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SOLICITATION AMENDMENT
MODIFICATION DE L'INVITATION

The referenced document is hereby revised; unless otherwise indicated, all other terms and conditions of the Solicitation remain the same.

Ce document est par la présente révisé; sauf indication contraire, les modalités de l'invitation demeurent les mêmes.

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Solicitation No. - N° de l'invitation 9F050-170252/A	**Amendment No. - N° modif.** 001
Client Reference No. - N° de référence du client 9F050-17-0252	**Date** 2018-02-23
GETS Reference No. - N° de référence de SEAG PW-$MTB-450-14779	
File No. - N° de dossier MTB-7-40257 (450)	**CCC No./N° CCC - FMS No./N° VME**
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9F050-17-0252	MTB-7-40257	

This amendment is raised to include Annex A: Statement of Work

Agence spatiale canadienne | Canadian Space Agency

CSA-SPEX-SOW-0003

Canadian Space Agency

Annex "A"

Space Exploration Concept Studies for Planetary Exploration and Space Astronomy

Statement of Work (SOW)

Initial Release
31 January, 2018

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APPROVALS

This document and all changes to it shall be approved by the undersigned. Proposed changes to the currently approved baselined version of this document shall be forwarded to the CSA Configuration Management Receipt Desk for evaluation and submission for approval. Approved changes shall be incorporated into this document.

Prepared by:

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1 INTRODUCTION

1.1 PROGRAM BACKGROUND

The exploration of space is a highly visible endeavour, a powerful driver for scientific and technical innovation, a magnet for world-class talent, and an incentive for young Canadians to pursue careers in science and technology. This study is part of the implementation of the Space Policy Framework of Canada in which the Government commits to: ensuring that Canada is a sought-after partner in the international space exploration Missions that serve Canada's national interests; and, continuing to invest in the development of Canadian contributions in the form of advanced systems and scientific instruments as part of major international endeavours.

To determine the nature of Canada's potential contributions to future international space exploration, the Canadian Space Agency (CSA) engages in several types of activities, which include the following possible groupings: (i) consultation and prioritisation; (ii) science definition studies; (iii) concept and contribution studies; (iv) science maturation studies; and, (v) prototyping, testing and deployment. Through these activities, and responding to Space Exploration stakeholders priorities, CSA's Space Exploration Strategic Planning defines the science and technology developments of highest strategic interest. Results from these activities prepare well-defined options in which Canada can confidently invest. In addition, these studies are of high importance to the CSA to encourage the growth and development of an internationally competitive Canadian space community and advance new ideas.

1.2 OBJECTIVE

The objective of a CSA Space Exploration Concept Study is to develop end-to-end concepts for future mission or payload contributions to Space Exploration endeavours. The results of these studies provide information to assess the viability of investments in potential subsequent developments.

The objective of this study to develop concepts for mission or instrument science investigations related to planetary exploration and/or space astronomy. Specific program requirements are provided in Appendix A.3. This work is part of a number of preparatory studies for future missions or mission contribution options that CSA is supporting related to priorities derived from the 2016 Space Exploration Topical Teams and Canadian Space Exploration Workshop (CSEW).

The outcome of the concept study should target CSA Space Exploration's Science Readiness Level (SRL) 3 or higher. The SRL scales are further described in MRD-03 (and summarized in Table 1-1).

TABLE 1-1: THE CSA SPACE EXPLORATION SRL SCALE

(see details in MRD-03)

Science Readiness Level Description	SRL No:	Program or Mission Phase
Basic scientific principles observed and reported	SRL 1	Fundamental research
Science investigation defined	SRL 2	SE R&D programs (preparatory phases including: Science Definition, Concept Studies, Science Maturation)
Science investigation proof of concept	SRL 3	
Science investigation validated using simulated and/or breadboard data	SRL 4	
Science investigation validated using analogue and/or instrument prototype data	SRL 5	CSA Capability Demonstration Programs; Phase 0/A
Science investigation validated using instrument Engineering Model calibration/ characterization data products	SRL 6	Phase BCD
Science investigation validated using instrument Flight Model pre-launch calibration data products (and analogue science operations where relevant)	SRL 7	
Science investigation data production proven through successful mission operations	SRL 8	Phase E operations
Science investigation outcomes generated through publication of results	SRL 9	Phase E data analysis or post operations analysis

For Science Concept Studies in topics identified in Table 1-2, the scope of work specific to each study category is described in detail in Appendix A.3

TABLE 1-2: STUDY CATEGORY

Study Category	Description	Requirements
Planetary Exploration	Planetary instruments	See Appendix A.3.1
Space Astronomy	Space astronomy instruments and missions	See Appendix A.3.2

1.3 DEFINITIONS

Planetary Exploration: Using space-based platforms to explore solar system bodies, serves to study the origins and evolution of the Solar System, including the investigation of habitable environments beyond Earth that may support (or may have supported) life.

Space-Based Astronomy uses space observatories and space-based missions to study the fundamental principles of the Universe, including exoplanets.

Science Investigation: For the purpose of this study, a mission or instrument science **investigation** is defined as a complete end–to-end activity to generate and use data and/or samples from space to address specific science objective(s). The investigation includes the mission definition, development, manufacture, integration, test and operations phases and must include a well-defined data analysis phase and the delivery of data to a public archive.

- Instrument investigations include the definition, development, test and calibration, characterisation, delivery, integration and operations of the instrument payload(s) and their flight software.
- Mission investigations include the definition, development, test and calibration, delivery, integration and operation of the mission instruments, spacecraft and systems and their flight software.
- For both mission and instrument concepts, the definition, development, test and operations of the ground segment is included as a necessary part of the investigation.

Science Baseline: Describes the recommended full investigation for which traceability has been provided to the mission design.

Science Threshold : The minimum acceptable data and scientific return for the mission, below which the science mission or contribution would not be worth pursuing.

Augmented Mission: Describes additions to the Baseline Science Mission should additional resources be available. The Augmented Mission may describe stretch goals for instrument performance where the projected performance is uncertain, or may describe additional payload elements and/or capabilities.

1.4 CONVENTION

The following verbs, as used in this document, have specific meaning as indicated below:

- "must" indicates a mandatory requirement
- "should" indicates a preferred but not mandatory alternative.
- "will" indicates a statement of intention or fact.

In the following, the term 'contractor' is used to describe the team that will conduct the study, which must be led by a Canadian university or company, and may consist of multiple sub-contracted organizations (universities, companies)

1.5 RESPONSIBILITIES

The CSA is the customer for this study. As such, the Agency has the scientific and technical authority on all matters concerning this study. The Contractor must perform the tasks as outlined in this Statement of Work (SOW) and must deliver the end items defined by this SOW.

1.6 SCOPE

The Contractor must provide the facilities, personnel, materials, and services required to perform the work described in this Concept Study (CS) SOW. This CS SOW provides the requirements and deliverables list that will enable the CSA to recommend options to the government for informed decision-making about potential future science investments.

The detailed scope of work specific to planetary and space astronomy Study Categories are provided in Appendix A.3.

2 MASTER REFERENCE DOCUMENTS

The documents identified in Table 2-1 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

MRD No.	Doc Number/ Source	Document Title	Rev. No.	Date
MRD-01	http://asc-csa.gc.ca/eng/publications/space-policy/default.asp	Government of Canada, Space Policy Framework	-	February, 2014
MRD-02	ftp://ftp.asc-csa.gc.ca/users/ExP/pub/Publications/CSEW2016/LowCostMissions-CSA-AMES-2015/	Report From the CSA/NASA Ames Information Session On Low Cost Space Exploration Missions	-	18 March, 2016
MRD-03	CSA-SPEX-GDL-001 ftp://ftp.asc-csa.gc.ca/users/TRP/pub/Exploration-Core-Science-Definition-Studies/2017	CSA SE Scientific Readiness Level Guidelines	Draft 2.0	June, 2017
MRD-04	JPL D-26359 https://pds.jpl.nasa.gov/documents/pag/pag.pdf	NASA Planetary Data System Proposer's Archiving Guide	Version 1.4	March 29, 2010
MRD-05	CSA-SE-STD-0001 ftp://ftp.asc-csa.gc.ca/users/TRP/pub/SE-STD/	CSA Technical Reviews Standard	A	Nov 7, 2008
MRD-06	CSA-ST-GDL-0001 ftp://ftp.asc-csa.gc.ca/users/TRP/pub/TRRA	CSA Technology Readiness Levels and Assessment Guidelines	C	March 31, 2017
MRD-07	CSA-ST-RPT-0003 ftp://ftp.asc-csa.gc.ca/users/TRP/pub/TRM	Technology Roadmap Worksheet	A	Sept 17, 2012
MRD-08	ftp://ftp.asc-csa.gc.ca/users/ExP/pub/Publications/CSEW2016/TopicalTeams-EquipesThematiques/	Topical Teams Reports on Planetary Exploration 2017		Aug 2017
MRD-09	ftp://ftp.asc-csa.gc.ca/users/ExP/pub/Publications/CSEW2016/TopicalTeams-EquipesThematiques/	Topical Teams Reports on Space Astronomy 2017		Aug 2017
MRD-10	ftp://ftp.asc-csa.gc.ca/users/ExP/pub/Publications/CSEW2016/	CSEW 2016 abstracts, presentations		November 2016

MRD No.	Doc Number/ Source	Document Title	Rev. No.	Date
MRD-11	http://www.casca.ca/lrp2010/index.php	CASCA Long Range Plan 2010 “Unveiling the Cosmos”	Final	2010
MRD-12	http://casca.ca/?page_id=2944	CASCA LRP MTR 2016 “Unveiling the Cosmos: Canadian Astronomy 2016-2020” - Report of the Mid-Term Review 2015 Panel		2016

3 TASK DESCRIPTION

The work to be performed by the Contractor under this concept study is divided into four major Work Packages (WPs). Each WP has one or more associated major tasks. Figure 3-1 describes the Work Breakdown Structure (WBS):

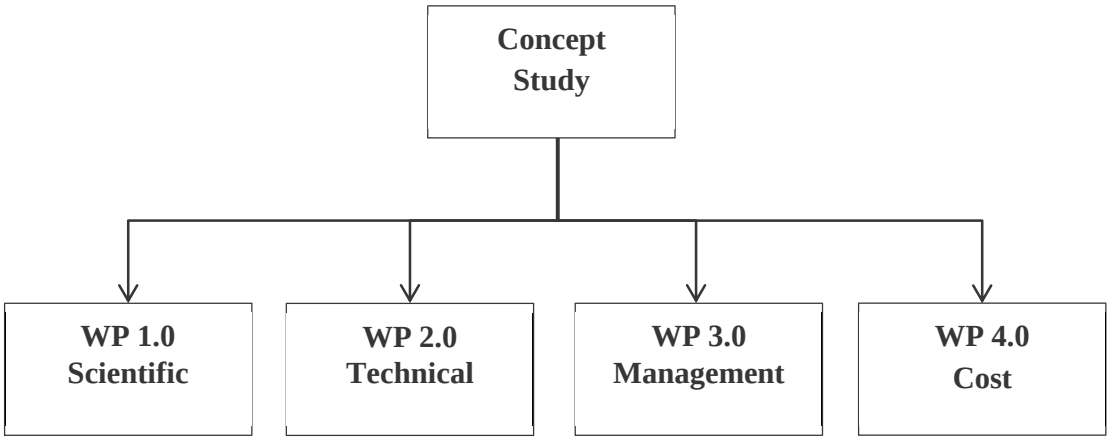

FIGURE 3-1: WORK BREAKDOWN STRUCTURE (TOP LEVEL)

3.1 SCIENTIFIC WORK PACKAGE

This WP includes the work needed to produce the development and documentation of items related to the scientific aspect of the investigation. The work must target SRL 3 or higher as per MRD-03.

The contractor must provide the following information in the Concept Study Report (CDRL 6):

1) The scope of the proposed science investigation including:
   - Science Investigation goals and objectives that address Canadian scientific priorities as identified in the relevant Study Category (MRD-08,MRD-09). These must be clearly identified and described and be supported by a literature review. During the study the contractor should further develop and refine the proposed goals and objectives.
   - Baseline and threshold science investigations must be described with clear description of loss of science on de-scope from baseline to threshold requirements.
   - Augmented science investigations should also be described.
   - Mission success criteria must be clearly defined for baseline and threshold investigations and should be clearly defined for an augmented mission.
2) Preliminary measurement and operations concept including:
   - Proposed nominal science operations timeline
   - High-level description of modes of operation
   - Nominal commissioning and calibration operations
3) The traceability of the proposed baseline investigation must be supported by narrative discussions in the concept study report and documented in the applicable Traceability matrix. Examples of a Science Traceability Matrix and a Mission Traceability Matrix are given in Table 3-1 and Table 3-2.
   - Science Traceability matrix: The flow-down from the science goals and objectives, to measurement objectives that constitute the baseline investigation, to the data to be returned, and the instrument or experiment complement to be used in obtaining the required data. This Matrix provides systems engineers with functional requirements needed to design the associated systems, and can be used to show the effects of de-scoping or loss of elements in terms of degradation of science.

   - Mission Traceability Matrix: The mission requirements that the science goals and objectives impose on the mission design elements, instrument accommodation, spacecraft design, , ground systems, communications approach, and mission operations plan. Specific information that describes how the science investigation imposes unique requirements on these mission design elements must be included, including contamination control and planetary protection requirements. This matrix should be completed for instrument as well as mission science investigations, providing details of the mission capabilities needed to implement the instrument investigation even if a target mission is not identified.

4) Science Readiness Level self-assessment, based on MRD-03.
5) A preliminary science plan which includes sufficient detail on which to base a rough schedule and order of magnitude costing for science team activities from Phase 0-E, and with detailed description of desired pre-Phase A science maturation activities:

- Preliminary description of Phase 0-E science development activities
- A description of the approach to science requirements validation/ verification
- A description of the approach to calibration and characterisation of the required instrument(s).
- A description of the approach to science operations staffing
- An assessment of the feasibility of the data product development plan

6) Preliminary plan for science dissemination
   - Plans to calibrate, analyze, publish results, and archive the returned data. Where available in the targeted scientific journal, open access options for publishing should be selected.
   - The data plans must identify and provide justification for any period of exclusive access to the data. The Government of Canada and international partners subscribe to open data policies and it is a requirement that data be publically archived.

TABLE 3-1: EXAMPLE SCIENCE TRACEABILITY MATRIX

Science Goals	Science Objectives	Science Measurement Requirements		Instrument Functional Requirements		Projected Performance	Mission Functional Requirements (top level)
		Observables	Physical Parameters				
Goal 1	Objective 1	Absorption line	% abundance of absorber	Vertical resolution	XXkm	ZZ km	Observing strategies: requires yaw and elevation manoeuvres (orbiter), or, traverse and instrument positioning (rover) Launch window: to meet nadir and limb overlap requirement (orbiter) ,or, to achieve landing site (rover) Need YY seasons to trace evolution of phenomena Need YY months of observation to observe variability of phenomena
		Morphological feature	Size of feature	Horizontal resolution	XX deg x XX lat x XX lon	ZZ deg x ZZ lat x ZZ lon	
		Rate of change of observable phenomenon	Duration of event	Temporal resolution	XX min	ZZ min	
				Precision	XX K	ZZ K	
				Accuracy	XX K	ZZ K	
	Objective 2 to N			Repeat above categories			
Goal 2	Repeat above categories						

TABLE 3-2: EXAMPLE MISSION TRACEABILITY MATRIX

Mission Functional Requirements	Mission Design Requirements	Spacecraft Requirements	Ground System Requirements	Operations Requirements
From Table 3-1	Launch date Mission length Orbit/landing site requirements and rationale Spatial coverage and how it drives orbit requirements or surface mobility system range Other	Spinning, stabilised, robotic surface system Pointing or Position Control: knowledge, stability, jitter, drift, other Mass Volume Power Data rate Autonomy Detector radiation shielding Other	Passes per day and duration Data volume per day Transmit frequency Power available for comm Downlink data rate Number of data dumps per day Spacecraft data destination (ground control centre) Science data destination (science operations centre)	General spacecraft manoeuvre reqts Special manouvre rqts and rationale Ephemeris rqts Changes in operations modes over time: by day, season, other, and rationale
Four different observing strategies: limb, solar, nadir and zenith: requires yaw and elevation manoeuvers		Slew rate of X degrees / s Settle = stability of better than 0.001 degrees after 30 secs		Target planning on 3 day centres Ephemeris accuracy of X with updates every day
Instrument X precision of 5K		Thermal stability of 1 degree /hr Bus stability of 0.01degree /10 s	Bit error rate better than 1e-5 Time correlation of 1 msec over 1 week	Weekly time correlation

3.2 TECHNICAL WORK PACKAGE

This WP includes the development and documentation of the technical aspects of the study.

The contractor must provide the following information in the Concept Study Report (CDRL 7).

1) Preliminary Systems Requirements: The Contractor must ensure that key and driving functional and performance requirements necessary for the baseline investigation are captured in the Science and Mission Traceability matrices and that the investigation concept is designed to meet these requirements.
   - Description of the proposed Mission or Instrument investigation concept architecture, including high level schematics of
     - mechanical system and interfaces
     - electrical system and interfaces
     - flight software
     - ground segment for baseline mission.

     Schematics must clearly identify science payload(s) and critical subsystems.

2) Development, Manufacturing and Qualification Approach
   - The Contractor must provide an overview of the development approach, potential key subcontractors, and the general strategy best suited for this approach. The Contractor must also list the major tasks required in the development and manufacturing cycles and identify the potential long lead items. The Contractor must provide the preliminary verification plan, qualification approach, and any assumptions made.
3) Technology Readiness and Risk Assessment (TRRA) and Technology Roadmap (TRM).

- The TRRA is used to assess project status and technical risks, and to guide definition of risk reduction work in the current and following phases. The Contractor must perform a TRRA in accordance with the requirements of the CSA Technology Readiness and Risk Assessment Guidelines (MRD-06) to formally document the technology status.
- The Contractor must also provide a Technology Development Plan, also known as Technology Roadmap (TRM), including the required technology developments to meet components needs, and a plan and timeline to reach TRL 6 and 8.

Additionally the contractor should provide the following information in the Concept Study Report (CDRL 7):

4) Preliminary environmental requirements assumed in this study, for operations and qualification, with justification.
5) Preliminary system budget estimates for mass, volume, power, thermal, software/processing, and, data communications for baseline mission.

3.3 MANAGEMENT WORK PACKAGE

The management work package includes work needed to complete the following tasks:

1) A preliminary schedule for the overall life cycle of the Concept

   The Contractor must prepare a preliminary schedule relative to the overall life cycle of the Concept. The project schedule prepared by the Contractor must provide a graphical representation of predicted tasks, milestones, dependencies, resource requirements, task duration, and deadlines.

   The timeline must include key milestones corresponding to, for instance, Preliminary Design Review (PDR), Critical Design Review (CDR), hardware delivery, readiness for integration, launch. The project's master schedule must inter-relate all tasks on a common time scale and be in the form of a Gantt chart.

   The project schedule must be detailed enough to show each WBS task to be performed, the resources required for completing the task, the start and end date of each task, the deliverables, the long lead items, the expected duration of the task, and finally the critical path. The flight project schedule must be presented in the management report with a Gantt Chart and with a table with all significant milestone dates.

2) A Preliminary Mission Risk Assessment

   The Contractor must provide a preliminary technical, schedule, cost and programmatic risks assessment. For each risk identified, the Contractor should identify the phase of the components to which the risk applies, 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 before the components or the phase starts. Specific mitigation actions must be identified for high risks at this time. Contingency plans (i.e., identifying alternative strategies) must also be developed for high risks, or when it is uncertain that mitigation plan will be effective. This general risk assessment must also consider access to information issues, like Export Control (International Traffic in Arms Regulations (ITAR)) and others as potential risks.

3) A Preliminary Business Case

   The Contractor must provide a narrative cost/benefit analysis that could justify government investment in the proposed contribution. This should include a discussion on future business opportunities and benefits to industry directly derived from the work, quantitative estimates of number of HQP whose expertise would be enhanced as a result of the mission broken down by type: engineering staff, faculty, post-doctorate fellows, PhD students, MSc students; quantitative estimate of scientific journal articles produced as a result of this mission, and a discussion on possible spin-off products, including markets. A brief commercialisation plan should be provided where further commercial business opportunities and/or spin-off products are identified, including an estimate of the potential market and markets that would purchase their product.

4) A proposed high level plan for public engagement

   The contractor must propose a plan to promote the science and engineering accomplishments of the mission in a manner that can be understood by the general public.

5) Canadian Capabilities Development

- The Contractor must provide an overview of its strategy to develop and maintain Canadian capabilities. This includes an assessment of current science and industry capability in Canada, and needs for capacity building.
- If the overall approach of the Contractor implies technology transfer and partnership with foreign entities to develop the Canadian capabilities, the Contractor must specify teaming arrangements, Intellectual Property (IP) ownership issues, royalties, etc., as well as opportunities that this partnership would open.

6) Intellectual Property Management

The Contractor must identify the Background Intellectual Property (BIP), the IP that will be generated, and the owners of these BIP and IP and how it will be managed and coordinated among the various collaborators and entities involved. This must be documented as per CDRL 7.

3.4 COST ESTIMATES

The Contractor must provide cost estimates as per Table 3-3 for all phases leading to the development, qualification, implementation, launch, operation and disposal of the hardware/software/instruments resulting from the concept. Each cost estimate must be substantiated by describing the methodology used for each (e.g., bottom-up, analogous, parametric, etc.) and any assumptions made for the derivation. The cost estimates must include planned activities required to mature the science readiness.

TABLE 3-3: COST

		Prior to Mission	Phase A	Phase B	Phase C	Phase D	Phase E	Phase F
Labour	Management							
	Science Support (cal/val/ops/ archiving (contract)							
	Science Data Analysis (grants)							
	Technology Development							
	Design							
	Documentation							
	Reviews							
	Manufacturing							
	Assembly							
	Testing							
	Product Assurance							
	Operations							
	Total Labour							
Non-Labour	HW/SW Procurement							
	Tools, Equipment & Facilities							
	Travel & Living							
	Overhead							
	Total Non-Labour							
Risk	Risk Contingency							
Total								
Total all Phases								

The Contractor must provide an estimate of the anticipated percentage of Canadian content relative to the overall cost. The contractor should recommend options that could be undertaken to maximize the Canadian content, and their corresponding impacts and benefits.

4 CONTRACT MEETINGS AND DELIVERABLES

This section reviews and describes the contract meetings and deliverables.

4.1 CONTRACT MEETINGS

The Contractor must organize the meetings listed in Table 4-1. The exact date and time of the meetings will be mutually agreed to by the PA, the SA, and the Contractor.

TABLE 4-1: MEETING SCHEDULE

Milestone	Meeting	Date	Deliverables (CDRL)	Location
M1	Kick-off Meeting	No later than 2 weeks after contract award	1, 2, 5	Telecon
M2	Mid-term Review Meeting	6 to 8 months after contract award	1, 3, 5, 7, 9	Telecon
M3	Final Review Meeting	2 weeks prior to end of contract	1, 4, 5, 7, 8, 9	CSA HQ or Telecon

Meetings are intended to provide an opportunity for the Contractor, the Project Authority (PA), the Scientific Authority (SA), and other invited attendees to review and discuss the concept. Canada reserves the right to invite additional knowledgeable people (public servants or others) to these meetings.

All key participants under the contract, including at least one representative from each subcontractor, must attend all the meetings. In keeping with a low cost approach to project management, it is assumed that contract meetings are by teleconference instead of in person, unless justified and by mutual agreement.

The purpose of the final review meeting is to demonstrate and confirm the feasibility, scientific merit, and overall value and benefits of the concept for Canadians. Should the concept be selected for future development the final review meeting may serve as a preliminary MCR and as such should address the objectives of an MCR as described in MRD-05.

The Contractor may request ad-hoc telecons with the CSA whenever required to resolve unforeseen and urgent issues. The CSA may also request such ad-hoc telecons with the Contractor. The selection of participants will depend on the nature of the issue.

4.2 DOCUMENTATION, REPORTING AND OTHER DELIVERABLES

The Contractor must submit the documentation as defined and at the date stipulated in the CDRL, Table 4-2, to the PA. All diagrams must be clearly drawn and labelled.

The Contractor must provide the PA with an electronic copy of all documentation in a format acceptable to the CSA. Both the PDF and original version, e.g. Microsoft Word or PowerPoint, must be provided to CSA. Original version of any figures or tables part of these documents must also be provided to CSA, e.g. Visio file of a figure created in Microsoft Visio, STEP file for models and drawings in Computer Aided Design (CAD) software. Instructions on how to name electronic documents are provided in Appendix A.1.

The cover page of each document must include the following text:

> © CANADIAN SPACE AGENCY yyyy (insert year)
>
> "RESTRICTION ON USE, PUBLICATION OR DISCLOSURE OF PROPRIETARY INFORMATION
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Then, on all internal pages, each document must include the following text:

> ***"Use, duplication or disclosure of this document or any of the information contained herein is subject to the Proprietary Notice at the front of this document."***

The Contractor must not publish, nor discuss verbally in public (i.e. conferences), nor have published any information contained within this, without the prior written approval of the CSA.

All documents must identify the organisation's name, contract number, title and document name and must be structured in accordance with the Data Item Description (DID) referenced in the CDRL.

TABLE 4-2: CONTRACT DATA REQUIREMENTS LIST (CDRL)

CDRL No.	Deliverable	Due Date	Version	DID No.
1.	Meeting Agendas	Meeting – 1 week	Final	CF
2.	Kick-off Meeting Presentation	Meeting – 1 week	Final	0002
3.	Mid-term Review Meeting Presentation	Meeting – 1 week	Final	0003
4.	Final Review Meeting Presentation	Meeting – 1 week	Final	0004
5.	Meeting Minutes	Meeting + 1 week	Final	CF
6.	Progress Reports	Quarterly	Final	0006
7.	Concept Study Report	Midterm Review End of contract – 2 weeks	Draft Final	0007
8.	Foreground Intellectual Property (FIP) Disclosure	End of contract – 2 weeks	Final	0008
9.	Technology Readiness and Risk Assessment	Midterm Review End of contract – 2 weeks	Draft Final	0010

5 LIST OF ACRONYMS

BIP	Background Intellectual Property
BLEO	Beyond Low Earth Orbit
CAD	Computer Aided Design
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CF	Contractor Format
CSA	Canadian Space Agency
CSEW	Canadian Space Exploration Workshop
CTE	Critical Technology Element
DID	Data Item Description
FIP	Foreground Intellectual Property
FTP	File Transfer Protocol
HW	Hardware
HQ	Headquarters
IP	Intellectual Property
ITAR	International Traffic in Arms Regulations
MCR	Mission Concept Review
MM	Animation/Multimedia
MN	Minutes of meeting
MRD	Master Reference Document
MTR	Mid-term Review
NASA	National Aeronautics and Space Administration
PA	Project Authority
PDF	Portable Document Format
PDR	Preliminary Design Review
PDS	Planetary Data System
PM	Project Manager
PR	Progress Report
PT	Presentation
RFP	Request For Proposal
SA	Scientific Authority
SOW	Statement Of Work
SRL	Science Readiness Level
STEP	Standard for the Exchange of Product Data

SW	Software
TN	Technical Note
TRL	Technology Readiness Level
TRM	Technology Roadmap
TRRA	Technology Readiness and Risk Assessment
WBS	Work Breakdown Structure
WP	Work Package
WPD	Work Package Description

APPENDICES

A.1 DOCUMENT NAMING CONVENTIONS

Context

This appendix presents the naming convention to follow for any documentation generated under this contract.

Documents must contain 4 main components:

1. Project identifier
2. Contract Number
3. Document title
   - revision number or letter
4. Date Tracking number

WXYZ-TYPE-NUM-CIE_ContractNumber document title rev no._sent2017-10-30

1. Project Identifier

The project identifier must contain:

- WXYZ: A 4-8 letter acronym of the project
- TYPE: A 2 letter acronym according to the table below.

Acronym	Description
AG	Agenda
ER	Executive Report
MN	Minutes of meeting
PR	Progress Report
PT	Presentation
TN	Technical Note
MM	Animation/Multimedia

- NUM: A three digits sequential number (e.g. 001, 002, etc.)
- CIE: Name of Company (no space, no hyphen)

2. Contract Number

- For example: _9F028-07-4200-03

3. Date Tracking Number

- _sentYEAR-MONTH-DAY_draft

The *_draft* mentioned should be removed on the final version of the document once approved by CSA.

A.2 DATA ITEM DESCRIPTION (DID)

DID-0002 – Kick-off Meeting Presentation

PURPOSE:

To present the Contractor's plan for carrying out the project and to address all significant issues.

PREPARATION INSTRUCTIONS:

The Kick-off Meeting Presentation must contain the following information, as a minimum:

1) Review major assumptions for the study
2) Review of contract deliverables;
3) Work requirements, WBS status and schedule;
4) Plan for FIP and review of BIP;
5) Licensing issues if any;
6) Project's funding and expected cash-flow;
7) Other items as deemed appropriate

   Presentation material must include the required copyrights and IP disclosure statements;

DID-0003 – Mid-Term Review Meeting Presentation

PURPOSE:

To present the results of the work done to date in the contract, and in particular since the previous meeting. The Mid-Term Review is intended as an opportunity for CSA to review the progress to date and provide feedback. The mid-term review must cover the work done to date and provide information on any issues that may impact the final outcome of the study.

PREPARATION INSTRUCTIONS:

The Mid-Term Review Meeting Presentation must contain the following information, as a minimum:

1) Current status of the work including WBS Status, schedule updates and ongoing work requirements
2) Discussion of preliminary results including as a minimum, draft concept of operations, Science Baseline, draft traceability matrices, and preliminary systems architecture
3) Technical and programmatic issues if any;
4) Proposed CTE for TRRA as per MRD-06.
5) Review of contract deliverables;
6) FIP and BIP should be summarized in a draft version of CDRL 7;
7) Licensing and IP issues if any;
8) Other items as deemed appropriate;

   Presentation materials must include the required copyright and intellectual property disclosure statements.

DID-0004 – Final Review Meeting Presentation

PURPOSE:

To present the overall results of the work done for the concept study including the elements of a Mission Concept Review (MCR). See CSA-SE-STD-0001 (MRD-05) for a description of the MCR.

PREPARATION INSTRUCTIONS:

The Final Review Meeting Presentation must contain the following information, as a minimum:

1) Detailed presentation of the work conducted (presentation of the content of the technical and/or science report, concept, design, interface, feasibility, etc.)
2) Elements of a Preliminary Mission Concept Review including a discussion of the following:
    a) Mission objectives and needs are clearly understood and comprehensively defined;
    b) The study proves that the mission is feasible;
    c) Mission success criteria have been established for baseline and threshold missions. Augmented mission criteria have been defined if applicable;
    d) The mission conceptual design meets mission objectives and needs;
    e) The preliminary Concept of Operations clearly supports the achievement of the mission objectives and needs;
    f) Interfaces with external systems have been identified.
    g) Technology dependencies (i.e. new or emerging technologies on which the project depends) are understood and alternative strategies for achievement of objectives are identified;
    h) Preliminary mission planning provides an approximate estimation of the resources required for mission execution, including preliminary life-cycle costs, schedule and programmatic resources;
    i) Technology Readiness Assessment (TRA) and Risk Analysis have been completed and potential Risks established;
3) Technical and programmatic issues if any;
4) Contract deliverables;
5) Review of project FIP and BIP;
6) Licensing and IP issues if any;
7) Discuss project management issues;
8) Contractor performance evaluation, must contain the following information, as a minimum:
    - Was the project completed on schedule (list deliverables with planned and actual delivery date)?
    - How many hours of work by highly qualified personnel (by category) did this work create or maintain?
    - New opportunities created by the work conducted under the study.

9) Assessment of Benefits to Canada anticipated from mission implementation
    - Canadian HQP training & development
    - Canadian Capabilities Development
    - Business Potential and/or Preliminary Commercialisation Plan
10) Other items as deemed appropriate;
11) Presentation's slides to include the required copyrights and intellectual property disclosure

DID-0006 – Progress Report

PURPOSE:

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

PREPARATION INSTRUCTIONS:

The Progress Report must contain the following information, as a minimum:

1) Current % of completion
2) Updated schedule showing planned and actual completion dates
3) Brief summary of the work performed in the current period
4) The work planned for the following 3 months
5) A highlight of problems, if any, and the proposed corrective approach
6) An Action Item Log in a tabular form, with the following headings in this order:
    - Item Number;
    - Action Item;
    - Open Date;
    - Source of Action Item (e.g. PDR meeting, RID, etc.);
    - Person responsible (for taking action);
    - Target/Actual Date of Resolution;
    - Status (Open or Closed); and
    - Remarks.
7) Any other relevant information deemed necessary.

Based on the above, the Progress Report should not exceed 3 pages.

DID-0007 – Concept Study Report

PURPOSE:

To fully describe the technical work done, problems encountered and achieved objectives.

(The author may define and organize additional sub-sections as deemed appropriate to present the comprehensive results of the concepts study.)

PREPARATION INSTRUCTIONS:

The Concept Study Report must contain the following information, as a minimum:

1) Executive summary suitable for public dissemination on a website (2 page graphic format describing the mission objectives, mission concept, team and the benefits to Canada)
2) Science Investigation
   a) Scope of the proposed investigation
      i) Science Investigation goals and objectives that address Canadian scientific priorities as listed in MRD-08,MRD-09.
      ii) Preliminary measurement and operations concept
      iii) Mission success criteria
   b) Traceability of proposed investigation
      iv) Science Traceability Matrix
      v) Mission Traceability Matrix
   c) Baseline and threshold investigations
   d) Planetary protection categorisation (for planetary instruments)
   e) Preliminary science plan
   f) Approach to science dissemination
   g) Science Readiness Level self-assessment, based on CSA-SPEX-GDL-0001 (MRD-03).
3) Technical Implementation
   a) Preliminary Systems Requirements
      a. Key systems requirements including reliability and performance for baseline science requirements case.
      b. Preliminary environmental requirements assumed in this study, for operations and qualification, with justification
   b) Mission concept description, including technical approach and possible options:

a. High level schematics of a) mechanical system b) electrical system c) flight software d) ground segment for baseline mission. Schematics must clearly identify science payload(s) and critical subsystems/development packages.
b. System budget estimates for mass, volume, power, thermal, software/processing, and, data communications for baseline mission
c. A detailed description of baseline science payload(s), and critical subsystems and development packages including schematics of a) mechanical system b) electrical system c) flight software d) ground segment.
d. Preliminary plan for implementation of contamination control requirements, including planetary protection.
e. Preliminary mission operations plan
f. Identification and discussion on design trades relevant to baseline mission
g. Identification and discussion on descopes implied by threshold mission requirements
h. Discussion on options related to augmented mission requirements

c) Interface definition – desired interface with Host Mission
    a. Identification of possible host missions if known.

d) Feasibility & Technology development needs, including
    a. Technology Readiness and Risk Assessment (TRRA) as per DID-0010
    b. Technology development roadmap as per DID-0011
    c. Identification of Canadian Key Industrial Capabilities
    d. Development, manufacturing and qualification approach

4) Management, Schedule and Risk
    a) Proposed Management Approach, including team roles and responsibilities
        i) Phase A-D
        ii) Phase E
    b) Proposed collaboration, if applicable
    c) Proposed Mission Schedule
    d) Estimated Mission Costs for Phases A through D
    e) Preliminary Mission Risk Assessment identification and mitigation:
        i) Technical
        ii) Schedule
        iii) Cost
        iv) Programmatic

DID-0008 – Contractor Disclosure of Intellectual Property

PURPOSE:

To list all Foreground and Background Intellectual Property related to the project, to be reviewed at the Final Review Meeting.

PREPARATION INSTRUCTIONS:

The Disclosure must address the questions listed the document

- CONTRACTOR DISCLOSURE OF INTELLECTUAL PROPERTY that can be found at:

ftp://ftp.asc-csa.gc.ca/users/GPITT-IPMTT/pub/ .

DID-0010 – Technology Readiness and Risk Assessment

PURPOSE:

Referring to the Technology Readiness and Risk Assessment (TRRA) Guidelines (CSA-ST-GDL-0001), the TRRA describes in a systematic and objective fashion, at a specific point in time (milestone) in the development process, the technological readiness of a system for a particular spaceflight mission or environment, the criticality of the constituent technologies, and the expected degree of difficulty to achieve the remaining technology development steps.

The TRRA provides for all the Critical Technology Elements (CTEs) of the proposed concept, as per the Product Breakdown Structure (PBS), a high-level summary of the maturity of the technologies and the technology development risks. Agreement on the appropriate PBS level and identification of the CTEs is required prior to the TRRA.

PREPARATION INSTRUCTIONS:

The Technology Readiness and Risk Assessment must be carried out in accordance with the CSA Technology Readiness and Risk Assessment Guidelines using the CSA provided worksheets (MRD-06): the Critical Technologies Elements Identification Criteria Worksheet (CSA-ST-FORM-0003), the Technology Readiness and Risk Assessment Worksheet (CSA-ST-FORM-0001) for each CTE and TRRA summary template (CSA-ST-FORM-0004).

All the completed worksheets must be provided to CSA, and a summary of the TRRA assessment and recommendations must be included in the project Final Report. The project Final Report should also contain the Technology Development Plan, Technology Roadmap (MRD-07) and appropriate inputs to the Risk Assessment, Budget, and Schedule.

DID-0011 – Technology Roadmap

PURPOSE:

The Technology Roadmap (TRM) is a plan that matches short-term and long-term goals with specific technology solutions to help meet those goals. Developing a roadmap has three major uses. It helps reach a consensus about a set of needs and the technologies required to satisfy those needs; it provides a mechanism to help forecast technology developments; and it provides a framework to help plan and coordinate technology developments.

PREPARATION INSTRUCTIONS:

The Technology Roadmap must be prepared as per CSA-ST-GDL-0001 [MRD-06] for each technology in a standard excel format as per CSA-ST-RPT-003 (MRD-07).

A.3 CATEGORY SPECIFIC REQUIREMENTS

The following sections describe the requirements which are specific the studies performed in the specified Study Category.

A.3.1 PLANETARY INSTRUMENT CONCEPTS REQUIREMENTS

A.3.1.1 Objective

This Concept Study Category supports the development of complete instrument investigation concepts that target integration, launch and operations as part of a future planetary flyby, orbiter, landed, rover or sample return mission. All solar system destinations beyond Low Earth Orbit can be considered.

A.3.1.2 Background

Recent Canadian instrument contributions to planetary missions have been developed as a result of launch opportunities characterized by selection through international competitions that welcome foreign contributions on a no exchange of funds basis.

Technical qualification for contributions to such competitions requires demonstration of a path to TRL 6 by Preliminary Design Review (PDR). Proposals to such competitions must also include a well-defined instrument science investigation with a properly funded data analysis phase, and traceability matrices similar to those presented in Table 3-1 and Table 3-2.

This concept study provides a means for teams to develop and advance the maturity of concepts in readiness for various possible launch opportunities, including possible selection as part of mission proposals to future NASA Discovery, NASA New Frontiers and NASA Europa Lander Instrument Investigations competitions.

Planetary Instrument Investigations that have previously undertaken Concept Studies, but not yet achieved SRL 3, may be proposed if they meet program requirements. In general, Planetary Instrument Concepts are feasibility studies that necessarily will incorporate exciting new ideas, responding to the latest developments in planetary science and building on the latest developments in technology.

A.3.1.3 Program Requirements and Objectives

The study must be compliant with following mandatory Space Exploration (SE) Program Requirements:

- **Requirement SP-1**. Instrument Investigations developed through this Concept Study must correspond to a community priority as listed in the Topical Teams Reports on Planetary Exploration 2017 (MRD-08). The investigations must address the corresponding science objective.

  Concepts should be science-driven, technology enabled.
- **Requirement SP-2**. The instrument investigation must be Canadian-led.

  Contributions from other Canadian and international organizations should be clearly identified, with detailed roles and responsibilities, and 'in-kind' and financial contributions.
- **Requirement SP-3**. The anticipated planetary protection categorization for the investigation must be provided.

In addition, the study must address the following SE Program Objectives:

- **Objective OSP-1:** Investigation Cost

  Costs to CSA should not exceed C$50M for instrument phases ABCD as defined in MRD-05(Systems Engineering standards).

  This cost cap includes industry and science team costs for the baseline mission investigation and excludes taxes and CSA overhead. There is no cost cap for the phase E operations and data analysis phase as the duration of phase E can vary significantly according to planetary destination. Cost estimates and technology readiness and risk analysis arising from this study will be an important factor for future planning.

- **Objective OSP-2:** Canadian niche

  The competitive advantage of the instrument investigation should be addressed where other countries have demonstrated prior space heritage in the proposed instrument technique

- **Objective OSP-3:** Mission launch date must be identified.

  Targeted launch dates should be no earlier than 2024. If the proposed concept is for an instrument on a planned mission the target mission should be identified. This includes candidate missions for future NASA Discovery or New Frontiers competitions which should be identified where known by mission PI, mission name, target competition, and earliest possible launch date. If targeting the anticipated NASA Europa Lander Instruments opportunity, or a partnership has not yet been established for the NASA Discovery or New Frontiers competitions, this should be stated, along with assumptions about launch date.

- **Objective OSP-4:** Instrument Investigation interface and mission architecture

  A realistic mission payload interface and mission operations architecture that will enable the investigation to be implemented should be described. Specific target mission details should be supplied, if known.

- **Objective OSP-5:** Mission management

  CSA Technical Reviews Standards (MRD-05) allow for modifications of the full-up approach to reviews for low cost missions. The Contractor may propose and describe a low cost systems engineering approach to planetary instrument investigation project management in CDRL 006 (Concept Study Report).

  Should a planetary instrument investigation be selected for implementation as a mission, CSA may consider awarding a single contract to a Principal Investigator (PI)-led team, comprising both industrial contractor and science team, rather than awarding separate science support and industrial prime contracts. The study should provide a recommendation and narrative describing the resulting decision-making structure and subcontract(s). In the event it is recommended that a PI institution subcontracts the industrial prime, the capability of the PI institution to manage the contract, and previous PI experience in missions should be discussed. In the event it is recommended that a PI-led science team is subcontracted by an industrial prime, the PI authority in decisions related to investigation scope and risk should be described.

A.3.2 SPACE ASTRONOMY STUDY CATEGORY

This Appendix describes eligible topics for proposals related to Space Astronomy.

The objective of a Mission Concept Study is to develop end-to-end concepts for future a mission or payload contribution to CSA Space Exploration endeavours. The results of the study provide information to assess the viability of investments in potential subsequent developments.

Mission Concept Studies are meant to propose concepts that target an accepted primary science objective. The study should examine and elaborate the science and investigations with innovative instrument and/or mission designs.

A.3.2.1 Priorities for Astronomy

Study objectives are selected and defined based on analyses of international and national space exploration priorities, through consultation committees, foreign space agency plans and strategies, agency-to-agency dialogue and national workshops, including the Canadian Space Exploration Workshop (CSEW 2016) and the resulting Topical Teams' reports identifying science priorities in space astronomy.

The current requirement will expand on the CSA Space Exploration priorities in Space Astronomy. Space-based observatories enables scientific measurements and imaging not possible from the ground, serving to increase our understanding of the origins and the nature and physics of the universe, its composition, matter and energy, age, structure and evolution.

For space astronomy, stakeholder priorities are reflected in the astronomical community (Canadian Astronomical Society (CASCA)) decadal plans – the Long Range Plan (LRP) 2010 and the LRP Mid-term review 2016 (MRD-11,MRD-12) and relevant CSA SE Topical Team reports (MRD-09) and material presented at the CSEW 2016 (MRD-10).

TABLE A3-1: STUDY TOPICS IDENTIFIED IN COMMUNITY REPORTS (MRD-09)

Cat #	Topic	Investigation(s)
SA-1	Cosmology: Cosmic Microwave Background (CMB) and inflation	Investigations related to CMB, measuring B-modes (polarization in CMB) and structure of the Universe
SA-2	Cosmology: Dark Energy and Dark Matter	Investigations related to wide field imaging, cosmological surveys, and low resolution spectroscopy. Cosmic expansion, matter density, DE equation of state parameter; influences of dark matter
SA-3	High-energy astrophysics	Investigations related to accretion physics, compact objects, gamma-ray bursts, active galaxies and X-ray binaries, stellar winds, supernova, black holes. X-ray imaging, spectroscopy, timing and polarimetry
SA-4	Cosmic origins: galaxy and stellar formation and evolution, interstellar medium	Investigations related to observational cosmology, galaxy population, distribution, stellar physics, dark matter influence
SA-5	Cosmic origins: Exoplanets and solar system bodies	Investigations related to search and characterization, photometry, spectroscopy, extreme imaging.