds to orbit

3.2.2. Key Milestones

Envelope Expansion Testing Milestone

The objective of this test phase is to safely expand the flight envelope of the XS-1 booster in preparation for both the 10 flights in 10 days and the orbital launch.

Minimum Accomplishment Criteria:

- Envelope Expansion Test Readiness Review
- Safe flight throughout XS-1 flight envelope that will allow for 10 flights in 10 days and the orbital flight demonstrations to be successfully executed

Fly XS-1 Booster 10 Flights in 10 days Milestone

The objective of this demonstration is to fly the XS-1 booster 10 times in 10 sequential days, taking off the table the idea that operating reusable launch vehicles is inherently manpower-intensive. These test flights should be flown such that they stress the system in ways that are traceable to operational environments associated with staging or other key design reference mission performance points.

Minimum Accomplishment Criteria:

- 10 flights in 10 days Test Readiness Review
- 10 flights

Fly XS-1 Booster to high speed Milestone

If the performer chooses to exceed threshold performance goals with their XS-1 system, this flight will be the highest-speed booster-only demonstration flight. Exceeding threshold performance goals will establish traceability to higher capabilities and future derived systems.

Minimum Accomplishment Criteria if the performer chooses to pursue this demonstration:

- High-speed booster-only Test Readiness Review
- High-speed booster-only flight

Insert a payload greater than 900 pounds into orbit Milestone

The objective of this demonstration is to insert a payload greater than 900 pounds into orbit.

Minimum Accomplishment Criteria:
- Orbital Flight Test Readiness Review
- Payload Interface Control Document (ICD) signed
- Applicable range procedures and documentation submitted and approved
- Safety and environmental approvals in place
- Payload established in orbit

3.2.3. Key Deliverables

Final Commercialization Plan and Corporate Decision Report: The performer shall provide their final plans for the transition of the XS-1 demonstration and operational system into a competitive commercial market. The transition plan shall identify a sustainable business model, updating the Commercialization Plan delivered in Phase II. The performer shall discuss the corporate decision gates that were assessed for the authorization of internal funding and transition, including the decisions made at each of these gates.

Final Operational Upper Stage Development Plan: The performer shall provide a final operational upper stage development plan, including an update to the Technology Maturation Plan for upper stage technology maturation in Phase II and an updated operational system capability description. This final plan shall also include a risk reduction approach and plan, including Rough Order of Magnitude (ROM) schedule and cost for key maturation and demonstration activities. This plan will be used to generate transition advocacy and drive the business case for a fully operational XS-1 system, including lifecycle considerations.

Payload User's Guide: The performer shall provide their updated Payload User's Guide, including all updates to the Draft Payload User's Guide delivered in Phase II and reflecting applicable knowledge gained from Phase III activities and corporate decisions. The Payload Users' Guide shall be consistent with the performer's Commercialization Plan and Corporate Decision Report.

Final XS-1 Program Report and Test and Engineering Data: The performer shall detail the activities performed in all phases of the program, which serves as an update to the Phase II Final Report and Engineering Data. Contractor format is acceptable, but as a minimum the report should include: top-level results of all testing; changes required to the vehicle's design and operational processes as well as lessons learned over the course of the test program; and a comparison of actual performance to projected performance with explanations regarding any significant discrepancies between projected and actual performance. Test and Engineering Data consists of flight test data files and any updated data files (in performer's preferred formats) necessary to understand and model the vehicle system. Pre-test predictions and test results for all major risk reduction activities

and demonstrations should also be included. These data files will encompass or supersede the engineering data files from Phase II. The overall demonstration and integration of all of the data and analysis work should identify the performer's readiness to enter into the commercial launch market with their XS-1 system. The combination of Phase III flight tests, ground tests and simulation should also identify whether the XS-1 system can consistently achieve suitable performance, has sufficiently robust flight controls to enable safe and repeatable launch and recovery, and can meet the capabilities envisioned using the operational upper stage. The contractor may submit a final report with addendums for each flight test if appropriate. Additionally, an updated $5M/Flight traceability analysis shall also be included in the Final Report.

3.3 Additional Guidance

3.3.1. Milestone Reviews

All milestone reviews are expected to be conducted at the performer's location(s). The Government may attend or support via teleconference. The purpose of the milestone reviews is to demonstrate that the performer has completed the required milestone accomplishment criteria. The review objective is to convey information and discuss accomplishments and issues, not to generate documentation. The Government intends to continue the interactive, limited structured briefing approach implemented in Phase I. Instead of written milestone reports, a complete copy of the annotated milestone review briefings may be provided prior to the review, referencing other program deliverables or documentation as appropriate.

The Government has defined the minimum content of several key milestones in Sections 3.1.2 and 3.2.2. The performer should supplement these milestones as well as propose the remainder of their milestone schedule based on key events and activities, as appropriate, from their TMP and XS-1 development schedule. Information provided at each milestone should include all significant program events and demonstrations since the last milestone, and the performer must define measurable accomplishment criteria. All milestone reviews will also include the following items:

- Program Decision Memoranda (if any during the milestone period)
- Updated IMS
- Monthly technical and financial status reports submitted in accordance with the agreement
- Electronic copy of draft milestone review charts delivered prior to review and final charts delivered within five business days after review

3.3.2. Technical Interchange Meetings (TIMs)

It is anticipated that performer-led bi-weekly technical interchange teleconferences will occur throughout Phase II. Additional TIMs may be conducted as appropriate and may include attendance at key test and demonstration events or additional visits to the performer's location. TIMs will continue to be small working-level meetings without formal documentation beyond Program Decision Memoranda if appropriate.

3.3.3. Monthly Technical and Financial Status Reports

The performer shall provide monthly technical and financial status reports. Although a formal earned value management system (EVMS) is not required for this effort, it is expected that these reports clearly communicate schedule progress against the payable milestone plan and integrated master schedule. For proposers seeking an award with adjustable payable milestones, monthly financial reporting with a level of detail similar to financial reporting provided from an EVMS will be required in order to provide insight into actual incurred costs for each milestone. These reports, as well as any other management or administrative issues, will be addressed in bi-weekly teleconferences as conducted during Phase II.

3.4 Additional Phase II/III Final Non-Hardware Deliverables

In addition to key deliverables identified in Sections 3.1.3 and 3.2.3, the following deliverables should also be provided by the performer:

- Procedures developed for operating and maintaining the XS-1 System
- Data packages associated with each payable milestone
- Operational Upper Stage Cost Traceability Analysis
- Safety data packages and documentation
- Interface control documents

3.5 Phase II/III Final Hardware

Prototype hardware developed under the XS-1 program will include:

- XS-1 booster, control station hardware and software, and
- Diagnostic, test and support equipment needed to support system testing and operations.

These items may be transitioned to the performer with consideration provided to the Government in accordance with the disposition of property article in OT agreement. Performers are encouraged to consider how they can provide fair value to the Government in compensation for title to the hardware developed in the program. Consideration may be in the form of continued flight testing, orbital flights supporting Government customers, purchase of title, etc.

In assessing the final hardware value, the Government intends to use the cost of materials, components, and labor spent in fabricating, integrating, assembling, and checkout test each integrated hardware item. A depreciation amount may also be debited commensurate with the amount of each hardware item's expected lifetime consumed in the course of Phase II/III.

4.0 PROPOSAL PREPARATION INSTRUCTIONS

This section provides guidance for developing each component of the proposal.

- Volume 1 – Phase II/III Overview and Execution Plan – *focused on program content*
- Volume 2 – Technical Proposal – *focused on the maturity of the proposed XS-1 system design*
- Volume 3 – Cost Proposal – *focused on cost detail and substantiation*

All proposals must be in the format given below. Nonconforming proposals may be rejected without review. All pages shall be submitted electronically using an 8-1/2 by 11 inch format with type not smaller than 12 point unless specifically noted otherwise. Foldouts of 11 by 17 inch paper are allowed, but shall count as 2 pages. 10 point font may be used for figures, tables and charts. Page limitations for proposal sections include all figures, tables, and charts. All proposals must be written in English.

An executive summary in PowerPoint format that reflects the content and claims in the proposal shall be provided on the two submitted CD/DVDs. A template for the executive summary has been provided in Appendix D of this program solicitation and proposers shall not exceed the three slide format in Appendix D. The Government strongly encourages that figures utilized in the proposal be provided as high-quality images in their original formats when possible. The submission of other supporting materials along with the proposals is strongly discouraged; such materials will not be considered for review.

4.1 Volume 1 – Phase II/III Overview and Execution Plan Proposal Instructions

The Phases II/III Overview Execution Plan should convince the Government that the proposer has a credible plan for successfully completing the Phase II/III Program Objectives outlined in Section 3 within cost and schedule constraints and at acceptable program execution risk. Sections I – V, Volume 1 are limited to a total of 40 pages, combined, not including resumes of key personnel. Sections VI-XI have no page limits.

4.1.1 Section I – System and Program Overview

The system and program overview section shall provide a top-level description of the vision, system architecture, key system elements, and unique features of the proposer's XS-1 program. This section shall include a summary schedule that includes key program events on the critical path. Proposers should clearly describe their approach for maturing the design, fabrication, integration assembly, flight/range safety, test, licensing, and transition to an operational system. The plan should address the level of risk inherent in the proposed program to enable completion of flight demonstration and orbital flight not later than FY20.

4.1.2 Section II – Management Plan

The proposer shall provide a management plan that describes the proposed engineering processes and management approach to support successful Phase II/III execution. The management approach shall encompass key roles and responsibilities and identification of the organization(s) fulfilling them. The proposer shall provide an overview of the systems engineering processes to be used along with the organizational responsibilities and authority for the engineering effort. The proposer shall describe their systems engineering approach to complete the final system design and ensure that the as-built system meets the DARPA threshold and/or goal objectives. The proposer shall describe how key system knowledge acquired during the program will be captured and made available to the Government, as well as describe the use of key tracking measures to enable efficient assessment of program progress.

The management plan shall also include the proposed programmatic approach to cost, schedule, and risk management. Although formal EVMS is not required for the program, the proposer must meet the intent and describe how they will provide ongoing assessment of technical and programmatic progress against the program plan, critical path, schedule, and cost. The proposer shall address its program control approach to include method, content, and frequency of cost performance reporting as well as its approach for conducting variance analyses, developing corrective action plans, and assessing the impact on estimates to complete. The proposer shall also describe their proposed approach to subcontractor management, quality control, safety, and security.

The proposer shall describe their proposed level of Government interaction to facilitate efficient interactions and streamlined decision making, to include situations in which variances arise. The proposer shall describe how activities will be managed and integrated across geographically and/or organizationally separate team elements. The proposer shall define the content of technical and financial progress reports that enables efficient program monitoring, tracking, and reporting. Program management tools should be the same tools used internally to manage the program. No additional unique information for the Government is desired.

4.1.3 Section III – Business Case and Transition Plan

The objective of this section is to show how the proposer plans to build and sustain a commercial launch services business with the XS-1 prototype vehicle and demonstrated system technologies. This section shall provide a discussion of traceability between the XS-1/demonstration upper stage and XS-1/operational upper stage design. The proposer should provide the following: their understanding of current and projected demand by key market segment, their understanding of core customer needs by market segment and how they plan to address them, expected business model and partnerships, ROI calculations associated with that business model, competitive analysis of existing vehicles and expected future vehicles, description of business model's robustness to key market uncertainties, and a top-level transition plan outlining additional activities needed to establish a commercial business. This should include a schedule for additional risk reduction and design maturation activities envisioned, as well as any additional investment or non-recurring expenses required to transition to the operational system, i.e., corporate decision gates.

4.1.4 Section IV – XS-1 $5M/Flight Traceability Analysis

Proposers shall provide a traceability analysis of how and when their system will be able to attain the $5 million cost per launch objective. Assumptions used in the traceability analysis shall be consistent with Section 2.1, Note 2. Appendix C provides a minimum list of cost elements that are to be considered when calculating costs. Analysis shall include proposer's business case assumptions, including justification for the assumed flight rates/mission model, that enable the program to transition to the commercial sector, such as annual flight rate, number of aircraft, size of expendable upper stage (demo/operational/etc.), payload mass and orbit, ground support equipment, and personnel required to operate the business. In addition to the proposer's own business cases analysis, the proposer shall also answer the following questions:

1) When would the proposer attain $5M/launch with the following flight rate: FY21 – 3 flights, FY22 – 6 flights, FY23 and beyond – 10 flights steady state

2) Same as above, but increase to 30 flights starting in FY24
3) What is the expected and maximum steady state sortie rate the performer can provide, given the availability and capacity associated with two (2) operational boosters plus spares?

4.1.5 Section V – Proposer's Capabilities/Related Experience

The proposer shall discuss its prior relevant experience on similar efforts, including identification of other Government sponsors, and ability to execute relevant technically challenging programs on time and within budget, as demonstrated by corporate experience and key personnel performance on past similar programs. The proposer should discuss how the proposed key personnel have adequate experience from past programs that is relevant to their proposed role on this program and the team's expertise and manage cost and schedule. This section should include resumes and qualifications of (at minimum) the proposed Program Manager, Chief Engineer, and a Deputy for Flight Test and Operations (or equivalent based on user's management construct), along with the percentage time commitment of each of these key personnel. The proposer shall also provide a description of the facilities that would be used for the proposed effort. The proposer must coordinate with the Government before any key personnel identified in this proposal are changed.

Resumes of key personnel are not included in the page limit.

4.1.6 Section VII – Task Description Document (TDD)

The TDD should identify all work to be performed in order to achieve the milestones and statement of objectives outlined in Section 3.0. To assist in the evaluation of the proposal as well as to integrate the agreement and the total program, the proposer shall employ a common work breakdown structure (WBS) for numbering all activities in the TDD, IMS, and cost proposal. This WBS should be fully populated to a minimum of level 3 such that individual task elements can be adequately assessed. For each task/subtask, provide:

- A general description of the objective (for each defined task/activity);
- A detailed description of the approach to be taken to accomplish each defined task/activity;
- Identification of the primary organization responsible for task execution (prime, sub, team member, by name, etc.);
- The completion criteria for each task/activity - a product, event or milestone that defines its completion;
- Define all deliverables (reporting, data, reports, software, etc.) to be provided to the Government in support of the proposed research tasks/activities;
- Clearly identify any tasks/subtasks (prime or subcontracted) that will be accomplished on-campus at a university; and
- Define any Government support (facilities, equipment, personnel, etc.) expected or required for all tasks.

The intent is to allow the Government sufficient visibility into the task element content and schedule to assess critical path, execution risk, and cost reasonableness. During Phase II execution, this level of visibility will be crucial for assessing program progress and managing the critical path. The TDD will become Attachment 1 to any negotiated OT agreement.

Section VII has no page limit.

4.1.7 Section VIII - Integrated Master Schedule (IMS)

The IMS shall detail the specific tasks to be accomplished, their interrelationship, and time sequencing. The IMS should be provided to a WBS level 4 or 5. The IMS shall be fully linked to show the critical path and provided in Microsoft Project electronic format.

Section VIII has no page limit. 11 by 17 inch foldout pages are acceptable in Section VIII.

4.1.8 Section IX – Government Furnished Material (GFM)

The proposer shall identify required Government-furnished facilities, data, manpower, additional facility improvements over existing facility capabilities, and equipment to support the proposer's development and demonstration approach. This list should include rationale, ROM cost, and dates needed. GFM, flight test support, etc. shall be paid for out of the $140M allocated for the Phase II/III Government budget.

Section IX has no page limit.

4.1.9 Section X – Subcontractor List

To facilitate Government conflict of interest determinations, proposers are required to submit a complete list of organizations participating on their team, including all subcontractors, their cage codes and DUNS numbers, and their role.

Section X has no page limit.

4.1.10 Section XI – Intellectual Property

The Government's desired objectives with respect to intellectual property are provided in Section 2.4 above. The proposer should describe how their proposed data rights assertions support the Government's objectives.

Proposers responding to this solicitation shall identify all data that it plans to furnish to the Government under any negotiated OT agreement in which the Government will acquire receive less than unlimited rights, and assert specific restrictions on that data. Proposers shall follow the format described below for this stated purpose. In the event that proposers do not submit the list, the Government will assume that it automatically has "unlimited rights" to all data generated, developed, and/or delivered under the OT, unless it is substantiated that development of the data occurred with private or mixed funding. If mixed funding is anticipated in the development of data generated, developed, and/or delivered under an OT agreement, then proposers may consider identifying the data in question as subject to Government Purpose Rights (GPR).

The proposer shall use the following table to assert restrictions to data.

DATA RESTRICTIONS				
Technical Data and Computer Software To be Furnished With Restrictions	Summary of Intended Use in the Conduct of the Research	Basis for Assertion	Asserted Rights Category	Name of Party Asserting Restrictions
(LIST)	(NARRATIVE)	(LIST)	(LIST)	(LIST)

For any items for which the proposer asserts data rights less than unlimited rights, the proposer shall describe the impact of the GPR or limited rights assertion. In other words, the proposer should describe what data the Government will get, how the Government will be able to use it, and describe the impact of this data rights assertion on the Government's ability to transition the program.

The Government will use this table during the proposal evaluation process to evaluate the impact of any identified restrictions. If no restrictions are intended, then the proposer should state "NONE." It is noted an assertion of "NONE" indicates that the Government has "unlimited rights" to all data delivered under the OT.

Regarding patents, include documentation proving your ownership or possession of appropriate licensing rights to all patented inventions (or inventions for which a patent application has been filed) that will be utilized under your proposal for the DARPA program. If a patent application has been filed for an invention that your proposal utilizes, but the application has not yet been made publicly available and contains proprietary information, you may provide only the patent number, inventor name(s), assignee names (if any), filing date, filing date of any related provisional application, and a summary of the patent title, together with either: (1) a representation that you own the invention, or (2) proof of possession of appropriate licensing rights in the invention.

For the purposes of this solicitation, the following definitions apply:

1. "Unlimited rights" means rights to use, modify, reproduce, perform, display, release, or disclose data in whole or in part, in any manner, and for any purpose whatsoever, and to have or authorize others to do so.

2. "Government purpose rights" means the rights to use, duplicate, or disclose Data, in whole or in part and in any manner, for Government purposes only, and to have or permit others to do so for Government purposes only.

3. "Limited rights" means the rights to use, modify, reproduce, release, perform, display, or disclose data, in whole or in part, within the Government. The Government may not, without the written permission of the party asserting limited rights, release or disclose the data outside the Government, use the data for manufacture, or authorize the data to be used by another party, except that the Government may reproduce, release, or disclose such data or authorize the use or reproduction of the data by persons outside the Government if—

(i) The reproduction, release, disclosure, or use is—

(A) Necessary for emergency repair and overhaul; or

(B) A release or disclosure to—

(*1*) A covered Government support contractor in performance of its covered Government support contract for use, modification, reproduction, performance, display, or release or disclosure to a person authorized to receive limited rights data; or

(*2*) A foreign government, of data other than detailed manufacturing or process data, when use of such data by the foreign government is in the interest of the Government and is required for evaluational or informational purposes;

(ii) The recipient of the data is subject to a prohibition on the further reproduction, release, disclosure, or use of the data; and

(iii) The contractor or subcontractor asserting the restriction is notified of such reproduction, release, disclosure, or use.

4. "Data" means recorded information, regardless of form or method of recording, which includes but is not limited to, technical data, software (including executable code), maskworks and trade secrets. The term does not include financial, administrative, cost, pricing or management information and does not include subject inventions.

5. "Covered Government Support Contractor" means a contractor under a contract, the primary purpose of which is to furnish independent and impartial advice or technical assistance directly to the Government in support of the Government's management and oversight of a program or effort (rather than to directly furnish an end item or service to accomplish a program or effort), provided that the contractor:

(i) Is not affiliated with the prime contractor or a first-tier subcontractor on the program or effort, or with any direct competitor of such prime contractor or any such first-tier subcontractor in furnishing end items or services of the type developed or produced on the program or effort; and

(ii) Receives access to Data for performance of a Government contract.

(iii) Enters into a non-disclosure agreement with the Performer, if required.

Section XI has no page limit.

4.2 Volume 2 - Technical Proposal Instructions

4.2.1 Section I – System Design

Section I of the Volume 2 Technical Proposal, is limited to a total of 100 pages. The recommended approach to Section I is to address the sections listed in the System Design Document Guidance, as per Appendices A1 and A2. These documents are DARPA's guidance to all XS-1 proposers regarding the Vehicle Overview Document and System Design Document, as discussed in Section 3 of this solicitation. The content of Section I shall discriminate between the values the current design is assessed to have ("status") and the target ("intent") values being sought through the detailed design process in Phase II. In Section I, large format drawings may be provided on 11 by 17 inch fold-out paper. Each such 11 by 17 inch drawing page will be considered two pages.

4.2.2 Section II – Technology Maturation Plan

Proposers shall provide a Technology Maturation Plan that includes description of program risks, risk assessment, basis for likelihood and consequence assessments, and metrics and methods by which risks will be retired in Phases II and III. This section shall include risk reduction schedules that are consistent with their proposed program. The TMP should also include the proposers' rationale for which activities are included in their proposal and which are deferred to the commercial transition program. The TMP shall underpin the proposer's Phase II and III program plans. The TMP should be focused on the information requested; ancillary data is not required.

Potential risk areas that may be addressed in the TMP include:

- An integrated booster design that satisfies the operability and responsiveness goals of the program
- A booster thermal protection system that satisfies the worst-case (2 sigma or better) predicted booster thermal environment while meeting program operational and responsiveness goals
- A booster propulsion system that supports program performance, operability, and durability requirements
- An upper stage retention and separation capability under worst-case nominal and booster-survivable abort flight conditions
- Booster flight controls that maintain vehicle control under worst-case nominal and survivable abort conditions
- A ground system that satisfies the operability and responsiveness goals of the program
- A rapid mission planning system that satisfies program responsiveness goals while complying with applicable Government regulations
- A flight termination system that satisfies range safety requirements and program recurring cost and responsiveness goals
- An upper stage that can deliver the demonstration payload to the specified orbit
- A design and vehicle management strategy that allows for delivery of payloads to mission orbit in those off-nominal conditions where the XS-1 vehicle can be safely recovered
- Sufficient design fidelity regarding the operational upper stage to ensure the booster fabricated and flown in Phase III is capable of successfully carrying and deploying the operational design reference payload without excessive modifications

Section II has no page limit.

4.2.3 Section III – Qualification Plan

The proposer may provide a Qualification Plan or, alternately, can propose an approach for arriving at an executable Qualification Plan early within the Phase II program.

The Qualification Plan shall describe the proposer's philosophy and approach to qualifying the XS-1 vehicle and subsystems for flight test. This should include the process for developing max predicted environments (MPEs) for the XS-1 missions flown under the DARPA program or modeled in the business case analysis, and any missions to be flown using residual capability of the XS-1 vehicle after the completion of Phase III. MPEs should encompass planned development and qualification testing, worst-case (2 sigma or higher) flight and survivable abort conditions, worst case weather and winds, and expected vehicle lifetime. If the proposer intends to use the XS-1 vehicle to launch a larger operational upper stage, it should describe whether or not those loads and environments are included in the XS-1 design and test program or if they will require additional verification following the completion of Phase III. The proposer should also describe the compliance and reference standards and associated tailoring to be used for engineering, parts, materials, processes, software development, range safety, and testing. These may include MIL-SPECs and other Government standards or equivalent commercial standards and practices. Describe any tailoring of these standards and rationale for tailoring.

The Qualification Plan should additionally provide an overview of the planned verification processes to include, but not be limited to, component, propulsion, subsystem, and system-level qualification and acceptance testing, including 10 engine ground tests in 10 days. It should describe approach, level of test, fidelity of hardware test article, and schedules for qualification testing of non-heritage hardware. Where verification will be performed by methods other than test (such as qualification by analysis or similarity), provide justification. Briefly describe the inputs, test configuration, test equipment (including models and simulators), outputs, and environment. Explain differences between the tests/test articles and flight vehicle/conditions. Where heritage hardware relies on prior qualification testing, it must be established that the XS-1 environments and use are bounded by the prior qualification testing and with applicable margins as specified in compliance specifications. Clear traceability will be expected between the testing contained in the Qualification Plan and the Phase II/III TEMP that will be developed and delivered under any negotiated agreement.

Section III has no page limit.

4.3 Volume 3 – Cost Proposal Instructions

4.3.1 Section I – Cost Information

Summary cost information shall be provided using the Microsoft Excel spreadsheet provided in Appendix E and using the same WBS at the same level of detail as the TDD. In addition to the requested Excel spreadsheet provided in Appendix E, proposers may submit additional cost volume material but should recognize that the data provided in the Excel spreadsheet submission will be the primary basis of assessment. The cost proposal spreadsheet and narrative shall include:

1) total program cost broken down by all cost elements (direct labor, including labor hours and categories; indirect costs (fringe, overhead, G&A, etc.); subcontracts; materials; travel; other direct costs; etc.) with Phase II and Phase III broken out separately;
2) total program costs by contractor fiscal year and Government fiscal year (Phase II and Phase III broken out separately);

3) program costs broken down by WBS;
4) an itemization of major subcontracts and equipment purchases;
5) an itemization of any information technology (IT) purchases[1];
6) the source, nature, and amount of any industry cost-sharing; at a minimum, cost-sharing needs to be allocated separately for both Phase II and Phase III;
7) identification of pricing assumptions that may require incorporation into the resulting OT (e.g., use of Government Furnished Property/Facilities/Information, access to Government Subject Matter Experts, etc.); and
8) provide appropriate cost or price analyses of subcontractor proposals to establish the reasonableness of proposed subcontract prices. Costs shall be allocated using the same WBS as the TDD and IMS.

The prime contractor is responsible for compiling and providing all subcontractor proposals. Subcontractor proposals include Interdivisional Work Transfer Agreements (IWTAs) or similar arrangements. Subcontractor cost proposals should be in the MS Excel template provided in Appendix E/F and are required from all subs or IWTAs, regardless of tier.

If the total subcontract value is below $150K, the proposed subcontractor should complete the Excel spreadsheet provided under Appendix F, which only requires completion of the summary table, materials, travel, equipment, and other direct costs tabs in the spreadsheet. If the value of the subcontractor effort exceeds $150K, the subcontractor or IWTAs must complete the Appendix E spreadsheet for all applicable fields, providing the same level of detail as required by the prime and using the same WBS as the prime.

All proprietary subcontractor proposal documentation, prepared at the same level of detail as that required of the prime, shall be provided to the Government either by the prime contractor or by the subcontractor organization when the proposal is submitted. Proprietary subcontractor proposals submitted to the Government by the prime contractor should be submitted in a sealed envelope that the prime contractor will not be allowed to view. The subcontractor must provide the same number of hard copies and/or electronic proposals as is required of the prime contractor.

Supporting cost and pricing information should be provided in sufficient detail to substantiate the summary cost estimates above. The basis of estimate (BOE) should include a description of the method used to estimate costs and supporting documentation. Supporting documentation is required for all proposed materials with a total cost >$20K. Material BOE should include bills of material for commercial and non-commercial items, vendor quotes, past purchase orders or past invoices with explanation of any adjustment factors, such as engineering estimates and complexity factors. For example, if the cost of a proposed material or equipment is based on a similar-to item from another past or current program, the proposer should provide a copy of the original purchase order for that similar-to item, an explanation of any engineering estimate or complexity factor applied, and a breakdown of any non-recurring engineering (NRE) costs (i.e. estimated NRE labor hours) proposed by the vendor to modify the design of the material or equipment for the purposes

[1] IT is defined as "any equipment, or interconnected system(s) or subsystem(s) of equipment that is used in the automatic acquisition, storage, analysis, evaluation, manipulation, management, movement, control, display, switching, interchange, transmission, or reception of data or information by the agency.

of this effort. The BOE and other supporting cost narrative may be provided in the proposer's format; however, an MS Excel spreadsheet with embedded files is preferred. The proposer shall also include in its proposed price the identification and cost of any Government furnished equipment (GFE) or facilities required to complete the effort. List the item/facility, the estimated cost, basis for the estimate, location and GFE POC at location. These items should be priced separately because the Government may determine it is more efficient to fund them outside the agreement. GFE costs are considered part of the total funding available from the Government.

The cost proposal must include a payable milestone plan. This plan shall include a detailed list of payment milestones. Each such payment milestone must include the following: milestone description, completion criteria (deliverables/accomplishments), due date, milestone payment amount (to include, if cost share is proposed, performer and Government share amounts). With regard to Milestone Amounts, the Government desires that the Government and performer cost shares associated with each milestone payment be proportionate to the relative total program cost share. To accommodate proportional payments, the proposer must identify proposed cost share for both Phase II and Phase III. It is noted that, at a minimum, such payable milestones should relate directly to accomplishment of program milestones/technical metrics criteria as defined in the solicitation and/or the proposer's proposal. Do not include proprietary data in the payable milestone plan.

Proposers may propose an OT agreement with fixed payable milestones or adjustable payable milestones. Fixed payable milestones are fixed payments based on successful completion of the milestone accomplishments agreed to in the milestone plan. Adjustable payable milestones reflect an expenditure based approach to milestones which reimburse the performer for actual incurred costs for accomplishing the milestone completion criteria in accordance with the cost share ratio negotiated for that milestone (if cost share is proposed). Ultimately, the final agreement type will be subject to negotiation by the Agreements Officer (AO). In deciding which payment structure is appropriate for a particular OT, the AO will take into account whether or not the performer has an established accounting system that complies with generally acceptable accounting procedures and/or if the performer's accounting system has been reviewed and considered adequate by the Defense Contract Management Agency or Defense Contract Audit Agency for performing under cost reimbursement procurement contracts.

If the proposer requests award of an OT as a non-traditional defense contractor, as defined by section 2302 (9) of title 10, United States Code, or as a small business, as defined under section 3 of the Small Business Act (15 U.S.C.632), information must be included in the cost proposal to support the claim. Additionally, if the proposer requests award of an OT agreement without the required one-third (1/3) cost share, information must be included in the cost proposal supporting that there is at least one non-traditional defense contractor or small business participating to a significant extent in the proposed prototype project or that all significant participants in the transaction other than the Federal Government are small businesses or non-traditional defense contractors. Proposers shall provide in their cost proposal an explanation of why the proposer believes the non-traditional defense contractor is participating to a significant extent.

If the proposer includes options, the cost proposal shall include ROM costs for these options.

There is no page limit for this section

4.3.2 Section II –Proposed Agreement Terms

The proposer shall submit any non-standard terms and conditions they suggest in an Agreement. It is expected that the proposer will suggest approaches for title and disposition of test assets, as discussed in section 3.5, including the XS-1 flight vehicle and ground control station and software. The proposer shall also include their proposed data rights assertion and payable milestone schedule. A model OT will be provided by the Government if the proposer is selected for negotiation of a potential award of an OT agreement. The TDD, milestone plan and schedule, and data rights assertions will be included as attachments to the agreement upon negotiation and award.

For additional information on DARPA's authority to award OT agreements for prototype projects, please refer to: http://www.darpa.mil/work-with-us/contract-management

There is no page limit for this section.

4.4 Other Information and Administrative Instructions

4.4.1 Proposal Format Instructions

Proposals will be submitted in electronic format only. The proposer's submissions shall not exceed page counts identified in Sections 4.1, 4.2 and 4.3. Page count will be based on the proposer's electronic submission using the 8 ½ by 11 inch page format. Indexes, cross reference tables, and tabs will not be included in the page count. Pages should be marked SOURCE SELECTION SENSITIVE. Proposals exceeding the page count or not employing the specified formats may not be reviewed. Electronic copies of the proposals shall be provided via CD in an unprotected PDF format. Proposers are encouraged to provide source documents in Microsoft Office (Word, Excel, PowerPoint), Project, and/or Adobe Acrobat Pro X/XI to facilitate extraction of graphics and tables to support proposal evaluation.

The Volume 3 submission will consist of a completed Microsoft Excel spreadsheet as provided in Appendix E and F as well as substantiating information to be provided in the proposer's format.

4.4.2 Proposal Due Date and Delivery

The proposal due date and number of copies are as follows:

Proposal	Hard Copies	Electronic Copies	Due Date
Volumes I, II, and III	0	2	Friday, July 22, 2016, 14:00 PM Eastern Daylight Time

Proposers may submit proposals at any time before the proposal due date. Authorized representatives of the proposer must sign proposal volumes.

4.4.3 Submission Information

The proposer's proposal shall be mailed or hand carried to:

Defense Advanced Research Projects Agency (DARPA)
XS-1 Program
675 N. Randolph St.
Arlington, VA 22203-1714
Attn: Contracts Management Office/D. Peter Donaghue
Program Solicitation Number: DARPA-PS-16-03

Proposals and proposal modifications, unless requested by the Agreements Officer, received after the due date set forth in Section 4.4.2 will be considered late and may not be evaluated.

4.4.4 Security

This effort is unclassified. There is no DD Form 254, "DoD Contract Security Classification Specification."

4.4.5 Communications

DARPA intends to use electronic mail for all correspondence regarding solicitation DARPA-PS-16-03. Proposals must NOT be sent by fax or e-mail; any proposals sent by fax or e-mail will be disregarded.

All communications with the Government regarding this solicitation, proposals, or any other issue relating to source selection can only be in the form of questions that are submitted by e-mail to the Agreements Officer at DARPA-PS-16-03@darpa.mil.

DARPA will provide a consolidated Question and Answer document to proposers after June 7, 2016. In order to receive a response to a question, submit questions by Tuesday, June 7, 2016, 14:00 PM Eastern Daylight Time to DARPA-PS-16-03@darpa.mil.

4.4.6 Proposal Handling

It is the policy of DARPA to treat all proposals as competition sensitive information and to disclose their contents only for the purpose of evaluation. Restrictive notices notwithstanding, during the evaluation process, submissions may be handled by support contractors for administrative purposes and/or to assist with technical evaluation. All DARPA support contractors performing this role are expressly prohibited from performing DARPA-sponsored technical research and are bound by appropriate nondisclosure agreements. No proposals will be returned. Upon completion of the source selection process, an electronic copy of each proposal received will be retained at DARPA and all other copies will be destroyed. A certification of destruction may be requested, provided that the formal request is received at this office within 5 days after notification that a proposal was not selected.

4.4.7 Eligibility Information

All responsible sources that meet one of the three conditions of 10 U.S.C. § 2371b(d)(1)(A), (B) or (C) and are capable of satisfying the Government's needs may submit a proposal that shall be considered by DARPA.

A. Eligible Applicants

1. Federally Funded Research and Development Centers (FFRDCs) and Government entities (e.g., Government/National laboratories, military educational institutions, etc.) are subject to applicable direct competition limitations and cannot propose to this BAA in any capacity unless they meet the following conditions: (1) FFRDCs must clearly demonstrate that the proposed work is not otherwise available from the private sector. (2) FFRDCs must provide a letter on official letterhead from their sponsoring organization citing the specific authority establishing their eligibility to propose to Government solicitations and compete with industry, and their compliance with the associated FFRDC sponsor agreement's terms and conditions. This information is required for FFRDCs proposing to be prime contractors or subcontractors. Government entities must clearly demonstrate that the work is not otherwise available from the private sector and provide written documentation citing the specific statutory authority and contractual authority, if relevant, establishing their ability to propose to Government solicitations. At the present time, DARPA does not consider 15 U.S.C. § 3710a to be sufficient legal authority to show eligibility. While 10 U.S.C.§ 2539b may be the appropriate statutory starting point for some entities, specific supporting regulatory guidance, together with evidence of agency approval, will still be required to fully establish eligibility. DARPA will consider FFRDC and Government entity eligibility submissions on a case-by-case basis; however, the burden to prove eligibility for all team members rests solely with the proposer.

2. Non-U.S. organizations and/or individuals may participate to the extent that such participants comply with any necessary nondisclosure agreements, security regulations, export control laws, and other governing statutes applicable under the circumstances.

4.4.8 Procurement Integrity, Standards of Conduct, Ethical Considerations, and Organizational Conflicts of Interest

Current federal employees are prohibited from participating in particular matters involving conflicting financial, employment, and representational interests (18 U.S.C. §§ 203, 205, and 208). Once the proposals have been received, and prior to the start of proposal evaluations, the Government will assess potential conflicts of interest and will promptly notify the proposer if any appear to exist. The Government assessment does NOT affect, offset, or mitigate the

proposer's responsibility to give full notice and planned mitigation for all potential organizational conflicts, as discussed below.

Without prior approval or a waiver from the DARPA Director, in accordance with FAR 9.503, a contractor cannot simultaneously provide scientific, engineering, technical assistance (SETA) or similar support and also be a technical performer. As part of the proposal submission, all members of the proposed team (prime proposers, proposed subcontractors, and consultants) must affirm whether they (their organizations and individual team members) are providing SETA or similar support to any DARPA technical office(s) through an active contract or subcontract. All affirmations must state which office(s) the proposer, subcontractor, consultant, or individual supports and identify the prime contract number(s). All facts relevant to the existence or potential existence of organizational conflicts of interest (FAR 9.5) must be disclosed. The disclosure must include a description of the action the proposer has taken or proposes to take to avoid, neutralize, or mitigate such conflict. If in the sole opinion of the Government after full consideration of the circumstances, a proposal fails to fully disclose potential conflicts of interest and/or any identified conflict situation cannot be effectively mitigated, the proposal will be rejected without technical evaluation and withdrawn from further consideration for award.

If a prospective proposer believes a conflict of interest exists or may exist (whether organizational or otherwise) or has questions on what constitutes a conflict of interest, the proposer should send his/her contact information and a summary of the potential conflict to the DARPA-PS-16-03@darpa.mil before time and effort are expended in preparing a proposal and mitigation plan.

4.4.9 Fundamental Research

It is DoD policy that the publication of products of fundamental research will remain unrestricted to the maximum extent possible. National Security Decision Directive (NSDD) 189 established the national policy for controlling the flow of scientific, technical, and engineering information produced in federally funded fundamental research at colleges, universities, and laboratories. The Directive defines fundamental research as follows:

> "'Fundamental research' means basic and applied research in science and engineering, the results of which ordinarily are published and shared broadly within the scientific community, as distinguished from proprietary research and from industrial development, design, production, and product utilization, the results of which ordinarily are restricted for proprietary or national security reasons."

As of the date of this program solicitation, the Government expects that program goals as described herein either cannot be met by proposers intending to perform fundamental research or the proposed research is anticipated to present a high likelihood of disclosing performance characteristics of military systems or manufacturing technologies that are unique and critical to defense. Therefore, the Government anticipates restrictions on the resultant research that will require the contractor to seek DARPA permission before publishing any information or results relative to the program.

Proposers should indicate in their proposal whether they believe the scope of the research included in their proposal is fundamental or not. While proposers should clearly explain the intended results of their research, the Government shall have sole discretion to select award instrument type and to negotiate all instrument terms and conditions with selectees. Appropriate clauses will be included in resultant awards for non-fundamental research to prescribe publication requirements and other restrictions, as appropriate.

For certain research projects, it may be possible that although the research being performed by the prime contractor is restricted research, a subcontractor may be conducting contracted fundamental research. In those cases, it is the prime contractor's responsibility to explain in their proposal why its subcontractor's effort is contracted fundamental research.

The following Article will be incorporated into any resultant non-fundamental OT agreement:

PUBLIC RELEASE OR DISSEMINATION OF INFORMATION

There shall be no dissemination or publication, except within and between the performer and any subcontractors, of information developed under this agreement or contained in the reports to be furnished pursuant to this agreement without prior written approval of DARPA's Public Release Center (DARPA/PRC). All technical reports will be given proper review by appropriate authority to determine which Distribution Statement is to be applied prior to the initial distribution of these reports by the performer. With regard to subcontractor proposals for Fundamental Research, papers resulting from unclassified fundamental research are exempt from prepublication controls and this review requirement, pursuant to DoD Instruction 5230.27 dated October 6, 1987.

When submitting material for written approval for open publication, the performer/awardee must submit a request for public release to the DARPA/PRC and include the following information: (1) Document Information: document title, document author, short plain-language description of technology discussed in the material (approx. 30 words), number of pages (or minutes of video) and document type (e.g., briefing, report, abstract, article, or paper); (2) Event Information: event type (conference, principal investigator meeting, article or paper), event date, desired date for DARPA's approval; (3) DARPA Sponsor: DARPA Program Manager, DARPA office, and agreement number; and (4) Performer/Awardee's Information: POC name, e-mail and phone. Allow four weeks for processing; due dates under four weeks require a justification. Unusual electronic file formats may require additional processing time. Requests may be sent either via email to public_release_center@darpa.mil or by mail to 675 North Randolph Street, Arlington VA 22203-2114, telephone (571) 218-4235. Refer to the following for link for information about DARPA's public release process: http://www.darpa.mil/work-with-us/contract-management/public-release.

In addition, articles for publication or presentation will contain a statement on the title page worded substantially as follows:

"This research was, in part, funded by the U.S. Government. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the official policies, either expressed or implied, of the U.S. Government."

4.4.10 Award Information

DARPA anticipates selecting a single proposal for award. The amount of resources made available under this program solicitation will depend on the quality of the proposals received and the availability of funds. The Government reserves the right to select for negotiation all, some, one, or none of the proposals received in response to this solicitation, and to make awards without communications with proposers. The Government also reserves the right to conduct communications if necessary. If warranted, portions of resulting awards may be segregated into pre-priced options. Additionally, DARPA reserves the right to accept proposals in their entirety or to select only portions of proposals for award. In the event that DARPA desires to award only portions of a proposal, negotiations may be opened with that proposer. The Government reserves the right to fund proposals in phases with options for continued work at the end of one or more of the phases. The Government reserves the right to remove proposers from award consideration should the parties fail to reach agreement on award terms, conditions and cost/price within a reasonable time or the proposer fails to timely provide requested additional information. In all cases, the Government agreements officer shall have sole discretion to select award instrument type and to negotiate all instrument terms and conditions with selectees.

Any objections to the terms of this solicitation or the conduct of receipt, evaluation or award of agreements must be presented in writing within ten (10) calendar days of (1) the release of this solicitation, or (2) the date the objector knows or should have known the basis for its objection. Objections should be provided in letter format, clearly stating that it is an objection to this solicitation or to the conduct of evaluation or award of an agreement, providing a clearly detailed factual statement of the basis for objection. Failure to comply with these directions is a basis for summary dismissal of the objection. Letters of objection should be sent to the Agreements Officer.

D. Peter Donaghue
Agreements Officer
675 North Randolph Street
Arlington, VA 22203-2114
desmond.donaghue@darpa.mil

4.4.11 Cost Sharing

Cost sharing may be required under the DARPA's authority of 10 U.S.C. § 2371b. . Proposers should review the statutory language to see if they are required to provide a minimum of one-third (1/3) cost share or if they meet the conditions for not providing cost share.

Consistent with 10 U.S.C. § 2371b(d), if the proposer requests award of an OT agreement as a non-traditional defense contractor, as defined by section 2302 (9) of title 10, United States Code, or as a small business, as defined under section 3 of the Small Business Act (15 U.S.C.632), information must be included in the cost proposal to support the claim. Additionally, if the

proposer requests award of an OT agreement without the required one-third (1/3) cost share, information must be included in the cost proposal supporting that there is at least one non-traditional defense contractor participating to a significant extent or that all significant participants in the transaction other than the Federal Government are small businesses or non-traditional defense contractors. Proposers shall provide in their cost proposal an explanation of why the proposer believes the non-traditional defense contractor or small business is participating to a significant extent.
If proposers meet the conditions under the statutory guidance for not providing cost share, proposers may still provide cost share at their discretion.

4.4.12 Administrative and National Policy Requirements

1. Human Subjects Research

All research selected for funding involving human subjects, to include use of human biological specimens and human data, must comply with the federal regulations for human subjects protection. Further, research involving human subjects that is conducted or supported by the DoD must comply with 32 CFR 219, *Protection of Human Subjects* (and DoD Instruction 3216.02, *Protection of Human Subjects and Adherence to Ethical Standards in DoD-Supported Research* (http://www.dtic.mil/whs/directives/corres/pdf/321602p.pdf).

Institutions awarded funding for research involving human subjects must provide documentation of a current Assurance of Compliance with Federal regulations for human subjects protection, such as a Department of Health and Human Services, Office of Human Research Protection Federal Wide Assurance (http://www.hhs.gov/ohrp). All institutions engaged in human subjects research, to include subcontractors, must also hold a valid Assurance. In addition, all personnel involved in human subjects research must provide documentation of completion of human subjects research training.

For all proposed research that will involve human subjects in the first year or phase of the project, the institution must provide evidence of or a plan for review by an Institutional Review Board (IRB) upon final proposal submission to DARPA as part of their proposal, prior to being selected for funding. The IRB conducting the review must be the IRB identified on the institution's Assurance of Compliance with human subjects protection regulations. The protocol, separate from the proposal, must include a detailed description of the research plan, study population, risks and benefits of study participation, recruitment and consent process, data collection, and data analysis. It is recommended that you consult the designated IRB for guidance on writing the protocol. The informed consent document must comply with federal regulations (32 CFR 219.116). A valid Assurance of Compliance with human subjects protection regulations along with evidence of completion of appropriate human subjects research training by all investigators and personnel involved with human subjects research should accompany the protocol for review by the IRB.

In addition to a local IRB approval, a headquarters-level human subjects administrative review and approval is required for all research conducted or supported by the DoD. The Army, Navy, or Air Force office responsible for managing the award can provide guidance and information about their component's headquarters-level review process. Note that confirmation of

a current Assurance of Compliance with human subjects protection regulations and appropriate human subjects research training is required before headquarters-level approval can be issued.

The time required to complete the IRB review/approval process varies depending on the complexity of the research and the level of risk involved with the study. The IRB approval process can last between one and three months, followed by a DoD review that could last between three and six months. Ample time should be allotted to complete the approval process. DoD/DARPA funding cannot be used towards human subjects research until ALL approvals are granted.

2. Animal Use

Award recipients performing research, experimentation, or testing involving the use of animals shall comply with the rules on animal acquisition, transport, care, handling, and use as outlined in: (i) 9 CFR parts 1-4, Department of Agriculture rules that implement the Animal Welfare Act of 1966, as amended, (7 U.S.C. § 2131-2159); (ii) National Institutes of Health Publication No. 86-23, "Guide for the Care and Use of Laboratory Animals" (8th Edition); (iii) DoD Instruction 3216.01, "Use of Animals in DoD Programs."

For projects anticipating animal use, proposals should briefly describe plans for Institutional Animal Care and Use Committee (IACUC) review and approval. Animal studies in the program will be expected to comply with the Public Health Service (PHS) Policy on Humane Care and Use of Laboratory Animals, available at http://grants.nih.gov/grants/olaw/olaw.htm.

All award recipients must receive approval by a DoD-certified veterinarian, in addition to an IACUC approval. No animal studies may be conducted using DoD/DARPA funding until the United States Army Medical Research and Materiel Command (USAMRMC) Animal Care and Use Review Office (ACURO) or other appropriate DoD veterinary office(s) grant approval. As a part of this secondary review process, the award recipient will be required to complete and submit an ACURO Animal Use Appendix, which may be found at https://mrmc-www.army.mil/index.cfm?pageid=Research_Protections.acuro&rn=1.

3. Export Control

(a) *Definition.* "Export-controlled items," as used in this clause, means items subject to the Export Administration Regulations (EAR) (15 CFR Parts 730-774) or the International Traffic in Arms Regulations (ITAR) (22 CFR Parts 120-130). The term includes:

(1) "Defense items," defined in the Arms Export Control Act, 22 U.S.C. 2778(j)(4)(A), as defense articles, defense services, and related technical data, and further defined in the ITAR, 22 CFR Part 120.

(2) "Items," defined in the EAR as "commodities", "software", and "technology," terms that are also defined in the EAR, 15 CFR 772.1.

(b) The Contractor shall comply with all applicable laws and regulations regarding export-controlled items, including, but not limited to, the requirement for contractors to register with the Department of State in accordance with the ITAR. The Contractor shall consult with the Department of

State regarding any questions relating to compliance with the ITAR and shall consult with the Department of Commerce regarding any questions relating to compliance with the EAR.

(c) The Contractor's responsibility to comply with all applicable laws and regulations regarding export-controlled items exists independent of, and is not established or limited by, the information provided by this clause.

(d) Nothing in the terms of this agreement adds, changes, supersedes, or waives any of the requirements of applicable Federal laws, Executive orders, and regulations, including but not limited to—

(1) The Export Administration Act of 1979, as amended (50 U.S.C. App. 2401, et seq.);

(2) The Arms Export Control Act (22 U.S.C. 2751, et seq.);

(3) The International Emergency Economic Powers Act (50 U.S.C. 1701, et seq.);

(4) The Export Administration Regulations (15 CFR Parts 730-774);

(5) The International Traffic in Arms Regulations (22 CFR Parts 120-130); and

(6) Executive Order 13222, as extended.

(e) The Contractor shall include the substance of this clause, including this paragraph (e), in all subcontracts.

4. Representations by Corporations Regarding an Unpaid Delinquent Tax Liability or a Felony Conviction under any Federal Law

The following representation will be included in all awards:

(a) In accordance with section 101(a) of the Continuing Appropriations Act, 2016 (Pub. L. 114-53) and any subsequent FY 2016 appropriations act that extends to FY 2016 funds the same restrictions as are contained in sections 744 and 745 of division E, title VII, of the Consolidated and Further Continuing Appropriations Act, 2015 (Pub. L. 113-235), none of the funds made available by this or any other Act may be used to enter into a contract with any corporation that —

(1) Has any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability, where the awarding agency is aware of the unpaid tax liability, unless the agency has considered suspension or debarment of the corporation and made a determination that this further action is not necessary to protect the interests of the Government; or

(2) Was convicted of a felony criminal violation under any Federal law within the preceding 24 months, where the awarding agency is aware of the conviction, unless the agency has considered suspension or debarment of the corporation and made a determination that this action is not necessary to protect the interests of the Government.

(b) The Offeror represents that –

(1) It is [ ] is not [ ] a corporation that has any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability,

(2) It is [ ] is not [ ] a corporation that was convicted of a felony criminal violation under a Federal law within the preceding 24 months.

5. Controlled Unclassified Information (CUI) on Non-DoD Information Systems

Controlled Unclassified Information (CUI) refers to unclassified information that does not meet the standards for National Security Classification but is pertinent to the national interests of the United States or to the important interests of entities outside the Federal Government and under law or policy requires protection from unauthorized disclosure, special handling safeguards, or prescribed limits on exchange or dissemination. All non-DoD entities doing business with DARPA are expected to adhere to the following procedural safeguards, in addition to any other relevant Federal or DoD specific procedures, for submission of any proposals to DARPA and any potential business with DARPA:

Do not process DARPA CUI on publicly available computers or post DARPA CUI to publicly available webpages or websites that have access limited only by domain or Internet protocol restriction.

Ensure that all DARPA CUI is protected by a physical or electronic barrier when not under direct individual control of an authorized user and limit the transfer of DARPA CUI to subcontractors or teaming partners with a need to know and commitment to this level of protection.

Ensure that DARPA CUI on mobile computing devices is identified and encrypted and all communications on mobile devices or through wireless connections are protected and encrypted.

Overwrite media that has been used to process DARPA CUI before external release or disposal.

6. Prohibition on Contracting with Entities that Require Certain Internal Confidentiality Agreements

(a) In accordance with section 101(a) of the Continuing Appropriations Act, 2016 (Pub. L. 114-53) and any subsequent FY 2016 appropriations act that extends to FY 2016 funds the same restrictions as are contained in section 743 of division E, title VII, of the Consolidated and Further Continuing Appropriations Act, 2015 (Pub. L. 113-235), none of the funds appropriated (or otherwise made available) by this or any other Act may be used for a contract with an entity that requires employees or subcontractors of such entity seeking to report fraud, waste, or abuse to sign internal confidentiality agreements or statements prohibiting or otherwise restricting such employees or contactors from lawfully reporting such waste, fraud, or abuse to a designated investigative or law enforcement representative of a Federal department or agency authorized to receive such information.

(b) The prohibition in paragraph (a) of this provision does not contravene requirements applicable to Standard Form 312, Form 4414, or any other form issued by a Federal department or agency governing the nondisclosure of classified information.

(c) *Representation*. By submission of its offer, the Offeror represents that it does not require employees or subcontractors of such entity seeking to report fraud, waste, or abuse to sign or comply with internal confidentiality agreements or statements prohibiting or otherwise restricting such employees or contactors from lawfully reporting such waste, fraud, or abuse to a designated investigative or law enforcement representative of a Federal department or agency authorized to receive such information.

7. Reporting

The number and types of reports will be specified in the award document, but will include as a minimum monthly technical and financial status reports. The reports shall be prepared and submitted in accordance with the procedures contained in the award document and mutually agreed on before award. Reports and briefing material will also be required as appropriate to document progress in accomplishing program metrics. A Final Report that summarizes the project and tasks will be required at the conclusion of the performance period for the award, notwithstanding the fact that the research may be continued under a follow-on vehicle. At least one copy of each report will be delivered to DARPA and not merely placed on a SharePoint site.

8. Electronic Systems

i. Wide Area Work Flow (WAWF)

Unless using another means of invoicing, performers will be required to submit invoices for payment directly to https://wawf.eb.mil. Registration in WAWF will be required prior to any award under this solicitation.

ii. i-Edison

The award document for each proposal selected for funding will contain a mandatory requirement for patent reports and notifications to be submitted electronically through i-Edison (http://s-edison.info.nih.gov/iEdison).

5.0 EVALUATION CRITERIA FOR AWARD

5.1 Evaluation Criteria

Proposals will be evaluated using the following criteria, listed in descending order of importance: (a) Overall Scientific and Technical Merit; (b) Potential Contribution and Relevance to the DARPA Mission, including Plans and Capability to Accomplish Technology Transition; (c) Proposer's Capabilities and/or Related Experience, (d) Cost Realism; and (e) Schedule Realism.

(a) Overall Scientific and Technical Merit

The proposed technical approach is innovative, feasible, achievable, complete and supported by a proposed technical team that has the expertise and experience to accomplish the proposed tasks. Task descriptions and associated technical elements provided are complete and in a logical sequence with all proposed deliverables clearly defined such that a final outcome that achieves the goal can be expected as a result of award. The proposal identifies major technical risks and planned mitigation efforts are clearly defined and feasible.

(b) Potential Contribution and Relevance to the DARPA Mission, including Plans and Capability to Accomplish Technology Transition

The potential contributions of the proposed effort are relevant to the national technology base. Specifically, DARPA's mission is to maintain the technological superiority of the U.S. military and prevent technological surprise from harming national security by sponsoring revolutionary, high-payoff research that bridges the gap between fundamental discoveries and their application. Furthermore, the proposer clearly demonstrates its capability, plans, and commitment to transition the technology to the industrial/commercial sector because transition of the proposed system to a sustainable commercial service offering is critical to the program vision. In addition, the evaluation will take into consideration the extent to which the proposed intellectual property (IP) rights will potentially impact the Government's ability to transition the technology, not just to Government customers, but also to the entrepreneurial and industrial sectors.

(c) Proposer's Capabilities and/or Related Experience

The proposer's prior experience in similar efforts clearly demonstrates an ability to deliver products that meet the proposed technical performance within the proposed budget and schedule. The proposed team has the expertise to manage the cost and schedule. Similar efforts completed/ongoing by the proposer in this area are fully described including identification of other Government sponsors.

(d) Cost Realism

The proposed costs are realistic for the technical and management approach and accurately reflect the technical goals and objectives of the solicitation. The proposed costs are consistent with the proposer's Task Description Document and reflect a sufficient understanding of the

costs and level of effort needed to successfully accomplish the proposed technical approach. The costs for the prime proposer and proposed subcontractors are substantiated by the details provided in the proposal (e.g., detailed cost proposals that include the type and number of labor hours proposed per task, the types and quantities of materials, equipment and fabrication costs, travel and any other applicable costs). It is expected that the effort will leverage all available relevant prior research in order to obtain the maximum benefit from the available funding. For efforts with a likelihood of commercial application, appropriate direct cost sharing may be a positive factor in the evaluation. DARPA recognizes that undue emphasis on cost may motivate proposers to offer low-risk ideas with minimum uncertainty and to staff the effort with junior personnel in order to be in a more competitive posture. DARPA discourages such cost strategies.

(e) Schedule Realism

The proposer can realistically achieve the Key Milestones outlined in the program solicitation, consistent with initiating Phase III of the program no later than sometime during Government FY20. The proposer's schedule identifies any potential risk, allocating sufficient time to address the risk and recover from any failures.

5.2 Review and Selection Process

DARPA will conduct a scientific/technical review of each conforming proposal. Proposals will not be evaluated against each other since they are not submitted in accordance with a common work statement. DARPA's intent is to review proposals as soon as possible after they arrive; however, proposals may be reviewed periodically for administrative reasons.

Based on the scientific/technical review of a proposals using the evaluation criteria listed above, an award will be made to the proposer(s) whose proposal is determined to be the most advantageous to the Government, all factors considered, including the potential contributions of the proposed work to the overall research program and the availability of funding for the effort.

It is the policy of DARPA to ensure impartial, equitable, comprehensive proposal evaluations and to select the source whose offer meets the Government's technical, policy, and programmatic goals. The primary basis for selecting proposals for acceptance shall be technical, importance to agency programs, and fund availability. In order to provide the desired evaluation, qualified Government personnel will conduct reviews and (if necessary) convene panels of experts in the appropriate areas.

For evaluation purposes, a proposal is the document described in "Proposal Preparation Instructions," Section 4.0.

Restrictive notices notwithstanding, proposals may be handled for administrative purposes by support contractors. These support contractors are prohibited from competition in DARPA technical research and are bound by appropriate non-disclosure requirements.

Input on technical aspects of the proposals may be solicited by DARPA from non-Government consultants/experts who are strictly bound by the appropriate non-disclosure requirements.

5.3 Award Notices

The following notices will be provided as applicable:

- Request for clarification (if applicable)
  - May occur at any time during the evaluation process
  - Proposal changes are not permitted
- Request to open communications (if needed)
  - Proposers shall be advised of any deficiencies and/or major weaknesses in their proposals and given an opportunity to respond, to include offering proposal revisions
- Notice of non-selection
- Notice of selection

As soon as the evaluation of proposals is complete, the proposers will be notified that (1) the proposal has been selected for funding, subject to OT agreement negotiations, or (2) the proposal has not been selected for funding. The above listed notifications will be sent by the Agreements Officer via Electronic Mail to the Technical and Administrative POCs identified on the proposal coversheet.

APPENDIX A1 – Guidelines for Vehicle Overview Document (VOD)

Purpose

This document establishes key parameters and a top-level framework for identifying the status of XS-1 Flight System designs and performance capabilities, termed the Vehicle Overview Document.

This document is provided for guidance; literal compliance is not required, and judgment is to be exercised on the part of the proposer. The VOD identifies key design details of interest to the Government and is intended to facilitate and simplify tracking design and performance progress.

Terminology

Status: a parameter whose value has been either set/prescribed by design, or is the outcome of analysis

Intent: a parameter whose value is a target, but has not been confirmed through analysis or design closure

TPM: Technical Performance Measure, a.k.a. Key Performance Parameter; a critical parameter that is driven in the design process to a specific target value or within a window spanning the range of objective-to-threshold

t: time after start of unrestrained flight (ascent)
d: net distance traveled by vehicle as projected onto the ground
L_{body}, D_{body} : length, diameter of body

All other variables used in customary aerospace engineering sense (i.e., alt, M, α, q, ɣ).

Protocol

The VOD may be used to identify key information of interest to the Government at incremental design reviews and technical interchange meetings. The information in the VOD should reflect a consistent design point across all included disciplines.

If used, any VOD given or presented to the Government team should indicate the vehicle's associated configuration code or number, and whether or not the document pertains to that coded configuration exactly or whether an interim or variant configuration is reflected. The date associated with the configuration code should correspondingly be included. Additional serialization information may be included.

If not otherwise annotated, it is assumed that the parameters reflected in the VOD are Status values; if a parameter value is only established as a design Intent, then it should be so designated clearly. If the Intent values for parameters have not yet been established, then placeholder indicators, such

as “TBD,” may be used. Intended parameters may also be given with qualifier prefixes or suffixes, such as “≤”, “≥”, and “TBR.”

The VOD is principally intended to aid tracking the baseline vehicle design. However, it may also be used as a template for presenting alternate configurations that are in trade.

An accompanying page should be available upon request, containing illustrations of reference dimension conventions and any sign conventions when deviating from commonly-accepted practice or when there is no common standard. When a parameter identified by this Guidance document corresponds to a design TPM, it should be so identified on the page(s) upon which it appears.

Primary units should be in the customary American aerospace engineering system.

Format and Information

Section: *Booster Characteristics*

- 3-view or comparable graphical depiction, with control surfaces clearly indicated
- Physical dimensions, including relevant aerodynamic lengths
- Wing and strake planform area, including control surfaces, but not including fuselage
- Aerodynamic reference area
- Maximum stack GLOW
- Maximum and useable propellant mass (total)
- Mass properties
    - Dry weight
    - Residual propellants and ancillary fluids
    - Mass growth allowance, margins, uncertainty, and reserve
    - Mass breakdown (pie chart/table) by maturity level and by subsystem
- Maximum landing weight and maximum sink rate
- Design limit loads*
    - Axial
    - Normal
    - Lateral
    - Dynamic events, such as landing slap down or stage separation loads

      * Alternate decompositions/presentations of design limit loads are acceptable instead
- Design maximum q
- Design maximum q*α
- Maximum allowable cross-wind landing capability
- Engine information
    - Number and type/model
    - Propellants

- Sea level Thrust and Isp
- Vacuum Thrust and Isp
- Chamber pressure corresponding to Thrust and Isp values
- Nominal mixture ratio
- Nozzle area ratio
- Number of missions (or flight time) before significant servicing/refurbishment required
- Mounted toe and cant angles
- Maximum gimbal angle ranges

Section: *Mission Performance Parameters with one section per Design Reference Mission, including, but not limited to, the following mission cases*: 1) Demonstration/Phase III Orbital Launch trajectory; 2) Operational Orbital Launch trajectory; 3) Maximum-performance Booster-only trajectory.

These pages may contain representative trajectory plots or three-dimensional illustrations. Each flight segment should be clearly marked. The following parameters should be present in these sections when they are applicable.

- Payload to orbit
  - Mass: nominal and worst-case expected conditions
  - Orbital parameters: altitude(s) (max and min if not circular), inclination
- Start and end of each flight segment (may be denoted on plot)
  - alt, M, α, q, t, ɣ, d, axial acceleration, normal acceleration
  - Cg position (coordinates both along and normal to body axis) segment, may be normalized by appropriate body dimension, e.g., L_{body} along vehicle and D_{body} normal to vehicle
  - Booster longitudinal static stability margin normalized to body length, i.e., $\frac{x_{aerodynamic\ center} - x_{Cg}}{L_{body}}$ where x = 0 corresponds to the nose tip
  - Aerodynamic L/D of stack, when mated, and booster after staging
- Maximum altitude point (may be denoted on plot)
  - alt, M, q, α, ɣ, t, d
- Maximum q point (may be denoted on plot)
  - alt, M, q, α, ɣ, t, d
- Upper stage (expendable) parameters
  - Stage count
  - Burnout masses
  - Payload adapter mass
  - Fairing mass
  - Propellants

    - Propulsion: type, engine quantity, propellant feed method, vacuum thrust, vacuum Isp
    - Usable and residual propellant masses
- Performance objective (e.g., fixed payload, minimizing propellant mass or fixed propellant mass, maximizing payload)
- Booster (not stack) GLOW
- Upper stage GLOW, less payload, but including fairing and adapter
- Upper stage mass growth allowance, margins, uncertainty, and reserve
- Booster and Upper Stage propellants: margins by category, uncertainty, and reserve
- Thrust over weight (T/W) at liftoff
- Landing mass
- Landing sink rate

Section: *Operational Labor and Timing*
This section provides measures of the system operability for the operational configuration under a nominal mission scenario assuming a pre-planned mission and payload. Measures may assume an encapsulated payload is ready but not mated to the upper stage prior to the launch campaign.

- Top-level task category, duration, and staffing level from receipt of the encapsulated payload to launch
- Top-level task category, duration, and staffing level for turnaround of booster and ground systems
- Margins for labor, time, etc., and identification of critical path constraints

Section: *Additional Flight System Technical Performance Measures, including those impacting Operability*

For any Flight System TPMs not already identified in the previous pages, each such TPM's associated objective and threshold, or target, and status values should be tabulated. If the VOD is included in a System Design Document (SDD), the Flight System TPMs may instead be combined with other TPM sections.

APPENDIX A2 – Guidelines for System Design Document (SDD)

Purpose

This document establishes a suggested framework for documenting the XS-1 system design. The SDD is intended to be a living document which can support Phase II/III proposals, key design reviews, and final reports. It is a synopsis of the most significant system-wide technical design information. Compared to the VOD, the scope of the SDD is system-wide and should convey both greater depth and more contextual information, such as design philosophy, rationale, maturity, and fidelity. The SDD identifies program details and processes of interest to the Government and is intended to facilitate and simplify tracking program progress.

This document is provided as Government guidance only; literal compliance is not required, and judgment is to be exercised on the part of the preparer.

The SDD is not a substitute for, nor a synopsis of, other key program documents such as the TMP, TEMP, System Safety Plan, Payload User's Guide, Licensing Plan, Development Plans, Qualification Plan, Manufacturing Plans, Transition Plan, Cost Analyses, Operator's Manual, or program schedule documents, though it is to be consistent with all such documents.

Format

- When page-limited (e.g., in proposals): each section is important, but it may not be possible to address all topics under each section. When the SDD content is submitted in support of a proposal, additional documents referenced will not be evaluated.
- During program execution, additional documents providing greater depth or background may be incorporated by reference or used as appendices, as long as these additional documents are available to reviewers.
- Technical Performance Measures for each area should be indicated in the section of the document pertinent to that area. Objective, status, and threshold TPM values, as applicable, should be indicated. An Index or combined list of TPMs is also encouraged. All TPMs should be captured in the SDD.
- Documented parameters should clearly differentiate between the current design state (Status) and the intended full design maturity (Intent) values. If a parameter is documented as Intent, then the corresponding current Status value (if applicable) should be documented.
- Cross-references are encouraged, but take care to keep them up-to-date.
- The flight and ground systems' associated configuration codes or numbers, as well as their associated dates, should be clearly indicated.

Definitions/Glossary

APU:	Auxiliary Power Unit
Cg:	Center of Gravity
CFD:	Computational Fluid Dynamics
CONOPS:	Concepts of Operation
Flight System:	Articles which leave the ground

PFS:	Payload Flight System; A "payload stack" from the perspective of the booster, i.e., upper stage (with or without orbital payload), free-flying powered or unpowered flight experiment, captively-carried flight experiment, etc.
Data:	Measured or observed parameters associated with hardware (i.e., not used in the sense of collections of digital information)
DOF:	Degree of Freedom
DRM:	Design Reference Mission
M&S:	Maintenance and Servicing
RCS:	Reaction Control System
TEL:	Transporter-Erector-Launcher

Sections

Recommended sections are numbered below, with each section followed by a list of suggested topics. The section ordering used below has no significance with respect to the importance of the relevant disciplines. Preparers may prioritize, resequence, merge, or present information differently. A non-exhaustive set of examples are also provided to elicit explicit discussion regarding the levels of fidelity associated with each section.

In the XS-1 system, operability, lifecycle costs, and margins are system-wide concerns expected to receive treatment in any section to which they are relevant. Therefore, neither operability nor lifecycle cost are placed into separate sections of their own. A cross-cutting reference providing a number of operability and lifecycle cost-related criteria that may be addressed in the SDD is AIAA 2009-5345, "Concepts for Life Cycle Cost Control Required to Achieve Space Transportation Affordability and Sustainability" by Rhodes, Zapata, Levack, Robinson, and Donahue.

In every relevant section, it is recommended that the driving requirements and their associated operating scenarios (nominal, abort, etc.) be identified and used to motivate the discussion of the solution approach.

Explicit identification of any standards or design practice documents used for guidance or compliance is strongly recommended and encouraged in context.

If alternative components for major systems or subsystems (e.g., actuators, engines) are being tracked along with the baseline (i.e., as design contingency plans), it is recommended that these alternatives receive at least a brief treatment in context.

Sections should clearly discriminate between values that are predicted solely by analyses versus values anchored by data (e.g., wind tunnel tests, scaled hardware panel tests) or where the values themselves are data. When both analytical predictions and data are available, comparisons are to be made between the two. Sources or references for the analytical or data values should be identified.

The Payload Flight Systems (PFS) shall be defined to a level of detail such that the Government can ascertain design, performance and flight safety of the integrated XS-1/PFS. For example, PFS concepts based on flight proven commercial stages may not require as much detail as new stage concepts. However, in all cases integrated performance and data relevant to flight safety shall be documented. The Government's will not assess the validity of commercial stage concepts independent of the XS-1 carriage.

Part 1: System Technical Overview

1. System Requirements
   - System requirements as derived from the XS-1 technical goals

2. Flight System Overview
   - The corresponding Vehicle Overview Document is to be the Flight System Overview

3. Ground System Overview
   - Key infrastructure, equipment, and facilities used to prepare, integrate, operate, recover, and reconstitute the system

4. Operations Overview
   - Any key CONOPS aspects that are neither explicit, nor obviously implicit, in DRMs/trajectories contained in the VOD/Flight System Overview
   - Driving operations-related TPMs to which the system is being designed
   - Basing options – fixed, transportable/mobile, abort landing, downrange options
   - Capabilities with respect to unplanned pre-flight changes of encapsulated payloads and mission parameters
   - Transportation/ferry options
   - Coordination with airspace control

5. Certification/Licensing and Safety Intent
   - Regulatory regimes to which the system is designed to comply, to what extent, and entities under whose authority flight release is to be granted
   - Range safety interface and flight safety/flight termination approach

6. System Reliability, Availability, and Survivability Intent
   - Governing intent and philosophy regarding system availability and reliability to which the system is being designed
   - Design philosophy regarding off-nominal/abort scenarios

Part 2: Flight Systems

Note:

a) The following sections may be addressed and organized as per the preparer's preferences; individual sub-parts corresponding to the Booster, key PFSs such as Demonstration and Operational Upper Stage, and remaining Design Reference PFSs may be used, but other logical groupings are acceptable as well

System-Level

7. Maturity and Robustness Approach
    - Mass margin, growth, uncertainty, reserve, and release philosophy; applicable standards being used (e.g., AIAA-S-120)
    - Margins and reserve for performance, weather, launch holds and delays, etc.
    - Performance allowances for effect of repairs on system
    - Redundancy and fault-tolerance

8. Missions, Performance, and Off-nominal/Abort Scenarios
    - Explicit discussion of level of fidelity/bases underpinning the work for this discipline (e.g., untrimmed aero, trimmed aero, 3 DOF, 6 DOF, etc.) by area
    - Any additional design-relevant details regarding concepts of operation/employment not included in VOD
    - Any additional design-relevant design reference mission information not included in VOD
    - Launch and recovery sites
    - Performance objectives guiding trajectory design/optimization
    - Top-level Failure Modes and Effects
    - Off-nominal scenarios, and trajectories, and identification of driving cases
    - Categories, timelines/events, and limitations associated with survivable and unsurvivable scenarios, from booster, PFS, and stack perspectives
    - Emergency propellant dump provisions
    - Identification of critical environments by vehicle region and/or by subsystem
    - Safety of flight analyses, assumptions (e.g., keep-out zones) guiding DRMs
    - Landing assumptions and limitations, including crosswinds

Booster-Specific

9. Booster Configuration
    - General arrangement drawing
    - Design rationale, philosophy
    - Inboard profile drawing, explicit identification of subsystem layout
    - Identification and functional roles of aerodynamic control effectors
    - Identification and functional roles of reaction control systems
    - Basic load paths
    - Interfaces for PFS carriage
    - Interfaces for ground systems
    - Tipback and turnover angles
    - Any additional information on configuration-related trades, dimensional optimization, etc.
    - Overall flight envelope(s) and identification of mission/configuration-specific footprint within envelope
    - PFS accommodation envelope
    - Propellant vent/dump provisions
    - Functional and software interfaces between systems and subsystems

10. Aerodynamics and Aerothermodynamics

- Explicit discussion of level of fidelity/bases underpinning the work for this discipline (e.g., FNS CFD and calibration/tuning of CFD models, provenance of aero database, wind tunnel data, etc.)
- Discrimination between ascent and descent characteristics
- Drag buildup and minimum drag vs. Mach number
- Lift curves as a function of angle-of-attack covering all critical aerodynamically-lifting flight conditions
- Uncertainties and approach to quantification, reduction, and accommodation
- Aerodynamic center travel for design reference missions
- Aerodynamic surface section details (airfoils, fuselage shaping, etc.)
- Control surface effectiveness and sizing, including aeroelastic considerations
- Design and worst-case control surface hinge moments
- Approach and characterization of energy management devices
- Aerodynamic trimmability/controllability over flight envelope, including landing and crosswinds
- Aerodynamic impacts of PFS carriage and attachment hardware
- Aerodynamic impacts of deployed secondary surfaces or hardware, e.g. doors, landing gear
- Aerothermal assessments over nominal and worst-case missions
- Propulsion-induced aft heating, from both booster and PFS
- Thermal Protection System, including weather/environment restrictions, and impacts of reflected plume-induced environments

PFS-Specific

11. PFS Configuration
    - General arrangement drawing
    - Design rationale, philosophy
    - Inboard profile drawing, explicit identification of subsystem layout
    - Identification of attitude/directional controls
    - Interfaces to booster
    - Inter-stage interfaces and arrangements, if any
    - Propellant vent/dump provisions
    - Functional and software interfaces between systems and subsystems

12. Payload Accommodations
    - Explicit discussion of level of fidelity/bases underpinning the work for this discipline (e.g., re-use of subsystems from previous programs, level of underlying modeling, analysis and simulation, etc.) by area
    - Payload volume – dynamic envelope
    - Fairing design and separation system
    - Standard and non-standard mechanical interfaces
    - Standard and non-standard electrical interfaces
    - Payload integration and encapsulation process
    - Discussion of late payload access and/or changeout capabilities
    - Payload environments

- Payload environmental control
- Non-standard services

Applicable to both Booster and PFSs

Note:

b) While these sections are generally applicable to both, some topics will only be relevant to the Booster or PFS

13. Maintenance and Servicing
    - Requirements related to maintenance and servicing
    - Affordances, design provisions, and accommodations
    - Substantiation of effectiveness in promoting ease, rapidity, and flexibility in M&S
    - System degradation mechanisms

14. Mass Properties
    - Explicit discussion of level of fidelity/bases underpinning the work for this discipline (e.g., parametric estimates, actual values from suppliers or hardware solid models, etc.) by area
    - Mass breakdowns, both by functional grouping and by fidelity level showing current best estimate, uncertainty, and margins
    - Cg travel for design reference missions
    - Allowable worst-case abort and landing masses and their relationship to survivable scenarios

15. Main Propulsion and Reaction Control Systems
    - Explicit discussion of level of fidelity/bases underpinning the work for this discipline (e.g., flight test, integrated ground test, component testing, modeling and simulation, etc.) by area
    - Maturity and basis for confidence in suitability
    - Cycle types and propellants
    - Mass flow rates through primary engine components, including main chamber and any secondary flowpaths
    - Nozzle dimensions and area ratios
    - Mixture ratios
    - Valves and actuation
    - Stable throttleability ranges
    - Ignition system and restartability parameters
    - Main propulsion thrust vector capability and mechanisms
    - Minimum RCS impulse
    - RCS total impulse budget
    - Propellant pressurization, feed, fill, drain, purge, venting, line routing, pogo prevention, relief, insulation, joints
    - Propellant capture and stabilization mechanisms

16. Structures and Dynamics

- Explicit discussion of level of fidelity/bases underpinning the work for this discipline (e.g., stress models, dynamics models, parameters underlying these models, etc.) by area
- Structural arrangement drawing
- Identification of sizing loads and load cases
- Factors of safety and rationale
- Materials selection and attributes
- Design envelope diagrams (e.g., V-n diagram)
- Tank design details, including joints and redundant load paths
- Buckling stability of tanks during stressing conditions
- Unsteady aeroelastic characteristics including modes, flutter, buffeting, and buzz by flight phase
- Landing and PFS carriage loads, including "spring back" and wheel spinup if applicable
- Seals and moving joints
- Manufacturing processes required and key manufacturability features/accommodations
- Replaceability, inspectability, and serviceability
- Launch hold-down and release

17. Mated Aerodynamics, Aerothermodynamics, Aeroacoustics, and Separation
    - Explicit discussion of level of fidelity/bases underpinning the work for this discipline (e.g., FNS CFD and calibration/tuning of CFD models, provenance of aero database, wind tunnel data, etc.)
    - Interference/interaction effects
    - Resultant environments
    - Key separation events and timeline
    - Time-varying characteristics during separation process

18. Flight Dynamics and Control
    - Explicit discussion of level of fidelity/bases underpinning the work for this discipline (e.g., dynamic scaling of existing models, vehicle-specific 6 DOF, spin tunnel tests, etc.) by area
    - Controllable flight envelopes, with and without PFSs
    - Dynamic stability characteristics such as time-to-double
    - Flight control system architecture and actuation schemes
    - Accommodation of aeroservoelastic effects
    - Loop architecture
    - Control bandwidth
    - Scheduled parameters
    - PFS separation flight dynamics

19. Guidance and Navigation
    - Explicit discussion of level of fidelity/bases underpinning the work for this discipline (e.g., re-use of software and algorithms from previous programs, etc.) by area
    - Overall mission guidance and navigation architecture
    - Distinct flight phases incorporated in logic
    - Approach/algorithms governing each flight phase

- Anomalous condition handling
- Manual override mechanisms and inputs required

20. Avionics and Flight System Software
    - Explicit discussion of level of fidelity/bases underpinning the work for this discipline (e.g., re-use of architecture from previous programs, etc.) by area
    - Overall avionics architecture
    - Software architecture
    - Power and environmental requirements
    - Interfaces and communication requirements
    - Processing and storage capacities
    - Command pathways, including external command sources
    - Flight termination/safety systems
    - Flight software implementation language(s) and providers
    - Operating systems and other software building blocks employed
    - Formal methods, static analysis, and other software quality and correctness methods used
    - Fault-tolerance characteristics
    - Flight data acquisition and recording
    - Telemetry approach, and identification of critical uplinked/downlinked parameters

21. Subsystems
    - Explicit discussion of level of fidelity/bases underpinning the work for this discipline (e.g., re-use of subsystems from previous programs, etc.) by area
    - Integrated Vehicle Health Monitoring and Prognostics
    - Electrical power and sources (e.g., batteries, APU), including required budgets for nominal and off-nominal operation
    - Actuation
    - Hydraulics
    - Pneumatics
    - Landing gear, brakes, and steering
    - Pressurized bays and pressurization system
    - Booster provided/routed support for PFS payload accommodations
    - PFS attachment and separation/release systems
    - Doors
    - External interfaces for propellant loading/unloading, purges, conditioning, communications and maintenance, etc.
    - Mechanized systems
    - Electrical power and electronic signaling wiring/cabling, and distribution concept
    - Communications/antennae

Part 3: Ground Systems

22. Operations Support Ground Systems

- Explicit discussion of level of fidelity/bases underpinning the work for this discipline (e.g., re-use of subsystems from previous programs, level of underlying modeling, analysis and simulation, etc.) by area
- Functional models
- High-level treatment of facilities, functions to be accomplished in each, and whether existing, modified, or new
- Payload integration and encapsulation facilities and equipment
- Launch support equipment (e.g., TEL, launch stand, lightning protection, etc.) and identification of existing/standardized equipment vs. specialized/new designs
- Propellant loading/management systems
- Transportation/ferry equipment
- Maintenance equipment
- Recovery equipment
- Flight Operations Control Center (FOCC)
- Provisions for payload provider participation in prelaunch and launch operations
- Software architecture, interfaces, and loci of control associated with FOCC and any other ground control/monitoring stations
- Telemetry requirements, both fixed and mobile

Part 4: Operations & Lifecycle

23. Mission Planning, Operations
    - Explicit discussion of level of fidelity/bases underpinning the work for this discipline (e.g., re-use of operational data, analysis, and simulations from previous programs, re-use of previously-developed software, etc.) by area
    - Maintenance model
    - Logistical approach to continuing operations
    - Mission planning
    - Overview of integration process with customers, including customer and payload provider interfaces, streamlined data interchange/processes
    - Nominal integration of encapsulated orbital payload to upper stage
    - Integration with booster of upper stage "stack" including orbital payload
    - Personnel requirements for all operations and key maintenance
    - Launch and mission automation
    - Pre-launch automated testing and anomaly resolution
    - Nominal mission event flows
    - Nominal recovery and turnaround process
    - Real-time streamed vs. discretely collected and batch-transferred data; parameters for testing vs. expected parameters for regular operations
    - Substantiation of 10 flights in 10 days campaign performance capability
    - Surge capability

24. Lifecycle Model
    - Explicit discussion of level of fidelity/bases underpinning the work for this discipline (e.g., re-use of operational data, analysis, and simulations from previous programs) by area

- Identification of major lifecycle milestones
- Key life-limiting components or subsystems
- Maintenance construct for major inspections/repairs/overhauls and basing
- Approach for spares and achieving intended level of system availability
- Provisions for preplanned improvement
- Plans to gather evidence justifying or extending expected lifetime of reusable booster

APPENDIX B – Top-Level Tailored Critical Design (tCDR) Criteria

ID	XS-1 System (Booster and Upper Stage) CDR Accomplishment Criteria
CDR-1a	XS-1 System (Booster and Demonstration Upper Stage) detailed design (hardware and software), including interface descriptions, is complete and satisfies all baseline system requirements (allocated and derived) with adequate margin and acceptable risk
CDR-1b	System baseline is consistent with all subsystems having undergone lower-level CDRs; identified issues are documented in action plans
CDR-1c	Integrated Master Schedule (IMS) identifies the critical path and is resourced at reasonable levels
CDR-1d	Program schedule is executable with an acceptable level of technical and cost risk
CDR-1e	Updated program cost estimate fits within the Phase 3 budgets and cost drivers have been identified
CDR-1f	Program is properly staffed
CDR-2a	XS-1 System (Booster and Demonstration upper stage) detailed design (i.e. drawings, specs, descriptions, interfaces, etc.) is sufficiently complete to enable hardware fabrication and software coding to proceed and has been placed under configuration control
CDR-2b	Critical Safety Items have completed drawings and/or specifications
CDR-2c	Allocation of the system functional baseline to the baseline physical system architecture is complete and documented
CDR-2d	XS-1 Demonstration System architecture, definition, and test & demonstration plans are traceable to the XS-1 Operational System
CDR-2e	XS-1 System modeling, simulation, and analysis, including performance assessment, is consistent with the baseline system and has sufficient breadth and depth to ensure technical and programmatic confidence in program success
CDR-2f	XS-1 System risk assessments and risk mitigation plans have been updated, documented, formally addressed, and implemented
CDR-2g	XS-1 System test plans address all HW test facilities and approvals, identify success criteria, include test instrumentation approach and drawings (i.e. identify measurements, required measurements accuracies and bandwidths, sensor redundancies), and identify required communication/data links
CDR-2h	Detailed XS-1 System hardware and software verification and validation plans are complete
CDR-2i	XS-1 Flight Safety and Licensing plan contains all schedule, processes, and tasks required to verify compliance with flight safety requirements and guidelines prior to execution of the XS-1 flight test program
CDR-2j	XS-1 System failure mode, effects, and criticality analysis is complete
CDR-2k	Estimate of system reliability and maintainability has been updated based on engineering analyses, initial test results, or other sources of demonstrated reliability and maintainability
CDR-2l	XS-1 System critical manufacturing processes that affect the key product characteristics have been identified, and the capability to meet design tolerances has been determined
CDR-2m	XS-1 commercialization plan has sufficient breadth and depth to ensure that the business case adequately closes. Corporate decision gates are properly identified and scheduled to ensure a seamless transition to the commercial sector.

APPENDIX C – Cost elements for $5M/flight traceability analysis

Mission Price (Market Price) = Average Mission Cost + Amortized Direct Non-Recurring Cost + Amortized Indirect Cost + Profit

Assumed Sortie Rate: 3/5/10 surge to 30

Program Factors
of Aircraft
Sortie Lifetime
Ground Support Equipment
Personnel
Mission Planning
Operational, Intermediate, and Depot Level Maintenance
Maintenance (A, B, C level)
Engineering
Range
Safety
Payload Support
Cost Element Inputs
Total Recurring Fixed Costs
Facilities/Infrastructure/Utilities
Maintenance - A, B, C Level (Vehicle, GSE)
Sustaining Engineering
Program Management & Admin
Total Recurring Variable Costs
Expendable Upper Stage
Consumables
Incremental Mission Planning
Incremental Mission Operations
Range Support
Safety
Insurance
Standard Payload Provisions
Direct Non-Recurring
XS-1 Booster
XS-1 Booster Spares
Engines
Engine Spares
Ground Support Equipment
Ground Support Equipment Spares
Development & Qual Testing
Transition Engineering
Certifications
Payload Specific Integration Engineering

Indirect Costs
Enterprise Management/Overhead
Facilities (Engineering and Management)
Capital Equipment
Marketing & Selling
Unplanned Vehicle Maintenance
Unplanned Engineering

APPENDIX D – Executive Summary Template

(See MS PowerPoint Attachment)

APPENDIX E – Cost Spreadsheet (Prime Performer and Subcontracts >$150K)

(See MS Excel Attachment)

APPENDIX F – Cost Spreadsheet (Subcontracts <$150K)

(See MS Excel Attachment)