Technology Demonstration Mission Cryogenic Propellant Storage and Transfer (TDM CPST) Project

Sources Sought Notification

Ref: NNC13ZMX002L

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It should be understood that there is no explicit or implied commitment for future procurements in this action.

1 PROJECT INTRODUCTION

The purpose of this Sources Sought Notification (SSN) is to provide industry with information regarding the Technology Demonstration Mission (TDM) Cryogenic Propellant Storage and Transfer (CPST) Project and to obtain relevant market research information for NASA. For purposes of this SSN, the term "TDM" should be understood to encompass all of the CPST Project technical work, which includes a spaceflight demonstration, ground tests and model correlation. The term "TDM CPST" will be used throughout the rest of this SSN to represent the TDM of the CPST Project.

The CPST Project, which is managed out of NASA Glenn Research Center (GRC), is soliciting market research information that **may** be used in a potential procurement for this TDM. The basic purpose of the TDM CPST is to test and validate key cryogenic capabilities and technologies required for possible future exploration architectures that will require large, long-duration cryogenic propulsion stages and propellant depots. The project scope, including a high-level description of the contractor responsibilities is described in greater detail in the Mission Synopsis found in Attachment 1 of this SSN. The current, notional schedule shown in Figure 1 for the TDM CPST Project reflects an acquisition strategy approved in September 2012. This schedule has the TDM CPST Flight Mission Definition Review (MDR) occurring in August 2014 and launch occurring in September 2018.

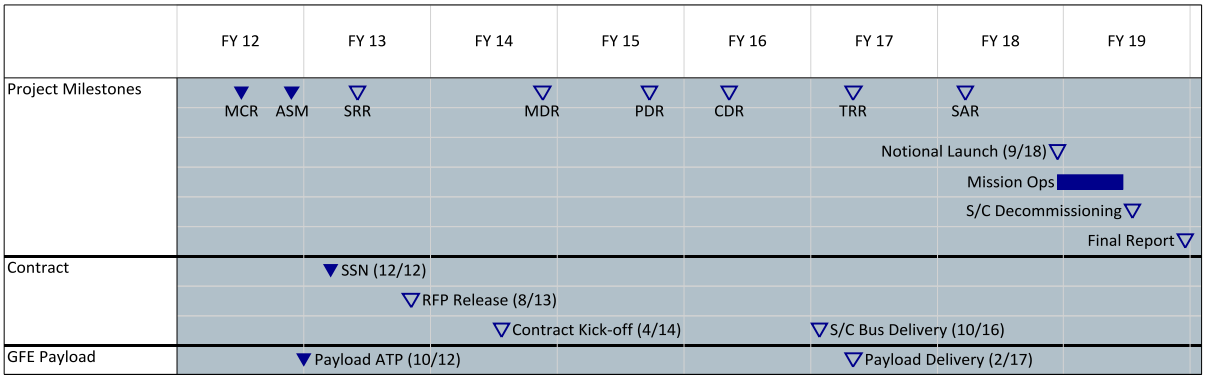

Figure 1: Notional TDM CPST Project Schedule

NASA Requirements

The TDM CPST Project is funded by the NASA Office of Chief Technologist (OCT) Space Technology Program (STP). The project is governed by NASA Procedural Directive (NPD) NPD 7120.4, NASA Engineering and Program/Project Management Policy and NPD 8700.1, NASA Policy for Safety and Mission Success and the following NASA Procedural Requirements (NPR):

- NPR 7120.5, NASA Space Flight Program and Project Management Requirements
- NPR 7123.1, NASA Systems Engineering Processes and Requirements

- NPR 7150.2, NASA Software Engineering Requirements
- NPR 8000.4, Agency Risk Management Procedural Requirements
- NPR 8715.3, NASA General Safety Program Requirements
- NPR 8715.7, Expendable Launch Vehicle (ELV) Payload Safety Program

2 SOURCES SOUGHT REQUEST

The National Aeronautics and Space Administration (NASA) Glenn Research Center (GRC) is seeking capability statements from all interested parties, including Small, Small Disadvantaged (SDB), 8(a), Woman-owned (WOSB), Economically Disadvantaged Woman Owned Small Business (ED-WOSB), Veteran Owned (VOSB), Service Disabled Veteran Owned (SD-VOSB), SBA certified Historically Underutilized Business Zone (HUB Zone) businesses, and Historically Black Colleges and Universities (HBCU)/Minority Institutions (MI) for the purposes of determining the appropriate level of competition and/or small business subcontracting goals for TDM CPST Project. The Government reserves the right to consider a Small, 8(a), Woman-owned (WOSB) or Economically Disadvantaged Woman Owned Small Business (ED-WOSB), Service Disabled Veteran (SD-VOSB), or SBA Certified HUB Zone business set-aside based on responses hereto.

The North American Industry Classification System (NAICS) code for the TDM CPST Project 541712, Research and Development in the Physical, Engineering, and Life Sciences (except Biotechnology with a size standard of 1000 employees).

Estimated award amount for the TDM CPST Project is $150M over 5.5 years. The estimated award date for the TDM CPST Project is spring 2014.

No solicitation exists; therefore, do not request a copy of the solicitation. If a solicitation is released it will be synopsized in FedBizOpps and on the NASA Acquisition Internet Service. It is the potential Offeror's responsibility to monitor these sites for the release of any solicitation or synopsis.

Sources Sought responses must include the following: name and address of firm, DUNS number, size of business; average annual revenue for past 3 years and number of employees; ownership; whether they are large, small, small disadvantaged, 8(a), Woman-owned or Economically Disadvantaged Woman Owned, Veteran Owned, Service Disabled Veteran Owned, SBA certified Historically Underutilized Business Zone and Historically Black Colleges and Universities)/Minority Institutions; number of years in business; affiliate information: parent company, joint venture partners, potential teaming partners, prime contractor (if potential sub) or subcontractors (if potential prime); list of customers covering the past five years (highlight relevant work performed, contract numbers, contract type, dollar value of each procurement; and point of contact - address and phone number). Please provide an estimate of the percentage of work to be performed by the prime contractor and for each major subcontractor.

In addition, large business concerns are requested to provide small business subcontracting goal recommendations for the following small business categories based on the contractor responsibilities set forth in Attachment 1 "Mission Synopsis with Contractor Performance Statements."

Small Business (SB)
Small Disadvantaged Business (SDB)
Women-Owned Small Business (WOSB)
HUBZone Small Business (HUBZone SB)
Veteran-Owned Small Business (VOSB)
Service-Disabled Veteran-Owned Small Business (SDVOSB)
Historically Black Colleges and Universities/Minority Institutions (HBCU/MI)

Lastly, responses to this sources sought must include a recommendation for the pricing structure (contract type) for the TDM CPST Project contract. Also, include your rationale for the recommended pricing structure.

3 FORMATTING INSTRUCTIONS FOR SUBMITTAL

Interested concerns shall submit their response in a single volume as specified, below.

Vol. I	Section 1. Business Information	Original plus 1 electronic copy

Plastic Bindings <u>ONLY</u> are requested for the submitted paper information. Paper copies are requested to be **tabbed** and separated into distinct outline sections. **The electronic copy** should be submitted on a standard 700 MB CD (Compact Disk) format. Acceptable file types are Microsoft Office Word 2007 and Microsoft Office Excel 2007. For pictures, the Government prefers encapsulated Postscript (.eps) or embedded (copying and pasting any format of graphic into a document) MS Word 7.0 pictures. The following formats for pictures, drawings, figures, etc., are also acceptable: .cgm, .jpg, .wmf, .mpp, .dxf, or .bmp.

Submittals shall be sent to: Timothy C. Pierce, 21000 Brookpark Road, MS 60-1, Cleveland, Ohio 44135

Questions regarding this SSN should be directed to: Timothy.C.Pierce@nasa.gov

This SSN is for information and planning purposes and is not to be construed as a commitment by the Government nor will the Government pay for information solicited. Respondents will not be notified of the results of the evaluation of the responses to this SSN.

ATTACHMENT 1 MISSION SYNOPSIS WITH CONTRACTOR PERFORMANCE STATEMENTS

Mission Synopsis

This mission synopsis describes the notional objectives and architecture of the TDM CPST Project, along with a summary of the Contractor responsibilities.

As part of U.S. National Space Policy, NASA is leading the Nation on a course of discovery and innovation that will provide the technologies, capabilities and infrastructure required for sustainable, affordable human, as well as robotic, presence in space. More specifically, this entails that NASA develop technology that will enable humans to safely reach multiple potential destinations, including the Moon, small bodies such as asteroids and comets, Mars, as well as Lagrange points, and other environs associated with these destinations.

As part of this overall technology development plan, NASA is contemplating a mission to conduct an in-space cryogenic propellant storage and transfer demonstration. The need for the TDM CPST Project is directly related to the 2011 NASA Strategic Plan, Strategic Goal 3: "Create the innovative new space technologies for our exploration, science, and economic future" and Sub-goals 3.2, 3.3, and 3.4:

- Sub-goal 3.2: Infuse game-changing and crosscutting technologies throughout the Nation's space enterprise to transform the Nation's space mission capabilities.
- Sub –goal 3.3: Develop and demonstrate the critical technologies that will make NASA's exploration, science, and discovery missions more affordable and more capable.
- Sub-goal 3.4: Facilitate the transfer of NASA technology and engage in partnerships with other government agencies, industry, and international entities to generate U.S. commercial activity and other public benefits.

Based on the agency level goals and input from the project stakeholders the TDM CPST project Need Statement is to reduce the development cost and risk associated with the cryogenic propellant systems on future, extended-duration, in-space missions. NASA's long-term goal for the CPST TDM is to have it lead to a well-established industrial capability ready and available to develop cryogenic fluid management systems for future human and robotic exploration missions beyond LEO. The TDM CPST will help NASA understand risks involved in the development of expertise, manufacturability, establishment of processes, and scalability to much larger exploration systems.

The goals of the TDM CPST Project are to:

- Demonstrate, in an relevant environment, the performance of integrated cryogenic propellant storage and transfer systems that incorporate technologies and techniques that are anticipated to be needed for future, extended-duration, in-space missions

- Develop ability to design effective Cryogenic Fluid Management (CFM) systems and predict their performance for extended-duration, in-space missions.

Mission Requirements

Draft Program Level requirements for the TDM CPST Project are:

CPST-PROG-1 Demonstration of Propellant Storage
Thermal conditioning of cryogenic propellants in microgravity in a manner extensible to long-duration storage in full-scale space systems shall be demonstrated.

CPST-PROG-2 Demonstration of Propellant Transfer
Delivery of bubble-free cryogenic propellants in a manner extensible to full-scale space systems via transfer in microgravity without prior settling shall be demonstrated.

CPST-PROG-3 Critical Scaling Data for Liquid Oxygen
Performance data necessary to address all critical scaling issues related to long-duration storage of liquid oxygen in microgravity with zero boil-off shall be obtained.

CPST-PROG-4 Critical Scaling Data for Liquid Hydrogen
Performance data necessary to address all critical scaling issues related to long-duration storage of liquid hydrogen in microgravity with an average boil-off rate of less than 0.05% (TBR) per day shall be obtained.

CPST-PROG-5 Development of Performance Models
Performance models suitable for designing full-scale space systems that store cryogenic propellants for long durations shall be developed.

To meet these requirements, NASA plans to develop and conduct this TDM CPST over the next five years. The TDM CPST challenge is to mature enabling technologies that can be extensible for long duration missions beyond LEO, while also remaining cost balanced. The TDM CPST plans to accomplish these goals through the development, launch and operation of a free flying satellite in Low Earth Orbit (LEO) that will demonstrate and mature CFM technologies. This in-space flight mission will be combined with ground testing and computer modeling in order to meet the needs and goals of NASA.

The specific capabilities being sought for the TDM CPST would include, but are not limited to systems to provide zero boil-off storage of liquid oxygen and reduced boil-off storage of liquid hydrogen, zero-g mass gauging of cryogenic fluids, and methods to transfer cryogenic fluids in microgravity. The approaches selected for performing these functions will be ones that have scalability and extensibility to future space exploration applications such as cryogenic propulsion stages. The mission duration is envisioned to be three to six months, which is based upon the time needed to complete Spacecraft checkout, demonstrate active and passive storage, and conduct transfer cycles under both unsettled and settled cryogenic liquid conditions. After the mission is complete, the collected data will be analyzed, and a final mission report released.

The cryogenic liquid to be used in the CPST Spacecraft is liquid hydrogen (LH2). The CPST Spacecraft will be launched to low earth orbit at an altitude between 400 – 600 kilometers and an inclination based on the launch site. A substantial amount of data will be collected during the mission to determine the state of the LH2 in the storage and transfer tanks. Instrumentation will collect temperature, pressure, and flow data at various phases of the mission including ascent,

orbit, LH2 transfer, and decommissioning. Data will be downlinked to ground stations as required based on the amount of data collected. A short period at the beginning of the mission will be used to initiate the CPST Spacecraft startup and determine vehicle status. During this time, it is anticipated that storage data will be collected, so systems will need to be operational to maintain the desired storage conditions. Once the CPST Spacecraft start has been confirmed, an additional storage period will be maintained and data gathered. The duration of the initial storage period is dependent on overall mission objectives. Several transfer operations will be conducted during the mission, and will be a function of the quantity of LH2 available. NASA will most likely require a minimum of two transfers in an unsettled condition at two different fill levels in the storage tank.

To implement the TDM CPST, the Government/Contractor team is expected to design, develop, integrate, test, launch, and operate a small-scale demonstration mission within the defined timeframe and budgetary constraints that will perform extended duration storage and transfer of cryogenic propellant to produce data that can be used for designing a large, long-duration space vehicle.

The TDM CPST Mission Requirements Document will define all mission requirements to satisfy the needs of NASA. This will include requirements for active and passive LH2 storage, settled and unsettled LH2 transfers, data collection, thermal and pressure control, etc. The mission requirements address the needs, goals and objectives of the TDM CPST, as they have been determined through the Stakeholder Expectations and the Program Level Requirements.

The Mission Requirements Document that will be provided as part of the subsequent RFP will encompass the top level requirements for the success of the mission and meeting the technology requirements. The mission requirements will be verified through a combination of ground demonstration activities, the fight demonstration, and analysis from predictive performance models. The decomposition of the mission requirements as they apply to the flight demonstration will be documented in the TDM CPST Flight Demonstration System Requirements Document which will also be provided along with other supporting material as part of a subsequent RFP. The requirements will be written so as to allow the contractor to identify their requirements within this government/contractor team. Enveloping environments and interface requirements will be also provided for the Contractor at time of the RFP for the Contractor to design to those conditions.

TDM CPST Project Notional Mission Architecture

The notional mission architecture consists of the TDM CPST Spacecraft, the NASA-provided launch vehicle, the Mission Operations Center (MOC), the Technology Operations Center(s) (TOC), and the necessary communications assets (ground and space based). The MOC performs the spacecraft command, control and data acquisition including dissemination of the technology data to the TOC(s). The TOC(s) are the remote sites at which the investigation team will receive the CFM technology data.

Contractor Performance Statements

For the flight mission part of the TDM CPST, the Government will have the responsibility of developing and delivering a certified cryogenic fluid system (CFS) payload for spacecraft integration to the Contractor. The Contractor will have the responsibility of the balance of the flight mission including spacecraft bus design and development, spacecraft integration and test, integration of the spacecraft with the launch vehicle (the launch vehicle will be provided under separate Government contract), selection of ground stations, design and operation of the MOC, distribution of the data from the MOC to the TOC(s), and spacecraft decommissioning at end of mission. A graphical representation of the major elements of the CPST spacecraft is shown in Figure 2.

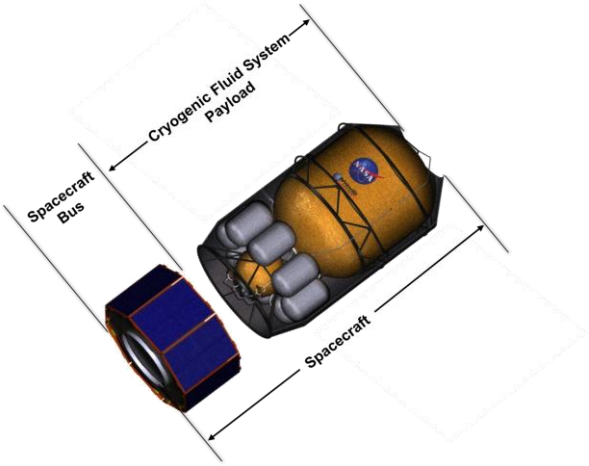

Figure 2: CPST Spacecraft Major Elements (Notional Configuration)

The work to be performed by the selected Contractor for the TDM CPST Project will include Project Management, Systems Engineering, Safety and Mission Assurance, Spacecraft Bus design and development, Mission Operations, Launch Vehicle Integration , Ground Systems, and Integration and Test of the Spacecraft. The Government will develop and deliver the Payload to the Contractor for further integration. Each area is described in further detail below:

Project Management

The Contractor Project Management (PM) team will provide overall guidance, leadership and direction to the Contractor project team to achieve the project's technical, cost, and schedule performance requirements. Specifically PM establishes the project's organization, team roles and responsibilities, and develops the Contractor Project Plan. The PM office performs business administration, configuration and data management, risk management, integrated schedule management, earned value management, information technology management and security, and export control. The Contractor PM team will be responsible for planning, coordinating, and conducting the milestone reviews with the Government.

Systems Engineering

The Contractor's Systems Engineering will be responsible for the flight mission systems design meeting the mission requirements and to plan and execute the requirements verification. An integrated systems engineering approach will be defined for completing the project, with consideration given for the contractor integration of the government provided payload into the overall system design, which includes the spacecraft bus and the launch vehicle. The contractor will be responsible for interface management across all elements of the flight system, with management of the interfaces between government and contractor elements being a joint NASA/contractor effort. The Contractor will perform all integrated systems design and analyses required to develop the flight mission. A Systems Engineering Management Plan (SEMP) will be developed by the contractor to describe how the technical objectives of the project will be met, what trades will be required as part of the project, and what alternatives will be considered. The Contractor SEMP will describe the Contractor interactions with the Government including the Government Payload team. Additional plans will be developed for various aspects of the project including reviews, testing, integration, verification and others as required.

Safety and Mission Assurance (SMA)

The developer will comply with the requirements for a Class C or D mission as defined in NPR 8705.4 "Risk Classification for NASA Payloads". The developer shall develop and implement a system safety, reliability, hardware quality, and software safety program to ensure all risks have been identified, controlled and mitigated to an acceptable level. The supplier shall have a Quality Management System that includes closed-loop problem reporting and corrective action, configuration management, GIDEP failure experience data, and NASA Advisory process. Software assurance includes formal project software assurance insight.

The supplier shall implement a system safety program that is compliant with NPR 8715.3 "NASA General Safety Program Requirements" and NPR 8715.7 Expendable Launch Vehicle (ELV) Payload Safety Program, and assure compliance with launch service provider requirements and launch range safety requirements. Reliability analyses are based on applicable safety requirements and should consider use or nonuse of redundancy, requirements for burn-in of parts, and requirements for total operating time without failure prior to flight.

The supplier shall comply with EEE-INST-002 "Instruction for EEE Parts Selection, Screening, Qualification, and Derating" for Level 3 parts.

Materials are assessed for application and life limits. Requirements are primarily based on NASA-STD-6016 and applicable safety standards.

Radiation effects assessments will be performed.

Contamination engineers will establish contamination allowances, methods for controlling contamination, and record test results.

NASA reviews are conducted in which the contractor is expected to participate.

Cryogenic Fluid System (CFS) Payload

The Government shall provide a CFS payload design, accompanying analyses, manufacturing program, and verification program at the times of the overall system level Preliminary Design Review (PDR) and Critical Design Review (CDR). The CFS Payload PDR and CDR products will be provided to the Contractor for use in the Spacecraft and Spacecraft Bus design activities and reviews. These products shall have incorporated the specific requirements of storage for the mission duration, desired mass gauging demonstrations, and fluid transfer capabilities as specified in the technical requirements, and of sufficient robustness consistent with the natural environments and proposed launch vehicle-specific induced environments. The CFS Payload design shall also be shown to be compatible with Ground Systems and/or Launch Vehicle cryogenic fluid loading capabilities and Range restrictions. The approach for the development of needed hardware items and then the readiness of these items to support the selected design for flight system implementation shall also be provided at the PDR and CDR, respectively, and include development test results, or equivalent, as appropriate to validate this readiness.

Upon successful closure of the system-level CDR, the Government shall transition to qualification and flight hardware procurement, fabrication, assembly, and check-out of the payload components and also responsible for the integration and verification testing of the Payload as a subsystem. Upon completion of the payload check-out, the Payload will be delivered to the Contractor. The Contractor shall be responsible for the integration of the overall Spacecraft design/hardware which includes provisions for Command and Data Handling (C&DH), power, attitude control, and de-orbit capabilities. It is also anticipated that during the development of the Payload that the Contractor remain cognizant of the design progress and identify any issues that may impact their efforts downstream.

Spacecraft Bus

The Spacecraft Bus (SC-Bus) supports the CFS Payload (PL). The SC-Bus developer will work with the PL developer to define the requirements that the PL places on SC-Bus and to define the interface (I/F) between the PL and the SC-Bus. The SC-Bus developer will also work with the Launch Vehicle (LV) Services provider to define the I/F between the Spacecraft and the LV and the constraints that the LV places on the SC-Bus. In addition, the SC-Bus developer will work with SE&I and SMA to make insure that the Spacecraft meets the overall CPST mission requirements. Finally, the SC-Bus developer will work with Mission Operations (MO) to insure communications compatibility, and that requirements for up-link and down-link data volumes and latency are met. Where issues are encountered, the SC-Bus developer will continue work with all of the above organizations until all issues are resolved. After determining requirements and interfaces, and resolving issues as required, the SC-Bus developer will design, develop, integrate and test the SC-Bus. Then the SC-Bus developer will turn the SC-Bus over to Contractor's Systems Integration and Testing (I&T) group to perform the I&T work required to join the PL to the SC-Bus and insure their correct operation as the integrated CPST Spacecraft. The SC-Bus developer will continue to support the CPST project during the phases of Spacecraft I&T, Launch Site I&T, and flight operations to monitor performance of the SC-Bus and to work to resolve any issues associated with the SC-Bus.

Mission Operations

The Contractor will be responsible for the TDM CPST Project missions operations. The requirements will include, but are not limited to: Mission Operations Center (MOC) interface design and verification, launch and flight operations planning, development and implementation of operations training, transfer of mission data, coordination of payload/spacecraft commanding, off nominal payload operations planning and implementation, and spacecraft decommissioning. The Mission Integration Contractor shall provide a MOC, whose function is to provide command, control and monitoring of the CPST Spacecraft operations including data acquisition and dissemination to the Technology Operations Center (TOC) for the duration of the CPST mission. The TOCs design and operations will be the responsibility of the Government. The Contractor will be responsible for providing the interface from the MOC to the TOC that meet the requirements of the Government.

Launch Vehicle Services

The Government will procure the Launch Vehicle Service; however, if the Contractor has the ability to procure a vehicle commercially then the Government would consider that option. It is anticipated this launch service will encompass processing of the spacecraft at the launch site, launch vehicle and CPST Spacecraft integration, mission unique modifications to the launch vehicle and launch operations. It may include modifications to the launch site facilities to provide for cryogenic loading of the CPST Spacecraft and other modifications to the ground infrastructure required to accommodate the use of cryogenic fluids aboard the CPST Spacecraft. The Mission Integration Contractor shall be responsible for identifying spacecraft unique requirements and supporting all launch vehicle /spacecraft integration activities.

Ground Systems

Unique ground systems for the TDM CPST Project may include the cryogenic loading system, hazardous gas monitoring systems for the CPST Spacecraft once it is encapsulated in the payload fairing and payload conditioning system modifications. The Contractor shall be responsible for defining the requirements for the unique ground systems required and developing or procuring them. The only exception is that the cryogenic loading system will either be supplied by the Government or the Launch Vehicle contractor and will not be the responsibility of the Mission Integration Contractor.

Systems Integration and Test

The contractor would be responsible for the integration across all elements of the flight system. They will also have the responsibility to plan and perform all component and subsystem testing on the flight system elements under their responsibility and for the planning and execution of the system testing required to verify and qualify the full flight system for flight, including support to the Launch Service provider during the environmental test campaign and launch preparation activities.

Government Furnished Equipment (GFE)

The Government has unique ground support equipment that can be made available to the Contractor. Examples include the TDRS Communication Van for ground testing and also T-0 quick disconnects. Any proposed usage of government-owned equipment would need to be pre-coordinated with the Government by the Contractor and submitted with their proposal as a separately priced task agreement.

Government Facilities, Capabilities, and Unique Manufacturing Capabilities

Contractors can consider use of unique Government Facilities for environmental testing, and missions operations. Additionally the Government can provide the Contractor access to some of NASA's unique capabilities for cryogenic fluid servicing and satellite tracking during the Spacecraft decommissioning event. Any proposed usage of government-owned facilities or capabilities would need to be pre-coordinated with the Government by the Contractor and submitted with their proposal as a separately priced task agreement.

ATTACHMENT 2: ACRONYM LIST

SNN Acronym List	
ASM	Acquisition Strategy Meeting
ATP	Authority to Proceed
C&DH	Command & Data Handling
CDR	Critical Design Review
CFM	Cryogenic Fluid Management
CFS	Cryogenic Fluid System
CPST	Cryogenic Propellant Storage and Transfer
ELV	Expendable Launch Vehicle
GFE	Government Furnished Equipment
GRC	John H. Glenn Research Center
I/F	Interface
I&T	Integration and Test
LEO	Low Earth Orbit
LH2	Liquid Hydrogen
MCR	Mission Concept Review
MDR	Mission Definition Review
MO	Mission Operations
MOC	Mission Operations Center
NASA	National Aeronautics and Space Administration
NPD	NASA Procedural Directive
NPR	NASA Procedural Requirements
OCT	Office of Chief Technologist
PL	Payload
PM	Project Management
PDR	Preliminary Design Review
RFP	Request for Proposal
SAR	System Acceptance Review
S/C	Spacecraft
SC-Bus	Spacecraft Bus
SE&I	Systems Engineering & Integration
SEMP	Systems Engineering Management Plan
SMA	Safety & Mission Assurance
SSN	Sources Sought Notification

SNN Acronym List	
STP	Space Technology Program
TDM	Technology Demonstration Mission
TDRS	Tracking Data Relay Satellite
TOC	Technology Operations Center
TRR	Test Readiness Review