CSA-SMSAT-SOW-0009

Canadian Space Agency

ANNEX A
Technical Support Services for the Demonstration of the Feasibility of the Canadian Atmospheric Tomography System (CATS) Microsatellite Mission

Statement of Work (SOW)

Date: October 20, 2013

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Canadian Space Agency | Agence Spatiale Canadienne

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1 INTRODUCTION

1.1 BACKGROUND

Over the last five years, the Canadian Space Agency (CSA), together with other Federal Departments, has been studying various concepts of missions that could meet the needs and priorities of the Government of Canada using space assets. Amongst those concepts of missions, some are using a microsatellite platform (microsatellite class of satellites).

The Canadian Atmospheric Tomography System (CATS) mission has been identified as a candidate microsatellite mission with great potential. Some work to establish the feasibility of that mission has already been conducted in the past. However, the CSA is enlarging the membership of the User and Science Team to other government departments and academia. With a revised User Requirements Document (URD) being written, some of the activities required to demonstrate the feasibility of the mission will need to be updated, and some additional activities might also need to be conducted.

The CSA would like to pursue the work on the demonstration of the feasibility of that mission with the support of a team of expert consultants from industry.

For a description of CSA's definition of the microsatellite class of satellites, please refer to Appendix C of this document.

1.2 PURPOSE

The purpose of this Request for Proposal (RFP) is to solicit bids from interested specialized Canadian organizations to provide to the Canadian Space Agency (CSA) a qualified team of consultants that will conduct professional services (per task authorizations) to support the demonstration of the feasibility of the Canadian Atmospheric Tomography System (CATS) microsatellite mission. The purpose of this Statement of Work (SOW) document is to define the potential tasks that could be performed on request by the CSA (Tasks authorizations) related to the CATS mission.

The various tasks to be performed will be based on detailed users' requirements. These requirements will be identified separately by the Users & Science Team (U&ST). The preliminary findings of the U&ST analyses will be provided by the CSA to the Contractor at the start of the contract in the form of a preliminary Users Requirements Document (URD). The execution of the tasks related to the demonstration of the feasibility of the mission will help finalize the URD.

Typical tasks that could be required for this demonstration of feasibility include the definition of Mission Requirements & Concept of Operations, Mission Conceptual Design, a reference system design, and reference system requirements that will then be used to produce a Mission Development Plan which includes substantive cost, schedule and risk assessment.

The vendor (prime contractor) performing the work shall be hereinafter referred to as the 'Contractor'.

In this document, the Canadian Space Agency is also referred to as ‘CSA’ or the ‘Agency’ and is the Customer. The Contractor will report directly to CSA.

1.3 SCOPE

This Statement of Work (SOW) defines the scope of the potential tasks that CSA could ask from the Bidder in order to complete the demonstration of the feasibility of the Canadian Atmospheric Tomography System (CATS) microsatellite mission. It identifies the potential tasks to be performed by the Contractor during the contract.

1.4 WORK PACKAGES FOR SERVICES

The work will be arranged through Work Packages (WP) in the contract based on Tasks similar to those described in Section 3. Work Packages will be issued by the CSA on an “As and When Requested” basis.

Previous work was performed for this mission. This material will be made available to the Contractor at the start of the Contract to support the feasibility demonstration activities.

In addition, the latest URD will be provided. An assessment of the total amount of work that needs to be performed to complete the demonstration of feasibility will be carried out as part of the first Task Authorization. The follow-on Task Authorizations, together with their duration and budget will be defined accordingly.

2 REFERENCE DOCUMENTS (RD)

The following documents provide additional information or guidelines that either may clarify the contents or are pertinent to the history of this document.

TABLE 2-1: REFERENCE DOCUMENTS

RD No.	Document Number	Document Title	Rev. No.	Date
RD-1.	PMBOK Guide	A Guide to the Project Management Body of Knowledge	4th Ed.	2008
RD-2.	CSA-SE-STD-0001	CSA Systems Engineering Technical Reviews Standard	Rev. A	2008-11-7
RD-3.	CSA-ST-GDL-0001	CSA Technology Readiness Levels and Assessment Guidelines	I.R.	January 2009
RD-4.	ANSI/AIAA G-043	Guide for the Preparation of Operational Concept Documents		1992

3 AREAS OF SUPPORT

Typical tasks to be expected during the contract are (but not necessarily limited to) listed below in this section. The selection of specific tasks to be performed and the exact description of each task will be defined in the actual Task Authorizations to be issued, as described in Section 1.4.

3.1 REVIEW OF EXISTING DOCUMENTATION AND ASSESSMENT OF LEVEL OF EFFORT

This task consists of reviewing existing documentation that resulted from previous work performed on the CATS mission. This material will be made available by the CSA to the Contractor. An assessment of the level of effort (cost and schedule) to complete the demonstration of feasibility, will need to be performed.

3.2 USER REQUIREMENTS

This task consists of reviewing and commenting on the User Requirements Document (DID-0200, Appendix A) from which the mission requirements will be derived. This document will be provided and maintained by the CSA in collaboration with the U&ST.

3.3 MISSION REQUIREMENTS

This task consists of developing the mission requirements (DID-0201, Appendix A) to respond to the user requirements. The mission requirements are to be provided in the form of a list, with each requirement in the list being traced to a user requirement or justified with respect to mission constraints, CSA objectives, regulations, etc.

3.4 MISSION CONCEPTUAL DESIGN

This task consists of elaborating the different elements to describe a mission concept that will serve to meet the mission requirements, and of developing a Mission Conceptual Design accordingly (DID-0202, Appendix A).

3.5 MISSION ANALYSIS

This task consists of defining and characterizing alternative mission concepts and architectures and identifying key mission requirements. This task also includes the alternative payload scheduling strategies to meet the mission requirements.

3.6 MISSION PLANNING AND DEVELOPMENT

The Mission Planning and Development task (DID-0203, Appendix A) includes:

- identification of the mission cost;

- identification of the mission schedule;
- identification of the technology development required to bring the technology readiness to the appropriate level at the appropriate time;
- identification of the development and manufacturing approach;
- provision of a mission risk assessment;
- identification of potential collaborations;
- provision of a Canadian capabilities development strategy; and
- provision of a commercialisation plan.

3.7 SYSTEM DESIGN

This task consists of developing a reference system design (DID-0401, Appendix A). This reference system design includes an overall system description and architecture, including the space segment (i.e. spacecraft subsystems including the payload), the ground segment and the launch segment. This reference system design also includes trade-off studies performed using the identified system drivers. System drivers are those mission parameters which greatly influence performance, cost, schedule and risk and which can be controlled. (e.g. attitude accuracy, revisit-time, coverage, aperture, resolution etc.).

3.8 SYSTEM REQUIREMENTS

This task consists of developing a set of reference system requirements (DID-0402, Appendix A) in response to the mission requirements. The reference system requirements are to be provided in the form of a list. Each reference system requirement indicates one or more of its parent requirements.

3.9 PRODUCT ASSURANCE REQUIREMENTS

This task consists of reviewing or developing the product assurance requirements (DID-0403, Appendix A) for all aspects of the mission.

3.10 GENERAL DESIGN AND INTERFACE REQUIREMENTS

This task consists of reviewing or developing the general design and interface requirements (DID-0404, Appendix A) applicable to the space segment.

3.11 ENVIRONMENTAL REQUIREMENTS AND TEST SPECIFICATION

This task consists of reviewing or developing the environmental requirements and test specification
(DID-0405, Appendix A) applicable to the space segment.

3.12 PAYLOAD, BUS AND GROUND SEGMENT SPECIFICATIONS

This task consists of developing reference payload, bus, and ground segment specifications (DID-0407, DID-0408, DID-0409 of Appendix A).

3.13 OTHERS

DID-0001, DID-0002, DID-0003, DID-0004, DID-0005, DID-0006, DID-0007 and other DIDs listed in Appendix A which are not mentioned in the previous sub-sections, may be called upon during the execution of specific Work Packages.

4 REQUIREMENTS

The Contractor must provide experienced professionals in Space Mission Analysis and Design, in Spacecraft Payload Design, in Spacecraft Bus Design, in the scientific and technical aspects specific to the CATS mission, in Space Mission Planning and Development and in project management.

Appendix B provides background information on the Canadian Atmospheric Tomography System (CATS) microsatellite mission to help the Bidder in assessing the scientific and technical aspects specific to the mission.

The Contractor must provide a team that has the knowledge and experience to perform the described work. This team (which includes sub-contractors and partners) must consist of a maximum of ten (10) persons, of which at least one person needs to be employed by the Bidder itself. During contract execution, replacement of any personnel in this team must be approved by the CSA. Any replacement personnel will be evaluated in a similar manner as the original team during the bids evaluation process.

5 DELIVERABLES

The specific statement of work and deliverables to be provided will be specified in each individual Work Package authorization issued to the Contractor. All documentation must be electronically provided in MS Word™ format unless stated otherwise. All software source code and supporting configuration files and data for specific analyses or simulations must be electronically provided along with the identification of the software version used.

6 SCHEDULE

The duration of the Contract is defined in the Request for Proposal. The schedule of each Work Package will be defined in its Work Package Authorization coming from the CSA.

7 LEVEL OF EFFORT

The level of effort for tasks as part of this work will depend on the scope of each individual Work Package.

8 MISCELLANEOUS

8.1 DOCUMENT TRANSMITTAL

Electronic documents must be prepared using the most appropriate tool (Microsoft Word, Excel, MS Project, etc.); released versions must be delivered in electronic format in both native format and pdf format. Schedules must be submitted in Microsoft Project format.

Documents and other data must be delivered via e-mail or direct transfer (FTP). For direct transfer, a notification of the document or data readiness and location on a contractor repository must be sent. In certain occasions, when specified in the Work Package, paper copies may be required.

Electronic documents or notifications of their availability on contractor repositories must be sent to the e-mail address of the CSA Project Manager.

Emails are to contain the project/program acronym or equivalent identifier in the "Subject" line and include the CDRL identifier under which deliverable documents are being submitted. Hard copy and media deliverables are to be addressed to:

Attention:
Canadian Space Agency
6767, Route de l'Aéroport
Longueuil, QC, J3Y 8Y9
Canada

At the end of each Work Package, all data, electronic files and documentation created by, or provided to the Contractor for the performance of the Work Package must be returned to CSA.

8.2 DOCUMENT FORMAT

All documentation must be written in English.

Documentation can be prepared in the Contractor’s format; however, it should contain the information as presented in the DIDs described in Appendix A.

8.3 ON-SITE SUPPORT

In general, the tasks will not require an on-site support, in CSA offices in St-Hubert. Most meetings will take place via teleconferences. Exceptionally, one-day meetings (estimated between 3 and 5 during the course of the contract) will be held at CSA St-Hubert facility.

8.4 FACILITIES

The Contractor will normally work at their offices. The Contractor must have full computing autonomy in working on-site and off-site (i.e. portable computers and ability to connect to the CSA computer system via modem/internet). It is also the responsibility of the Contractor to have the proper licensed software tools to complete the requested tasks. Refer to Section 3 and Appendix A for the identification of typical tasks that may be requested.

8.5 LANGUAGE

Proposed personnel must be able to communicate (spoken and written) either in English or French language.

9 INTELLECTUAL PROPERTY

All documents prepared by the Contractor and its related intellectual property must remain the property of the CSA.

The Contractor must sign a Non-Disclosure Agreement at contract signature.

10 GOVERNMENT FURNISHED EQUIPMENT AND INFORMATION

No government furnished equipment is expected to be deliverable under this contract. If applicable, any government furnished information must be returned to the Crown at the conclusion of each Work Package.

APPENDICES

A DATA ITEMS DESCRIPTIONS (DIDS)

DID-0000 - General Preparation Instructions

PURPOSE:

This DID describes the standard format for the preparation of deliverable project documentation.

PREPARATION INSTRUCTIONS:

1. GENERAL INSTRUCTIONS

1.1. Electronic Copies

The electronic file name and the identification number written on the document itself must have the following format:

WXYZ-CDRL-NUM-CIE_ContractNumber_sent2007-03-30

where:

WXYZ:	A 4 letter acronym of the project
CDRL-NUM:	The CDRL Identifier
CIE:	Name of the Company (no space, no hyphen)
Contract Number:	For example: _9F028-07-4200-03
_sent YEAR-MONTH-DAY:	Date Tracking Number

When DVD-ROM disks are used to transmit information, the label must present the following information:

a) Company Name
b) Document Title
c) Document Number and Revision Status
d) CDRL Number
e) Contract Number

1.2. Electronic Documents Format

Electronic copies of text documents must be formatted for printing on 8.5" x 11" paper.

Page Numbering
General format of documents should include page numbers and be formatted according to the Contractor's normal standard. If the document is divided into volumes, each such volume must restart the page numbering sequence.

Document Numbers
All pages must contain the Document Number at the top of the page. Document Numbers must include revision status and volume identification as applicable.

2. DOCUMENT STRUCTURE AND CONTENT

2.1. Overall

Except as otherwise specified, all documents must have the overall structure as follows:

a) Cover/Title Page;
b) Table of Contents;
c) Scope;
d) Applicable and Reference Documents;
e) Body of Document; and
f) Appendices.

2.2. Cover/Title Page

The title page must contain the following information:

- Document Number and date: Volume x of y (if multivolume)
- Rev. indicator / date of Rev.
- Document Title
- Project Name
- Contract No.
- CDRL Item No. or Nos., if one document responds to more than one CDRL, subject to prior approval from the CSA Project Manager.
- Prepared for: Canadian Space Agency
- Prepared by: Contractor name, CAGE Code, address, and phone number
- Product tree identifier, if applicable
- © HER MAJESTY THE QUEEN IN RIGHT OF CANADA [YEAR]

2.3. Table of Contents

The table of contents must list the title and page number of each titled paragraph and subparagraph, at least down to the third level inclusive. The table of contents must then list the title and page number of each figure, table, and appendix, in that order.

2.4. Scope

This section must be identified as section 1 and must, as a minimum, provide the following information:

a) Identification (number, title) of the system, hardware, or software to which the document applies;
b) A brief overview of the system to which the document applies; and
c) A summary of the purpose and content of the document.

2.5. Applicable and Reference Documents

This section must list by Document Number and title, all applicable and reference documents. This section must also identify the source of all applicable and reference documents and the revision indicator.

2.6. Body of Document

The body of the document must be prepared in accordance with the content and format requirements defined in the specific Data Item Description or the Work Package description.

2.7. Appendices

Appendices may be used to provide information published separately for convenience of document maintenance. All assumptions and constraints must be clearly summarized as a list in the appendix.

3. DOCUMENT REVISIONS

Changes in revised documents must be identified by a sidebar.

DID-0001 – CWBS and Work Package Descriptions

PURPOSE:

The Contractor Work Breakdown Structure (CWBS) is used during planning for estimating resources and scheduling the work. During the implementation phase, it is used for reporting and controlling costs and schedule.

CONTENT:

The Work Breakdown Structure (WBS) describes all the elements of a project or activity, that organise and define the total scope of the project, and is deliverable-oriented.

The WBS Dictionary is made up of Work Package Descriptions (WPDs) for every element to the lowest level of the WBS. Each WPD includes, as a minimum:

a) A unique identifier traceable to the WBS;

b) A title;

c) The name of the individual responsible for completion of the work;

d) The scope of the work package;

e) The start date and duration;

f) Required inputs and dependencies;

g) A description of every activity covered by the WPD including the level of effort and earned value measurement method for each activity, and all non-labour costs;

h) Assumptions; and

i) Output and work package acceptance criteria.

DID-0002 – Project Schedule

PURPOSE:

Provide a timeline of the actions required to complete a project or an activity.

CONTENT:

The project schedule is based on the WBS, in the form of a Gantt chart. The schedule is detailed enough to show each WBS task to be performed, and provides the following information:

1) dependencies,
2) resource requirements,
3) the start and end date of each task,
4) task duration,
5) deadlines and milestones; and
6) critical path.

The schedule shows dependencies between the Contractor and other organizations.

The tasks related to deliverables are limited to two months in the schedule. When applicable, longer tasks should be divided into smaller significant tasks.

Tasks that are not related to any specific deliverable, such as Project Management activities, are grouped separately from deliverables activities, and are shown at the top of the chart. The schedule should be provided in MS Project native format.

DID-0003 – Progress Report

PURPOSE:

The Progress Report records the status of the work in progress during the previous calendar period. The Progress Report is used by the Government to assess the Contractor's progress in performance of the work.

CONTENT:

The progress report addresses the following:

1) a brief summary of the work performed in the current period;
2) a table of all milestones with actual and expected completion dates;
3) a table of all deliverables with the current percentage completion and the actual and expected completion dates;
4) a brief summary of the work planned for the following period;
5) a short narrative description of any tasks that are behind schedule, the impact on the overall program schedule, and the solutions that are planned to achieve the overall program schedule;
6) a list of all problems and the proposed corrective action;
7) a table showing the current financial status;
8) significant changes to the project organisation; and
9) any other items that the Contractor wants to bring to the attention of the CSA.

The report must be concise and should not exceed 3 pages.

DID-0004 – Meeting Agenda

PURPOSE:

Identify the purpose, content and timings of a meeting.

CONTENT:

The meeting agenda contains the following information, as a minimum.

1. DOCUMENT HEADER:

a) Title;
b) Type of meeting;
c) Project title, project number, and contract number;
d) Date, time, and place;
e) Chairperson; and
f) Expected duration.

2. DOCUMENT BODY:

a) Introduction;
b) Opening Remarks: CSA;
c) Opening Remarks: Contractor;
d) Review of previous minutes and all open action items;
e) Project technical issues;
f) Project management issues;
g) Other topics;
h) Review of any action items as a result of the current meeting; and
i) Set or confirm dates of future meetings.

DID-0005 – Minutes of Meetings

PURPOSE:

The minutes of reviews or meetings provide a record of decisions and agreements reached during reviews/meetings.

CONTENT:

Minutes of meeting are prepared for each formal review or meeting and include the following information, as a minimum:

1) Title page containing the following:
    a) Title, type of meeting and date,
    b) Project title, project number, and contract number,
    c) Space for signatures of the designated representatives of the Contractor, the CSA and the Public Works and Government Services Canada (PWGSC), and
    d) Name and address of the Contractor;
2) Purpose and objective of the meeting;
3) Location;
4) Agenda;
5) Summary of the discussions, assumptions, decisions and agreements reached;
6) List of the attendees by name, position, phone numbers and e-mail addresses as appropriate;
7) Listing of open action items and responsibility for each action to be implemented as a result of the review;
8) Other data and information as mutually agreed; and
9) The minutes must include the following statement:

    "All parties involved in contractual obligations concerning the project acknowledge that minutes of a review/meeting do not modify, subtract from, or add to the obligations of the parties, as defined in the contract."

The list of action items must include the following information:

1) the action item number;
2) a description of the action required;
3) the date the action item was opened;
4) the person responsible for ensuring that the action is carried out;
5) the due date for the action;
6) the status of the action (open or closed); and

7) any comments or remarks relevant to the action.

Once an action item is closed, the action item list should also indicate the date the action was complete.

DID-0006 – Action Items Log

PURPOSE:

The Action Item Log (AIL) lists, in chronological order, all items on which some action is required, allows tracking of the action, and in the end provides a permanent record of those Action Items (AI).

CONTENT:

The AIL is in a tabular form, with the following column headings in this order:

1) Item Number;
2) Status color (red, yellow, green);
3) Item Title;
4) Open Date;
5) Source of AI (e.g., MCR meeting, RID, etc.);
6) Originator;
7) Office of Prime Interest;
8) Person responsible (for taking action);
9) Target Date/Actual Date of Resolution;
10) Status (Open or Closed);
11) Remarks; and
12) Chart of graphical representation of open, closed, and total action items.

The date in column 9 will be the target date as long as the item is open, and the actual date once the item is closed.

DID-0007 – Review Data Packages

PURPOSE:

The Review Data Package is a collection of all documents to be presented by the Contractor for a specific Technical Review (MCR, MRR, SRR).

CONTENT:

Each Review Data Package contains the documents identified in the Work Package, plus the presentations made at the meeting, the agenda, the minutes, and the AI list.

DID-0200 – User Requirements Document

PURPOSE:

To capture the fundamental objectives of a mission, which can be operational-driven, science-driven or technology-driven.

CONTENT:

The document includes the following:

1) An introduction including the scope, the purpose and a list of assumptions (if any);
2) A list of applicable and reference documents (if any);
3) A discussion of mission needs and justification, providing current status, need for measurement, technology demonstration, etc.
4) A list of mission objectives, stating the fundamental reasons for the mission
5) A list of specific user requirements properly numbered.
6) Core user team description.

DID-0201 – Mission Requirements Document

PURPOSE:

To capture the mission requirements.

CONTENT:

The document includes the following:

1) an introduction including the scope, the purpose and a list of assumptions (if any);
2) a list of applicable and reference documents (if any);
3) a short description of the mission including the mission objectives, the overall requirements of the host spacecraft, the payloads and the ground segment architecture;
4) a list of all mission requirements to respond to known and/or anticipated user requirements including explanatory notes when required;
5) a list of any mission goals that would enhance the mission objectives if implemented including explanatory notes when required;
6) A traceability matrix to identify the correlation between mission requirements and user requirements, and
7) any appendices required to provide detailed information pertinent to the mission requirements that is not suitable to be contained in the main document as explanatory notes.

DID-0202 - Mission Conceptual Design Description

PURPOSE:

To provide an overview of the main elements of the mission.

CONTENT:

The Mission Conceptual Design Description contains the following information:

1) an introduction including the scope, the purpose and a list of assumptions (if any);
2) a list of applicable and reference documents (if any);
3) Definition and characterization of the alternative mission concepts and architectures and the identification of key mission requirements;
4) Mission concept justification: providing a discussion of the main drivers and rationale for the selection of the concept;
5) Mission overview including system decomposition, concept of operation, data distribution;
6) Space segment description including spacecraft, payload, bus, additional elements if applicable;
7) Ground segment description and architecture;
8) Potential launchers;
9) Operations;
10) Key engineering budgets.

DID-0203 – Mission Planning and Development Report

PURPOSE:

Detail the programmatic requirements to implement the mission.

CONTENT:

The report includes the following:

1) an introduction including the scope, the purpose and a list of assumptions (if any);
2) a description of the estimated mission life cycle cost;
3) a description of the estimated mission schedule including all major milestones;
4) a description of the technology development required;
5) a description of the proposed development and manufacturing approach including product assurance and quality control;
6) a description of the preliminary mission risk assessment;
7) a description of potential collaborations;
8) a description of the intellectual property to be generated throughout the whole project;
9) a description of the proposed Canadian capabilities development strategy;
10) a description of the proposed commercialisation plan; and
11) recommendations for follow-on activities.

1. MISSION COST ESTIMATE

This task consists of providing an indicative Mission Cost Estimate, in accordance with Treasury Board (TB) guidelines, for all phases leading to the development, implementation, operation and disposal. Along with the cost estimate, a detailed justification for those costs should be included. The justification describes the type of analysis (analogous, bottom-up, etc.), as well as assumptions made.

At mission level, an analogous analysis should also be performed with other completed missions.

TABLE A-1 – MISSION COST BREAKDOWN

The following cost breakdown should be provided for each phase separately (A, B, C, D, E, F)

Name of Work Package	Labour (Persons-days)	Labour Est. ($)	Purchased Equipment ($)	Travel& Living ($)	TOTAL
1) Program Management					
2) Systems Engineering					
3) Product Assurance					
4) Space Segment					
• Bus					
• Payload					
• Spacecraft Level Support Equipment (incl. Simulator)					
• Spacecraft Assembly Integration and Test (including EGSE, MGSE)					
5) Ground Segment					
• Satellite Control System incl. Antenna					
• Payload Management System incl. Antenna					
6) Operations Planning (Exercise and Rehearsal)					
7) Launch Vehicles and LV Adapters					
8) Operation					
9) Disposal					
TOTAL					

2. OVERALL MISSION SCHEDULE

This task consists in defining a preliminary Mission Schedule relative to the overall life cycle of the mission. The timeline should include key milestones such as Preliminary Design Review, Critical Design Review and Launch. Refer to RD-2 for a full description of all the possible reviews, which may vary depending on the nature of the mission architecture. The schedule should show the Critical path.

3. TECHNOLOGY READINESS ASSESSMENT (TRA)

This task consists in identifying the required technology development requirements to bring the technology to the proper TRL at the appropriate time to meet the mission schedule.

The TRA process and the TRL definitions are provided in RD-3. A preliminary Critical Technologies Development Plan should also be identified and should include functional and performance requirements, and a roadmap (mapping TRL to a timeline coordinated with the mission development schedule) for each Critical Technology.

4. DEVELOPMENT AND MANUFACTURING APPROACH

The Contractor should provide an overview of the development and manufacturing approach, including product assurance and quality control. The major tasks required for the development and manufacturing cycles and the general strategy best suited for this approach are to be included. Identification of the potential long-lead items is also necessary.

5. PRELIMINARY MISSION RISK ASSESSMENT

This task consists in providing a preliminary technical, schedule, cost and programmatic risk assessment for the entire mission lifecycle, starting with Phase A through to Phase F. For each risk identified, the phase of the mission to which the risk applies should be identified, along with the likelihood of occurrence, the impact should the risk occur and any possible mitigation actions that may be taken to decrease either the likelihood or the impact. Specific mitigation actions should be identified for medium and high risks. Contingency plans (i.e.: identifying alternative strategies) should also be developed for medium and high risks, or when it is uncertain that mitigation plans will be effective.

All risks should be integrated when producing risk-related information and document it in a Risk Assessment Matrix. The risk assessment process and matrix are provided in RD-1.

6. CANADIAN CAPABILITIES DEVELOPMENT

This task provides an estimate of the anticipated percentage of Canadian content relative to the overall cost, what options could be undertaken to maximize the Canadian content and their corresponding impacts and benefits.

It also provides an overview of possible strategies to develop and maintain Canadian capabilities. If the overall approach implies technology transfer and partnership with foreign entities to

develop the Canadian capabilities, then teaming arrangements, Intellectual Property (IP) ownership issues, licensing, royalties and opportunities should be identified.

7. PRELIMINARY COMMERCIALISATION PLAN

This task provides information on the minimum business in the field required to maintain the necessary expertise in the long run.

This also includes a preliminary commercialisation plan to support further Canadian positioning beyond the scope of the proposed CSA program. This should include an analysis of who the competitors are (national and international) for the proposed subsystem, technology or concept and for the overall mission. It should identify who are the stakeholders and how Canada is positioned. It should also identify potential spin-offs (space and non-space).

DID-0204 – FIP and BIP Disclosure Report

PURPOSE:

Disclose all FIP and BIP resulting from the contract.

CONTENT:

The report includes the following:

- an introduction including the scope and the purpose;
- a list and description of all FIP resulting from the contract; and
- a list and description of all BIP required by CSA for use of the FIP resulting from the contract.

DID-0205 – Mission Feasibility Report

PURPOSE:

The feasibility report is used to assess the strengths and weaknesses of the proposed mission and its objectives. It determines the practicality of the mission objectives, evaluate the prospects of success and provide recommendations based on the findings of the report.

CONTENT:

The document includes the following:

1) an introduction including the scope, the purpose and a list of assumptions (if any);
2) a list of applicable and reference documents (if any);
3) a short description of the mission including the mission objectives, performance criteria , the overall requirements of the spacecraft, bus, payload(s), launcher, ground segment, and user terminals.
4) define the success criteria for the mission and analyze the current status of the project for comparison
5) Assess present and future needs
6) Define alternatives to meet those needs
7) Evaluate viable alternatives (note: consider the most applicable approach for the mission)
    a) Experimental approach: demonstrate the viability of achieving the performance criteria for each mission objective through experimental data and results.
        i. The experimental data and results are compared to the applicable theories. Any divergence between theory and experiment are explained and suggestions are made for possible improvements to reduce the deviation between experimental results and theory.
    b) Analytical approach: demonstrate the viability of achieving the performance criteria for each mission objective through previously obtained experimental data and flight demonstration results.
        i. Demonstrate the applicability of the analytical data used to evaluate the feasibility of the performance criteria of the mission objectives. Provide a description of the methods used to obtain the analytical data and present the applicability of the analytical data to the current mission.
        ii. Propose improvements/changes to obtain the analytical results to conform to the current mission performance criteria and applicable theories.
8) Identify and develop the preferred solution

9) Programmatic Aspects:

   a) Provide an estimation of the cost of developing the most viable technologies that are essential to the completion of the project.

   b) Provide a realistic timeline of the development of the viable technologies

   c) Deduce from cost and scheduling estimations; the most cost and time efficient technology to develop and apply in the project.

   d) State the benefits of the technological developments and the project itself toward Canada in social and economical terms.

10) Any appendices required to provide detailed information pertinent to the mission requirements that is not suitable to be contained in the main document as explanatory notes.

DID-0301 – Preliminary Operations Requirements

PURPOSE:

The purpose of the Preliminary Operations Requirements is to fulfill the mission requirements and to demonstrate the validity of the operations requirements.

CONTENT:

The content of the Preliminary Operations Requirements includes:

1) The mission requirements have been logically and fully flowed down to the operations requirements;
2) The operations requirements, including operational interface requirements, have been defined and are verifiable;
3) Clearly identify the traceability of operational requirements to mission requirements and justify "orphan" operational requirements.
4) The requirements regarding the Flight System autonomy are understood and have been agreed with the system development team;
5) The requirements regarding the Ground System automation are understood and have been agreed with the system development team;
6) The requirements regarding the payload data generation, downlinking, turnaround time, processing and distribution are understood and have been agreed with both the system development and the science/payload (if any) teams;
7) System operations requirements and constraints:
    a) System description,
    b) End-users description and requirements,
    c) Payload(s) Health and Safety Requirements,
    d) Programmatic and operational constraints,
    e) Relationship with other missions / programs, and
    f) External dependencies or interfaces with other organisations;

DID-0302 – Concept of Operations

PURPOSE:

To describe how the system will be executed in order to meet the operational requirements of the mission.

CONTENT:

This document is to be prepared in accordance with standard ANSI/AIAA G-043-1992 - Guide for the Preparation of Operational Concept Documents RD-4.

The Concept of Operations contains the following information:

1) an introduction including the scope, the purpose and a list of assumptions and constraints (if any);
2) a comprehensive summary of all operability aspects of the mission.
3) space segment characteristics including payload(s) monitoring and control, and payload(s) operational capabilities;
4) ground segment characteristics including validation and commissioning phase, as well as routine operations phase;
5) operations concepts:
    a) Planning processes;
    b) Operations execution processes;
    c) Evaluation and validation processes;
    d) Payload(s) Calibration;
    e) Support processes;
    f) Data Reception and Transfer;
    g) Data Processing and turnaround time;
    h) Operations team;
    i) Orbit determination and maintenance.
6) Theoretical Operational Scenarios that apply to the mission.

DID-0401 – Reference System Design Document

PURPOSE:

To detail a reference system design proposed to meet the mission requirements.

CONTENT:

The document includes as a minimum:

1) an introduction including the scope, the purpose and a list of assumptions (if any);
2) a description of the overall system design, including the space segment, the ground segment and the launch segment.
3) a description of all the sub-systems that are part of the system design
4) a description of trade-off studies performed using key system drivers.

Note: the reference system design should address every element of the mission.

DID-0402 – Reference System Requirements Document

PURPOSE:

To define detailed reference system requirements of an integrated microsatellite solution that responds to the mission requirements.

CONTENT:

The document includes the following:

1) an introduction including the scope, the purpose and a list of assumptions (if any);
2) a list of applicable and reference documents (if any);
3) a short description of the mission including the mission objectives;
4) a short description of the system including the spacecraft, payloads, launch segment, ground segment, and system interfaces;
5) a list of all system requirements to respond to known and/or anticipated mission requirements including explanatory notes when required, for the following:
    a) overall system;
    b) space segment;
    c) launch segment;
    d) ground segment;
    e) system interfaces;
    f) environmental aspects.
6) a list of any system goals that would enhance the mission objectives if implemented including explanatory notes when required
7) one or more parent requirements for each system requirement.

DID-0403 - Preliminary Product Assurance Requirements Document

PURPOSE:

To detail the requirements for a Product Assurance Program which will control and ensure the quality and reliability of the space segment.

CONTENT:

The Product Assurance Requirements are divided into nine basic elements:

a) Organization and Management of the PA activities;
b) A Product Design Assurance Program;
c) A Reliability Program;
d) A Parts Program;
e) A Materials and Processes Program;
f) A Software Product Assurance Program;
g) A Quality Assurance Program;
h) A Configuration Management Program;
i) A Safety Program.

DID-0404 - Preliminary General Design and Interface Requirements

PURPOSE:

To detail the general design and interface requirements applicable to the space segment.

CONTENT:

The General Design and Interface Requirements (GDIR) document addresses the following parameters:

a) General Design and Interface Requirements
b) Mechanical Design and Interface Requirements
c) Thermal Interface
d) Electrical Design and Interface Requirements
e) EMC Control Plan
f) EMC Design Requirements
g) EMC Analysis Requirements
h) EMC Documentation Requirements
i) EMC Test Requirements.

DID-0405 - Preliminary Environmental Requirements and Test Specification

PURPOSE:

To detail the environmental requirements and test specification applicable to the space segment.

CONTENT:

The Environmental Requirements and Test Specification (ERTS) addresses the following parameters:

a) Spacecraft and Launch Vehicle Axes
b) Generic Environmental Test Factors
c) Protoflight Testing
d) Structural / Mechanical Environmental Design Requirements
e) Thermal Environmental Design Requirements
f) Electrostatic and EMC Environmental Design Requirements
g) Atmospheric Model
h) Radiation Model
i) Meteoroid Environment and Space Debris
j) Contamination
k) Transportation and Ground Environments
l) Structure Development Model Tests
m) General Test Requirements.

DID-0407 - Reference Bus Specification

PURPOSE:

To detail a reference bus specification of the spacecraft.

CONTENT:

The Reference Bus Specification document is extracted from the reference system requirements and addresses all requirements related to the bus, which includes (but is not limited to) the following:

a) Bus Module Requirements
b) Bus Module Interface Requirements
c) Command and Telemetry Requirements
d) Data Handling and Processing Requirements
e) Orbit Requirements
f) Attitude Determination and Control Requirements
g) Propulsion Requirements
h) Power Requirements
i) Electrical Distribution Requirements
j) Pyrotechnic Requirements
k) Structure and Mechanism Requirements
l) Thermal Subsystem Requirements
m) Guidance and Navigation Requirements
n) EMC Requirements
o) Ground Support Requirements
p) Software Requirements

DID-0408 - Reference Payload Specification

PURPOSE:

To detail a reference payload specification of the spacecraft.

CONTENT:

The Reference Payload Specification document is extracted from the reference system requirements and addresses all requirements related to the payload, which includes (but is not limited to) the following:

a) Functional and Performance Requirements
b) All Interface Requirements (Mechanical, Thermal, Power/Electrical, Command and Telemetry, etc.)
c) Operational Requirements
d) Safety and Health Requirements
e) Environmental Requirements
f) Assembly, Integration and Test Requirements
g) Design and Construction Requirements
h) Software Requirements

DID-0409 - Reference Ground Segment Specification

PURPOSE:

To detail a reference ground segment specification of the mission.

CONTENT:

The Reference Ground Segment Specification document is extracted from the reference system requirements and addresses all requirements related to the ground segment, which includes (but is not limited to) the following:

a) General Requirements
b) Hardware and Software Requirements
c) High Level Spacecraft Simulator Requirements
d) Interface Requirements
e) Operational Requirements
f) Availability Requirements
g) Security Requirements
h) Maintenance Requirements

DID-0410 - Reference Subsystem Requirements Traceability Matrix

PURPOSE:

To show how the reference system requirements flow into reference subsystem requirements.

CONTENT:

The Traceability Matrix may include the following:

1) mission requirements
2) system requirements
3) operation requirements
4) product assurance requirements
5) general design and interface requirements
6) environmental requirements
7) subsystem requirements (bus, payload, ground segment)
8) a matrix showing the relationship between the subsystem requirements and the system, operation, product assurance, general design and interface, and environmental requirements (child-parent relationship).

B MICROSATELLITE MISSION DESCRIPTION

The Canadian Atmospheric Tomography System (CATS) mission concept stems from a dual payloads mission concept aimed to study the Stratosphere-Troposphere Exchange Processes (STEP). The primary mission objectives are: 1) To elucidate the extent of, and the mechanisms responsible for the Arctic stratospheric "ozone hole" and to study the impact of pollutants such as sulphate aerosols at non- polar regions, and study the coupling between the recovery of the ozone layer from the effect of ozone-depleting substances and climate change, and 2) To study some of the mechanisms that provide coupling between the upper and lower atmosphere, e.g., downward transport of NO with its effects on ozone photochemistry.

CATS like measurements are deemed essential to monitor the Arctic stratospheric ozone and detect any strong depletion in ozone during spring time which could impact the Arctic ecosystem. Also, climate change prediction requires improved climate models and processes understanding as well as long-term observations for trending.

Now embodied in a microsatellite platform, it would provide data continuity to the still operating and highly successful OSIRIS payload on the ODIN spacecraft. Derived from the performance delivered by the heritage instrument, improved performances are sought for this limb scattering spectrograph that would need to cover a spectral range from 280nm to 960nm with a target resolution of approximately 1nm. Multiple lines of sight should be measured simultaneously in order to provide a limb scan every 100km along track and cover an altitude range from 5 to 60km with a 200m vertical sampling. It would provide measurements of high spatial resolution vertically resolved profiles of O3, sulphate aerosol, BrO and NO2.

C CSA MICROSATELLITE CLASS DEFINITION

The CSA definition of the Microsatellite class of satellites is given in Table C.1.

TABLE C-1 – CSA MICROSATELLITE CLASS DEFINITION

Orbit	Low Earth Orbit (500 – 850 km altitude), high inclination (TT&C from Canada)
Spacecraft launch mass	75 – 150 kg (including payload)
Payload mass allocation	30 – 60 kg
Payload power allocation	30W to 60W orbit average; 60W to 120W peak;
TT&C	S-band, 4 - 16kbps uplink, 2 - 4 Mbps downlink; Optional C or X-band high speed data downlink
Mission design lifetime	2 years
Cost Envelope	10 – 50 M$ Can
Project Development Time	3 – 4 years (Phase A-D)
Propulsion	End-of-life de-orbiting only, if required.

Microsatellites are mostly used for the development of new technologies, applications and capabilities.

D ACRONYMS AND ABBREVIATIONS

ACA	After Contract Award
AD	Applicable Document
AI	Action Items
AIL	Action Item Log
BAC	Budget at Completion
BIP	Background Intellectual Property
CA	Contract Authority
CADM	Configuration and Data Management
CAGE	Contractor And Government Entity
CATS	Canadian Atmospheric Tomography System
CCB	Configuration Control Board
CDRL	Contract Data Requirements List
CGRP	Controlled Goods Registration Program
CIE	Company
CM	Configuration Management
COTS	Commercial Off-The-Shelf
CRB	Configuration Review Board
CSA	Canadian Space Agency
CWBS	Contract Work Breakdown Structure
DID	Data Item Description
DND	Department of National Defence
DVD-ROM	Digital Versatile Disk - Read Only Memory
EAC	Estimate at completion
ECN	Engineering Change Notice
ECP	Engineering Change Proposal
ECR	Engineering Change Request
EGSE	Electrical Ground Support Equipment
EMC	Electromagnetic Compatibility
ERTS	Environmental Requirements and Test Specification
FIP	Foreground Intellectual Property
GDIR	General Design and Interface Requirements
GEO	Geosynchronous Earth Orbit
GFE	Government Furnished Equipment
GS	Ground Segment

ICD	Interface Control Documents
IP	Intellectual Property
ITAR	International Traffic in Arms Regulations
KOM	Kick-off Meeting
LEOP	Launch and Early Operations
LV	Launch Vehicle
MCD	Mission Concept Document
MCR	Mission Concept Review
MGSE	Mechanical Ground Support Equipment
MRD	Materials Review Document
MRR	Mission Requirements Review
OGD	Other Government Departments
PA	Product Assurance
PI	Principal Investigator
PT	Project Team
PWGSC	Public Works and Government Services Canada
RD	Reference Document
RFP	Request for Proposal
RID	Review Items Discrepancy
ROM	Rough Order of Magnitude
RT	Review Team
SOW	Statement Of Work
SRR	System Requirements Review
STEP	Stratosphere-Troposphere Exchange Processes
TB	Treasury Board
TBC	To Be Confirmed
TBD	To Be Determined
TMA	Technology Maturity Assessment
TN	Technical Note
TRA	Technology Readiness Assessment
TRL	Technology Readiness Level
TT&C	Tracking, Telemetry and Command
U&ST	Users & Science Team
URD	Users Requirements Document
WBS	Work Breakdown Structure
WPD	Work Package Description