



RETURN BIDS TO:

RETOURNER LES SOUMISSIONS À:

Travaux publics et Services gouvernementaux
Canada

Place Bonaventure,
800 rue de la Gauchetière Ouest

Voir aux présentes - See herein

Montréal

Québec

H5A 1L6

FAX pour soumissions: (514) 496-3822

REQUEST FOR PROPOSAL DEMANDE DE PROPOSITION

**Proposal To: Public Works and Government
Services Canada**

We hereby offer to sell to Her Majesty the Queen in right of Canada, in accordance with the terms and conditions set out herein, referred to herein or attached hereto, the goods, services, and construction listed herein and on any attached sheets at the price(s) set out therefor.

**Proposition aux: Travaux Publics et Services
Gouvernementaux Canada**

Nous offrons par la présente de vendre à Sa Majesté la Reine du chef du Canada, aux conditions énoncées ou incluses par référence dans la présente et aux annexes ci-jointes, les biens, services et construction énumérés ici sur toute feuille ci-annexée, au(x) prix indiqué(s).

Comments - Commentaires

Vendor/Firm Name and Address

Raison sociale et adresse du

fournisseur/de l'entrepreneur

Issuing Office - Bureau de distribution

Travaux publics et Services gouvernementaux Canada
Place Bonaventure,

800 rue de la Gauchetière Ouest

Voir aux présentes - See herein

Montréal

Québec

H5A 1L6

Title - Sujet Dev. of enabling space tech.	
Solicitation No. - N° de l'invitation 9F063-160953/B	Date 2017-11-07
Client Reference No. - N° de référence du client 9F063-16-0953	
GETS Reference No. - N° de référence de SEAG PW-\$MTB-575-14606	
File No. - N° de dossier MTB-6-39409 (575)	CCC No./N° CCC - FMS No./N° VME
Solicitation Closes - L'invitation prend fin at - à 02:00 PM on - le 2017-12-07	Time Zone Fuseau horaire Heure Normale du l'Est HNE
F.O.B. - F.A.B. Plant-Usine: <input type="checkbox"/> Destination: <input checked="" type="checkbox"/> Other-Autre: <input type="checkbox"/>	
Address Enquiries to: - Adresser toutes questions à: Jurca, Anca	Buyer Id - Id de l'acheteur mtb575
Telephone No. - N° de téléphone (514) 496-3378 ()	FAX No. - N° de FAX (514) 496-3822
Destination - of Goods, Services, and Construction: Destination - des biens, services et construction: AGENCE SPATIALE CANADIENNE 9F063-SC ET TECH SPAC GEST DEV TECH 6767 ROUTE DE L'AEROPORT ST HUBERT Québec J3Y8Y9 Canada	

Instructions: See Herein

Instructions: Voir aux présentes

Delivery Required - Livraison exigée .	Delivery Offered - Livraison proposée
Vendor/Firm Name and Address Raison sociale et adresse du fournisseur/de l'entrepreneur	
Telephone No. - N° de téléphone Facsimile No. - N° de télécopieur	
Name and title of person authorized to sign on behalf of Vendor/Firm (type or print) Nom et titre de la personne autorisée à signer au nom du fournisseur/ de l'entrepreneur (taper ou écrire en caractères d'imprimerie)	
Signature	Date

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Amd. No. - N° de la modif.
File No. - N° du dossier
MTB-6-39409

Buyer ID - Id de l'acheteur
MTB575
CCC No./N° CCC - FMS No./N° VME

This bid solicitation cancels and supersedes the Priority Technologies (PTs):

- **PT 1: Focal Plane Array for Coastal & Inland Water Color Hyperspectral Imager; and**
- **PT 2: Breadboard of Next Generation Coastal and Inland Water Color Imaging Spectrometer**

of the previous bid solicitation number 9F063-160953/A dated April 18, 2017 with a closing date of June 12, 2017 at 02:00PM.

A debriefing or feedback session will be provided upon request to bidders/offerors/suppliers who bid on the previous solicitation.

CHANGE OF ADDRESS – BIDS DELIVERY

For bids delivered starting Monday, May 8, 2017:

In person or by mail:

**Place Bonaventure, 1st Floor
800 de la Gauchetière Street West
Suite 1110
Montreal (QC), H5A 1L6**

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PART 1 - GENERAL INFORMATION

1.1 Introduction

The bid solicitation is divided into seven parts plus annexes and attachments, as follows:

- Part 1 General Information: provides a general description of the requirement;
- Part 2 Bidder Instructions: provides the instructions, clauses and conditions applicable to the bid solicitation;
- Part 3 Bid Preparation Instructions: provides Bidders with instructions on how to prepare their bid;
- Part 4 Evaluation Procedures and Basis of Selection: indicates how the evaluation will be conducted, the evaluation criteria that must be addressed in the bid, and the basis of selection;
- Part 5 Certifications and Additional Information: includes the certifications and additional information to be provided;
- Part 6 Financial and Other Requirements: includes specific requirements that must be addressed by Bidders; and
- Part 7 Resulting Contract Clauses: includes the clauses and conditions that will apply to any resulting contract

The following Annexes:

Annex A Statement of Work
Annex B Basis of Payment

The following Attachments:

Attachment 1 to Part 3 Technical and Managerial Bid Preparation Instructions
Attachment 2 to Part 3 Electronic Payment Instructions
Attachment 1 to Part 4 Point Rated Evaluation Criteria
Attachment 1 to Part 5 Federal Contracts Program for Employment Equity – Certification

1.2 Summary

Project title

Development of enabling space technologies

Description

Public Works and Government Services Canada (PWGSC) on behalf of Canadian Space Agency (CSA) located in St-Hubert, (Quebec), is seeking bids to develop and advance two (2) Priority Technologies that are in line with the Canadian Space Agency's (CSA) priorities and mission roadmaps. Priority Technologies are those that have been established by the CSA as the critical technologies to be developed to meet objectives set forth by the Canadian Space Strategy.

For every Priority Technologies (PTs) the work solicited is the development and advancement of these technologies up to potentially Technology Readiness Level 5 (TRL 5) to reduce technical uncertainties and support approval and implementation of specific potential future space missions of interest to Canada.

Period of Contract

Depending on the Technology Readiness Level (TRL) covered by each technology development contract periods are expected to vary between 18 and 24 months.

Intellectual Property

The Intellectual property will vest with the contractor.

Security Requirements

There are no security requirements associated with this requirement.

Trade agreements

This requirement is not subject to the trade agreements.

Canadian Content

The requirement is limited to Canadian goods and/or Canadian services. Please refer to Part 5 – Certifications and Additional Information.

Controlled Goods Program

This procurement is subject to the Controlled Goods Program. The *Defence production Act* defines Canadian Controlled Goods as certain goods listed in Canada's Export Control List, a regulation made pursuant to the Export and Import Permits Act (EIPA).

Federal Contractors Program for Employment Equity

"The Federal Contractors Program (FCP) for employment equity applies to this procurement; see Part 5 – Certifications and Additional Information, Part 7 - Resulting Contract Clauses and the annex titled *Federal Contracts Program for Employment Equity – Certification*."

1.3 Debriefings

Bidders may request a debriefing on the results of the bid solicitation process. Bidders should make the request to the Contracting Authority within fifteen (15) working days from receipt of the results of the bid solicitation process. The debriefing may be in writing, by telephone or in person.

PART 2 - BIDDER INSTRUCTIONS

2.1 Standard Instructions, Clauses and Conditions

All instructions, clauses and conditions identified in the bid solicitation by number, date and title are set out in the *Standard Acquisition Clauses and Conditions Manual* (<https://buyandsell.gc.ca/policy-and-guidelines/standard-acquisition-clauses-and-conditions-manual>) issued by Public Works and Government Services Canada.

Bidders who submit a bid agree to be bound by the instructions, clauses and conditions of the bid solicitation and accept the clauses and conditions of the resulting contract.

The 2003 (2017-04-27) Standard Instructions - Goods or Services - Competitive Requirements, are incorporated by reference into and form part of the bid solicitation.

Subsection 5.4 of 2003, Standard Instructions - Goods or Services - Competitive Requirements, is amended as follows:

Delete: 60 days
Insert: 240 days

2.2 Submission of Bids

Bids must be submitted only to Public Works and Government Services Canada (PWGSC) Bid Receiving Unit by the date, time and place indicated on page 1 of the bid solicitation:

Public Works and Government Services Canada
Quebec Region,
Place Bonaventure, 1st Floor
800 de la Gauchetière Street West
Suite 1110
Montreal (QC), H5A 1L6

Due to the nature of the bid solicitation, bids transmitted by facsimile or by electronic mail to PWGSC will not be accepted.

2.3 Former Public Servant

Contracts awarded to former public servants (FPS) in receipt of a pension or of a lump sum payment must bear the closest public scrutiny, and reflect fairness in the spending of public funds. In order to comply with Treasury Board policies and directives on contracts with FPS, Bidders must provide the information required below before contract award. If the answer to the questions and, as applicable the information required have not been received by the time the evaluation of bids is completed, Canada will inform the Bidder of a time frame within which to provide the information. Failure to comply with Canada's request and meet the requirement within the prescribed time frame will render the bid non-responsive.

Definitions

For the purposes of this clause, "**former public servant**" is any former member of a department as defined in the Financial Administration Act, R.S., 1985, c. F-11, a former member of the

Canadian Armed Forces or a former member of the Royal Canadian Mounted Police. A former public servant may be:

- a. an individual;
- b. an individual who has incorporated;
- c. a partnership made of former public servants; or
- d. a sole proprietorship or entity where the affected individual has a controlling or major interest in the entity.

"lump sum payment period" means the period measured in weeks of salary, for which payment has been made to facilitate the transition to retirement or to other employment as a result of the implementation of various programs to reduce the size of the Public Service. The lump sum payment period does not include the period of severance pay, which is measured in a like manner.

"pension" means a pension or annual allowance paid under the Public Service Superannuation Act (PSSA), R.S., 1985, c.P-36, and any increases paid pursuant to the Supplementary Retirement Benefits Act, R.S., 1985, c.S-24 as it affects the PSSA. It does not include pensions payable pursuant to the Canadian Forces Superannuation Act, R.S., 1985, c.C-17, the Defence Services Pension Continuation Act, 1970, c.D-3, the Royal Canadian Mounted Police Pension Continuation Act, 1970, c.R-10, and the Royal Canadian Mounted Police Superannuation Act, R.S., 1985, c.R-11, the Members of Parliament Retiring Allowances Act, R.S., 1985, c.M-5, and that portion of pension payable to the Canada Pension Plan Act, R.S., 1985, c.C-8.

Former Public Servant in Receipt of a Pension

As per the above definitions, is the Bidder a FPS in receipt of a pension? **Yes () No ()**

If so, the Bidder must provide the following information, for all FPS in receipt of a pension, as applicable:

- a. name of former public servant;
- b. date of termination of employment or retirement from the Public Service.

By providing this information, Bidders agree that the successful Bidder's status, with respect to being a former public servant in receipt of a pension, will be reported on departmental websites as part of the published proactive disclosure reports in accordance with Contracting Policy Notice: 2012-2 and the Guidelines on the Proactive Disclosure of Contracts.

Work Force Adjustment Directive

Is the Bidder a FPS who received a lump sum payment pursuant to the terms of the Work Force Adjustment Directive? **Yes () No ()**

If so, the Bidder must provide the following information:

- a. name of former public servant;
- b. conditions of the lump sum payment incentive;
- c. date of termination of employment;
- d. amount of lump sum payment;
- e. rate of pay on which lump sum payment is based;
- f. period of lump sum payment including start date, end date and number of weeks;
- g. number and amount (professional fees) of other contracts subject to the restrictions of a work force adjustment program.

For all contracts awarded during the lump sum payment period, the total amount of fees that may be paid to a FPS who received a lump sum payment is \$5,000, including Applicable Taxes.

2.4 Enquiries - Bid Solicitation

All enquiries must be submitted in writing to the Contracting Authority no later than ten (10) calendar days before the bid closing date. Enquiries received after that time may not be answered.

Bidders should reference as accurately as possible the numbered item of the bid solicitation to which the enquiry relates. Care should be taken by Bidders to explain each question in sufficient detail in order to enable Canada to provide an accurate answer. Technical enquiries that are of a proprietary nature must be clearly marked "proprietary" at each relevant item. Items identified as "proprietary" will be treated as such except where Canada determines that the enquiry is not of a proprietary nature. Canada may edit the question(s) or may request that the Bidder do so, so that the proprietary nature of the question(s) is eliminated and the enquiry can be answered to all Bidders. Enquiries not submitted in a form that can be distributed to all Bidders may not be answered by Canada.

2.5 Applicable Laws

Any resulting contract must be interpreted and governed, and the relations between the parties determined, by the laws in force in Quebec.

Bidders may, at their discretion, substitute the applicable laws of a Canadian province or territory of their choice without affecting the validity of their bid, by deleting the name of the Canadian province or territory specified and inserting the name of the Canadian province or territory of their choice. If no change is made, it acknowledges that the applicable laws specified are acceptable to the Bidders.

2.6 Improvement of Requirement During Solicitation Period

Should Bidders consider that the specifications or Statement of Work contained in the bid solicitation could be improved technically or technologically, Bidders are invited to make suggestions, in writing, to the Contracting Authority named in the bid solicitation. Bidders must clearly outline the suggested improvement as well as the reason for the suggestion. Suggestions that do not restrict the level of competition nor favour a particular Bidder will be given consideration provided they are submitted to the Contracting Authority at least ten (10) days before the bid closing date. Canada will have the right to accept or reject any or all suggestions.

2.7 Maximum Funding

The maximum funding available for each contract, one contract by category, resulting from the bid solicitation is indicated in Table 1: *List of Priority Technologies* (Applicable Taxes extra, as appropriate). Bids valued in excess of this amount will be considered non-responsive. This disclosure does not commit Canada to pay the maximum funding available.

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Rank	PT #	Priority Technology Title	Maximum funding (K\$)
1	PT 1	Focal Plane Array for Coastal & Inland Water Color Hyperspectral Imager	1,400
2	PT 2	Breadboard of Next Generation Coastal and Inland Water Color Imaging Spectrometer	1,500

Table 1: List of Priority Technologies

PART 3 - BID PREPARATION INSTRUCTIONS

3.1 Bid Preparation Instructions

A Bidder can bid on more than one Priority Technology specified in Table 1: *List of Priority Technologies* of Part 2 – *Bidder Instructions* but must submit one separate bid for each Priority Technology. Canada requests that the Bidder clearly identifies in the first page of its bid which Priority Technology he is bidding on. The Bidder must follow the same instructions described in this Request for proposal for each bid he submits.

Canada requests that Bidders provide their bid in separately bound sections as follows:

Section I: Technical and Managerial Bid (1 hard copy and 1 soft copy on CD/DVD/USB)

Section II: Financial Bid (1 hard copy and 1 soft copy on CD/DVD/USB)

Section III: Certifications (1 hard copy and 1 soft copy on CD/DVD/USB)

- a) If there is a discrepancy between the wording of the soft copy and the hard copy, the wording of the hard copy will have priority over the wording of the soft copy;
- b) For the soft copies of Section I (Technical and Managerial Bid as well as the Executive Summary), all of the information must be contained in a single file or two files (one for the Technical and Managerial Bid and one for the Executive Summary). The only acceptable formats are: MS Word, PDF and HTML. Format chosen for Section I must allow the text to be copied (unprotected) for evaluation and other operational purposes;
- c) For the soft copy of Section II (Financial Bid), all of the information must be contained in one file. The only acceptable formats are: MS Word, PDF and HTML. Format chosen for Section II must allow the text to be copied (unprotected) for evaluation and other operational purposes;
- d) The soft copy of Section II must be submitted on a separate CD/DVD key than the soft copy submitted for Section I;
- e) Prices must appear in Section II (Financial Bid) only. No prices must be indicated in any other section of the bid;
- f) The total number of pages for Section I should not exceed 50 pages (8.5 X 11 inches) (216 mm X 279 mm) paper excluding bid appendices;
- g) The bid should use a numbering system that corresponds to the bid solicitation;

In April 2006, Canada issued a policy directing federal departments and agencies to take the necessary steps to incorporate environmental considerations into the procurement process [Policy on Green Procurement](http://www.tpsgc-pwgsc.gc.ca/ecologisation-greening/achats-procurement/politique-policy-eng.html) (<http://www.tpsgc-pwgsc.gc.ca/ecologisation-greening/achats-procurement/politique-policy-eng.html>). To assist Canada in reaching its objectives, Bidders should:

- 1) use 8.5 x 11 inch (216 mm x 279 mm) paper containing fibre certified as originating from a sustainably-managed forest and containing minimum 30% recycled content; and

-
- 2) use an environmentally-preferable format including black and white printing instead of colour printing, printing double sided/duplex, using staples or clips instead of cerlox, duotangs or binders.

Section I: Technical and Managerial Bid

In their technical and managerial bid, Bidders should demonstrate their understanding of the requirements contained in the bid solicitation and explain how they will meet these requirements. Bidders should demonstrate their capability and describe their approach in a thorough, concise and clear manner for carrying out the work.

The technical and managerial bid should address clearly and in sufficient depth the points that are subject to the evaluation criteria against which the bid will be evaluated. Simply repeating the statement contained in the bid solicitation is not sufficient. In order to facilitate the evaluation of the bid, Canada requests that Bidders address and present topics in the order of the evaluation criteria under the same headings. To avoid duplication, Bidders may refer to different sections of their bids by identifying the specific paragraph and page number where the subject topic has already been addressed.

Part 4: *Evaluation Procedures and Basis of Selection* contains additional instructions that Bidders should consider when preparing their technical and managerial bid.

The structure and content requested for the Technical and Managerial Bid (Section I) are detailed in Attachment 1 to Part 3: *Technical and Managerial Bid Preparation Instructions*.

Section II: Financial Bid

3.1.1 Bidders must submit their financial bid in accordance with the following:

- (a) A firm, all inclusive lot price for the Work, which must not exceed the maximum funding available for each contract resulting from the bid solicitation specified in Part 2, Table 1: *List of Priority Technologies*. The total amount of Applicable Taxes must be shown separately, if applicable.
- (b) Prices must be in Canadian funds, Applicable Taxes excluded and Canadian customs duties and excise taxes included.

3.1.2 Electronic Payment of Invoices – Bid

If you are willing to accept payment of invoices by Electronic Payment Instruments, complete Attachment 2 to Part 3 - Electronic Payment Instruments, to identify which ones are accepted.

If Attachment 2 to Part 3 - Electronic Payment Instruments is not completed, it will be considered as if Electronic Payment Instruments are not being accepted for payment of invoices.

Acceptance of Electronic Payment Instruments will not be considered as an evaluation criterion.

3.1.3 Price Breakdown

Bidders are requested to detail the following elements for the performance of each task, milestone or phase of the Work, as applicable:

- (a) Labour: For each individual and (or) labour category to be assigned to the Work, indicate:
 - i) the hourly rate, inclusive of overhead and profit; and ii) the estimated number of hours.
- (b) Equipment: Specify each item required to complete the Work and provide the pricing basis of each one, Canadian customs duty and excise taxes included, as applicable.
- (c) Materials and Supplies: Identify each category of materials and supplies required to complete the Work and provide the pricing basis.
- (d) Travel and Living Expenses: Indicate the number of trips and the number of days for each trip, the cost, destination and purpose of each journey, together with the basis of these costs which must not exceed the limits of the National Joint Council (NJC). With respect to the NJC's Directive, only the meal, private vehicle and incidental allowances specified in Appendices B, C and D of the Directive <http://www.njc-cnm.gc.ca/directive/travel-voyage/index-eng.php>, and the other provisions of the Directive referring to "travellers", rather than those referring to "employees", are applicable. The Treasury Board Secretariat's Special Travel Authorities, http://www.tbs-sct.gc.ca/pubs_pol/hrpubs/tbm_113/statb-eng.asp, also apply.
- (e) Subcontracts: Identify any proposed subcontractor and provide for each one the same price breakdown information as contained in this article.
- (f) Other Direct Charges: Identify any other direct charges anticipated, such as long distance communications and rentals, and provide the pricing basis.
- (g) Applicable Taxes: Identify any Applicable Taxes separately.

Section III: Certifications

Bidders must submit the certifications required under Part 5.

PART 4 - EVALUATION PROCEDURES AND BASIS OF SELECTION

4.1 Evaluation Procedures

- (a) Bids will be assessed in accordance with the entire requirement of the bid solicitation including the technical and managerial and financial evaluation criteria;
- (b) An evaluation team composed of representatives of Canada will evaluate the bids;

4.1.1 Technical and Management Evaluation

4.1.1.1 Point Rated Technical and Management Criteria

The Point Rated Technical and Management Criteria are described at Attachment 1 to Part 4: *Point Rated Evaluation Criteria*. Criteria not addressed will be given a score of zero.

4.1.2 Financial Evaluation

4.1.2.1 Mandatory Financial Criteria

The Bidder must submit a firm, all inclusive lot price for the Work, which must not exceed the maximum funding available for each contract resulting from the bid solicitation indicated in Part 2, Table 1: *List of Priority Technologies* (Applicable Taxes extra, as appropriate).

Bids which fail to meet the mandatory financial criteria will be declared non-responsive. Bids valued in excess of this amount will be considered non-responsive. This disclosure does not commit Canada to pay the maximum funding available.

4.1.2.2 Evaluation of Price

The price of the bid will be evaluated in Canadian dollars, the Applicable Taxes excluded, FOB destination, Canadian customs duties and excise taxes included.

4.2 Basis of Selection – Highest Combined Rating of Technical Merit and Price

4.2.1 To be declared responsive, each bid must:

- (a) comply with all the requirements of the bid solicitation;
- (b) meet all mandatory evaluation criteria;
- (c) obtain the required minimum of 20 points, on a scale of 40 points, for the Evaluation Criterion #4: *Feasibility of proposed solution in meeting the technical objectives* indicated in Table 4A.1: *List of Evaluation Criteria and Associated Ratings*, of Attachment 1 to Part 4;

- (d) obtain the required minimum of 70 points, on a scale of 100 points, for the overall Technical Evaluation portion of the bid as indicated in Table 4A.1: *List of Evaluation Criteria and Associated Ratings*, of Attachment 1 to Part 4.

- 4.2.2 Bids not meeting (a) or (b) or (c) or (d) will be declared non-responsive;
- 4.2.3 The responsive bids will be grouped within the Priority Technology in which they belong (PT1, PT2, etc...) and each Priority Technology will be evaluated separately;
- 4.2.4 Responsive Bids, within each Priority Technology will be ranked according to their combined score made up of the overall technical score and pricing score.
- For each responsive bid, the overall technical score and the pricing score will be added to determine its combined score.
- Bids will be ranked starting from the Bid with the highest combined score down to the lowest combined score resulting in a Responsive Bid List;
- 4.2.5 For each responsive bid, the score obtained for each technical criterion will be added to determine its overall technical score (maximum of 100 points);
- 4.2.6 To establish the pricing score, the following equation will be used:

$$\text{pricing score} = \left(\frac{\text{max funding} - \text{bid price}}{\text{max funding}} \right) \times 50$$

the pricing score is limited to 10 points. It therefore follows that the maximum pricing score is awarded to bids with a price representing 80% of the maximum funding. Bids with a price lower than 80% funding will receive the maximum score of 10;

- 4.2.7 Neither the responsive bid obtaining the highest overall technical score nor the one with the highest pricing score will necessarily be accepted. The responsive bid with the highest combined score of technical merit and price will be recommended for award of a contract.

In the event that more than one responsive bid has the same combined score in a Priority Technology, the bid which obtained the highest overall technical score will be recommended for award of a contract.

In the event that there are no responsive bids in a particular Priority Technology, that all available budget has not been spent or that additional budget is made available, Canada may elect to award one or more contracts to responsive bids that finished second for a particular Priority Technology under the other remaining Priority Technologies. The CSA will look at all the bids that finished second and will make a decision based on the availability of funds, its priorities in terms of technology development and the complementary nature of the bids that finished second. In this context, "complementary" means "a different technical acceptable approach of interest to CSA".

The table below illustrates an example where all three bids are responsive and the selection of the contractor is determined by adding the overall technical score and pricing scores, respectively. In this example, the maximum funding is 100 000\$ (100)

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Ex. Basis of Selection – Highest Combined Rating of Technical Merit and Price

Bidder	Bidder 1	Bidder 2	Bidder 3
Overall Technical Score	70	85	92
Bid Price	\$90 000	\$80 000	\$100 000
Calculation of Pricing Score	$((100-90)/100) \times 50 = 5$	$((100-80)/100) \times 50 = 10$	$((100-100)/100) \times 50 = 0$
Combined Score	75	95	92
Overall Rating	3 rd	1st	2nd

PART 5 - CERTIFICATIONS AND ADDITIONAL INFORMATION

Bidders must provide the required certifications and additional information to be awarded a contract.

The certifications provided by Bidders to Canada are subject to verification by Canada at all times. Unless specified otherwise, Canada will declare a bid non-responsive, or will declare a contractor in default if any certification made by the Bidder is found to be untrue, whether made knowingly or unknowingly, during the bid evaluation period or during the contract period.

The Contracting Authority will have the right to ask for additional information to verify the Bidder's certifications. Failure to comply and to cooperate with any request or requirement imposed by the Contracting Authority will render the bid non-responsive or constitute a default under the Contract.

5.1 Certifications Required with the Bid

Bidders must submit the following duly completed certifications as part of their bid.

5.1.1 Integrity Provisions - Declaration of Convicted Offences

In accordance with the Ineligibility and Suspension Policy (<http://www.tpsgc-pwgsc.gc.ca/ci-if/politique-policy-eng.html>), the Bidder must provide with its bid the required documentation, as applicable, to be given further consideration in the procurement process.

5.2 Certifications Precedent to Contract Award

The certifications and additional information listed below should be submitted with the bid but may be submitted afterwards. If any of these required certifications or additional information is not completed and submitted as requested, the Contracting Authority will inform the Bidder of a time frame within which to provide the information. Failure to provide the certifications or the additional information listed below within the time frame specified will render the bid non-responsive.

5.2.1 Integrity Provisions – Required Documentation

In accordance with the Ineligibility and Suspension Policy (<http://www.tpsgc-pwgsc.gc.ca/ci-if/politique-policy-eng.html>), the Bidder must provide the required documentation, as applicable, to be given further consideration in the procurement process.

5.2.2 Federal Contractors Program for Employment Equity - Bid Certification

By submitting a bid, the Bidder certifies that the Bidder, and any of the Bidder's members if the Bidder is a Joint Venture, is not named on the Federal Contractors Program (FCP) for employment equity "FCP Limited Eligibility to Bid" list (http://www.labour.gc.ca/eng/standards_equity/eq/emp/fcp/list/inelig.shtml) available from Employment and Social Development Canada (ESDC) - Labour's website.

Canada will have the right to declare a bid non-responsive if the Bidder, or any member of the Bidder if the Bidder is a Joint Venture, appears on the "FCP Limited Eligibility to Bid" list at the time of contract award.

Canada will also have the right to terminate the Contract for default if a Contractor, or any member of the Contractor if the Contractor is a Joint Venture, appears on the "FCP Limited Eligibility to Bid" list during the period of the Contract.

The Bidder must provide the Contracting Authority with a completed annex Federal Contractors Program for Employment Equity - Certification, before contract award. If the Bidder is a Joint Venture, the Bidder must provide the Contracting Authority with a completed annex Federal Contractors Program for Employment Equity - Certification, for each member of the Joint Venture.

5.2.3 Former Public Servant

Contracts awarded to former public servants (FPS) in receipt of a pension or of a lump sum payment must bear the closest public scrutiny, and reflect fairness in the spending of public funds. In order to comply with Treasury Board policies and directives on contracts with FPS, Bidders must provide the information required below before contract award. If the answer to the questions and, as applicable the information required have not been received by the time the evaluation of bids is completed, Canada will inform the Bidder of a time frame within which to provide the information. Failure to comply with Canada's request and meet the requirement within the prescribed time frame will render the bid non-responsive.

Definitions

For the purposes of this clause, "**former public servant**" is any former member of a department as defined in the Financial Administration Act, R.S., 1985, c. F-11, a former member of the Canadian Armed Forces or a former member of the Royal Canadian Mounted Police. A former public servant may be:

- a. an individual;
- b. an individual who has incorporated;
- c. a partnership made of former public servants; or
- d. a sole proprietorship or entity where the affected individual has a controlling or major interest in the entity.

"**lump sum payment period**" means the period measured in weeks of salary, for which payment has been made to facilitate the transition to retirement or to other employment as a result of the implementation of various programs to reduce the size of the Public Service. The lump sum payment period does not include the period of severance pay, which is measured in a like manner.

"**pension**" means a pension or annual allowance paid under the Public Service Superannuation Act (PSSA), R.S., 1985, c.P-36, and any increases paid pursuant to the Supplementary Retirement Benefits Act, R.S., 1985, c.S-24 as it affects the PSSA. It does not include pensions payable pursuant to the Canadian Forces Superannuation Act, R.S., 1985, c.C-17, the Defence Services Pension Continuation Act, 1970, c.D-3, the Royal Canadian Mounted Police Pension Continuation Act, 1970, c.R-10, and the Royal Canadian Mounted Police Superannuation Act, R.S., 1985, c.R-11, the Members of Parliament Retiring Allowances Act, R.S., 1985, c.M-5, and that portion of pension payable to the Canada Pension Plan Act, R.S., 1985, c.C-8.

Former Public Servant in Receipt of a Pension

As per the above definitions, is the Bidder a FPS in receipt of a pension? **Yes () No ()**

If so, the Bidder must provide the following information, for all FPS in receipt of a pension, as applicable:

- a. name of former public servant;
- b. date of termination of employment or retirement from the Public Service.

By providing this information, Bidders agree that the successful Bidder's status, with respect to being a former public servant in receipt of a pension, will be reported on departmental websites as part of the published proactive disclosure reports in accordance with Contracting Policy Notice: 2012-2 and the Guidelines on the Proactive Disclosure of Contracts.

Work Force Adjustment Directive

Is the Bidder a FPS who received a lump sum payment pursuant to the terms of the Work Force Adjustment Directive? **Yes () No ()**

If so, the Bidder must provide the following information:

- a. name of former public servant;
- b. conditions of the lump sum payment incentive;
- c. date of termination of employment;
- d. amount of lump sum payment;
- e. rate of pay on which lump sum payment is based;
- f. period of lump sum payment including start date, end date and number of weeks;
- g. number and amount (professional fees) of other contracts subject to the restrictions of a work force adjustment program.

For all contracts awarded during the lump sum payment period, the total amount of fees that may be paid to a FPS who received a lump sum payment is \$5,000, including Applicable Taxes.

5.3 Additional Certifications Precedent to Contract Award

5.3.1 Canadian Content Certification

This procurement is limited to Canadian goods and/or Canadian services.

For the Priority Technology 1 (PT-1):

The Bidder certifies that:

() a minimum of 80 percent of the total bid price consist of Canadian services as defined in paragraph 2 of clause A3050T.

For the Priority Technology 2 (PT-2):

The Bidder certifies that:

() a minimum of 80 percent of the total bid price consist of Canadian goods and Canadian services as defined in paragraph 5 of clause A3050T.

For more information on how to determine the Canadian content for a mix of goods, a mix of services or a mix of goods and services, consult Annex 3.6.(9), Example 2, of the Supply Manual

5.3.1.1 SACC *Manual* clause A3050T (2014-11-27) Canadian Content Definition.

5.3.2 Status and Availability of Resources

The Bidder certifies that, should it be awarded a contract as a result of the bid solicitation, every individual proposed in its bid will be available to perform the Work as required by Canada's representatives and at the time specified in the bid solicitation or agreed to with Canada's representatives. If for reasons beyond its control, the Bidder is unable to provide the services of an individual named in its bid, the Bidder may propose a substitute with similar qualifications and experience. The Bidder must advise the Contracting Authority of the reason for the substitution and provide the name, qualifications and experience of the proposed replacement. For the purposes of this clause, only the following reasons will be considered as beyond the control of the Bidder: death, sickness, maternity and parental leave, retirement, resignation, dismissal for cause or termination of an agreement for default.

If the Bidder has proposed any individual who is not an employee of the Bidder, the Bidder certifies that it has the permission from that individual to propose his/her services in relation to the Work to be performed and to submit his/her résumé to Canada. The Bidder must, upon request from the Contracting Authority, provide a written confirmation, signed by the individual, of the permission given to the Bidder and of his/her availability. Failure to comply with the request may result in the bid being declared non-responsive.

5.3.3 Education and Experience

The Bidder certifies that all the information provided in the résumés and supporting material submitted with its bid, particularly the information pertaining to education, achievements, experience and work history, has been verified by the Bidder to be true and accurate. Furthermore, the Bidder warrants that every individual proposed by the Bidder for the requirement is capable of performing the Work described in the resulting contract.

PART 6 - FINANCIAL AND OTHER REQUIREMENTS

6.1 Financial Capability

SACC *Manual* clause A9033T (2012-07-16), Financial Capability

6.2 Controlled Goods Requirement

SACC *Manual* clause A9130T (2014-11-27), Controlled Goods Program – Bid

PART 7 - RESULTING CONTRACT CLAUSES

The following clauses and conditions apply to and form part of any contract resulting from the bid solicitation.

7.1 Statement of Work

The Contractor must perform the Work in accordance with the Statement of Work in Annex A and the Contractor's technical and Managerial Bid entitled _____, dated _____ (*will be inserted at contract award*).

7.2 Work Authorization

Despite any other condition of the Contract, the Contractor is only authorized to perform the Work up to the "Work Authorization Meeting and Decisions" (see Annex A – Statement of Work, section A.7.2.3). Depending on the results of the review and evaluation of the Work, Canada will decide at its discretion whether to continue with the Work.

If Canada decides to continue with the Work, the Contracting Authority will advise the Contractor in writing to continue with the work in accordance with the Statement of Work. The Contractor must immediately comply with the notice.

If Canada decides not to proceed with the Work, the Contracting Authority will advise the Contractor in writing of the decision and the Contract will be considered completed at no further costs to Canada. In no event will the Contractor be paid for any cost incurred for unauthorized work.

7.3 Standard Clauses and Conditions

All clauses and conditions identified in the Contract by number, date and title are set out in the Standard Acquisition Clauses and Conditions Manual(<https://buyandsell.gc.ca/policy-and-guidelines/standard-acquisition-clauses-and-conditions-manual>) issued by Public Works and Government Services Canada.

7.3.1 General Conditions

2040 (2016-04-04), General Conditions - Research & Development, apply to and form part of the Contract.

7.3.2 Supplemental General Conditions

The following supplemental general conditions apply to and form part of the Contract:

4002 (2010-08-16), Software Development or Modification Services
4003 (2010-08-16), Licensed Software

7.4 Term of Contract

7.4.1 Period of the Contract (*will be inserted at contract award*)

Depending on the Technology Readiness Level (TRL) covered by each technology development contract periods are expected to vary between 18 and 24 months.

7.5 Authorities

7.5.1 Contracting Authority

The Contracting Authority for the Contract is:

Anca Jurca
Chief, Procurement
Public Works and Government Services Canada
Quebec Region
Place Bonaventure, 1st Floor
800 de la Gauchetière Street West
Suite 1110
Montreal (QC), H5A 1L6

Telephone: 514-496-3378
Facsimile: 514-496-3822
E-mail address: anca.jurca@tpsgc-pwgsc.gc.ca

The Contracting Authority is responsible for the management of the Contract and any changes to the Contract must be authorized in writing by the Contracting Authority. The Contractor must not perform work in excess of or outside the scope of the Contract based on verbal or written requests or instructions from anybody other than the Contracting Authority

7.5.2 Project Authority *(will be inserted at contract award)*

The Project Authority for the Contract is:

Name : _____
Title : _____
Organization : _____
Address : _____

Telephone: ____ ____ ____
Facsimile: ____ ____ ____
E-mail address: _____

The Project Authority is the representative of the department or agency for whom the Work is being carried out under the Contract and is responsible for all matters concerning the administrative, programmatic and technical content of the Work under the Contract. These matters may be discussed with the Project Authority; however, the Project Authority has no authority to authorize changes to the scope of the Work. Changes to the scope of the Work can only be made through a contract amendment issued by the Contracting Authority.

7.5.3 Contractor's Representative *(will be inserted at contract award)*

The Contractor's Representative for the Contract is:

Name: _____

Title: _____

Organization: _____

Address: _____

Telephone: ____ - ____ - ____

Facsimile: ____ - ____ - ____

E-mail: _____

7.6 Proactive Disclosure of Contracts with Former Public Servants

SACC Manual Clause A3025C (2013-03-21)

7.7 Payment

7.7.1 Basis of Payment

In consideration of the Contractor satisfactorily completing all of its obligations under the Contract, the Contractor will be paid a firm price, as specified in the Contract for a cost of \$ _____ *(the amount will be inserted at contract award)*. Customs duties are included and Applicable taxes are extra, if applicable.

Canada will not pay the Contractor for any design changes, modifications or interpretations of the Work, unless they have been approved, in writing, by the Contracting Authority before their incorporation into the Work.

7.7.2 Method of Payment

7.7.2.1 Milestone Payments

Canada will make milestone payments in accordance with the Schedule of Milestones detailed in Annex B - Basis of Payment and the payment provisions of the Contract if:

- (a) an accurate and complete claim for payment using form PWGSC-TPSGC 1111 (<http://www.tpsgc-pwgsc.gc.ca/app-acq/forms/documents/1111.pdf>) and any other document required by the Contract have been submitted in accordance with the invoicing instructions provided in the Contract;
- (b) all the certificates appearing on form PWGSC-TPSGC 1111 have been signed by the respective authorized representatives;
- (c) all work associated with the milestone and as applicable any deliverable required has been completed and accepted by Canada.

7.7.2.2 Schedule of Milestones

The schedule of milestones for which payments will be made in accordance with the Contract is detailed in Annex B.

7.8 SACC Manual Clauses

SACC Manual Clause A9117C (2007-11-30), T1204 - Direct Request by Customer Department

7.9 Electronic Payment of Invoices – Contract

The Contractor accepts to be paid using any of the following Electronic Payment Instrument(s):

- a. Visa Acquisition Card;
- b. MasterCard Acquisition Card;
- c. Direct Deposit (Domestic and International);
- d. Electronic Data Interchange (EDI);
- e. Wire Transfer (International Only);
- f. Large Value Transfer System (LVTS) (Over \$25M)

7.10 Invoicing Instructions - Progress Claim - Firm Price

1. The Contractor must submit a claim for progress payment using form PWGSC-TPSGC 1111 Claim for Progress Payment (<http://www.tpsgc-pwgsc.gc.ca/app-acq/forms/documents/1111.pdf>).

Each claim must show:

- (a) all information required on form PWGSC-TPSGC 1111;
 - (b) all applicable information detailed under the section entitled "Invoice Submission" of the general conditions;
 - (c) the description and value of the milestone claimed as detailed in the Contract.
2. The Contractor must prepare and certify **one (1) original and two (2) copies** of the claim on form PWGSC-TPSGC 1111, and forward:
- a) the **original and one (1) copy** to the Canadian Space Agency at the address shown on page 1 of the Contract under "Invoices" (Financial Services Section) for appropriate certification by the Project Authority identified herein after inspection and acceptance of the Work takes place;
- and,
- b) **one (1) copy of the original** progress claim to the Contracting Authority identified under the section entitled "Authorities" of the Contract.
3. The CSA's Financial Services Section will then forward the original and one (1) copy of the claim to the Contracting Authority for certification and onward submission to the Payment Office for the remaining certification and payment action.

4. The Contractor must not submit claims until all work identified in the claim is completed.

7.11 Certifications and Additional Information

7.11.1 Compliance

Unless specified otherwise, the continuous compliance with the certifications provided by the Contractor in its bid or precedent to contract award, and the ongoing cooperation in providing additional information are conditions of the Contract and failure to comply will constitute the Contractor in default. Certifications are subject to verification by Canada during the entire period of the Contract.

7.11.2 Federal Contractors Program for Employment Equity - Default by the Contractor

The Contractor understands and agrees that, when an Agreement to Implement Employment Equity (AIEE) exists between the Contractor and Employment and Social Development Canada (ESDC)-Labour, the AIEE must remain valid during the entire period of the Contract. If the AIEE becomes invalid, the name of the Contractor will be added to the "FCP Limited Eligibility to Bid" list. The imposition of such a sanction by ESDC will constitute the Contractor in default as per the terms of the Contract.

7.11.3 SACC Manual Clause

A3060C (2008-05-12), Canadian Content Certification

7.12 Applicable Laws

The Contract must be interpreted and governed, and the relations between the parties determined, by the laws in force in _____ (*to be inserted at contract award*).

7.13 Priority of Documents

If there is a discrepancy between the wording of any documents that appear on the list, the wording of the document that first appears on the list has priority over the wording of any document that subsequently appears on the list.

- (a) the Articles of Agreement;
- (b) the supplemental general conditions 4002 (2010-08-16), Software Development or Modification Services and 4003 (2010-08-16), Licensed Software;
- (c) the general conditions 2040 (2016-04-04) General Conditions - Research & Development;
- (d) Annex A, Statement of Work;
- (e) Annex B, Basis of Payment;
- (f) the Contractor's bid dated _____ (insert date of bid) (If the bid was clarified or amended, insert at the time of contract award: "as clarified on _____" **or** ", as amended on _____" and insert date(s) of clarification(s) or amendment(s))

7.14 Foreign Nationals (Canadian Contractor)

SACC Manual clause A2000C (2006-06-16), Foreign Nationals (Canadian Contractor)

7.15 Insurance

SACC Manual clause G1005C (2016-01-28), Insurance

7.16 Controlled Goods Program

SACC Manual clause A9131C (2014-11-27), Controlled Goods Program

7.17 Directive on Communications with the Media

1. DEFINITIONS

“Communication Activity(ies)” includes: public information and recognition, the planning, development, production and delivery or publication, and any other type or form of dissemination of marketing, promotional or information activities, initiatives, reports, summaries or other products or materials, whether in print or electronic format that pertain to the present agreement, all communications, public relations events, press releases, social media releases, or any other communication directed to the general public in whatever form or media it may be in, including but without limiting the generality of the preceding done through any company web site.

2. COMMUNICATION ACTIVITIES FORMAT

The Contractor must early coordinate with the Canadian Space Agency (CSA) all Communication Activities that pertain to the present contract.

Subject to review and approval by the CSA, the Contractor may mention and/or indicate visually, without any additional costs to the CSA, the CSA's participation in the contract through at least one of the following methods at the complete discretion of the CSA:

- a. By clearly and prominently labelling publications, advertising and promotional products and any form of material and products sponsored or funded by the CSA, as follows, in the appropriate official language:

“This program/project/activity is undertaken with the financial support of the Canadian Space Agency.”

“Ce programme/projet/activité est réalisé(e) avec l'appui financier de l'Agence spatiale canadienne.”

- b. By affixing CSA's corporate logo on print or electronic publications, advertising and promotional products and on any other form of material, products or displays sponsored or funded by the Canadian Space Agency.

Any and all mention or reference to the Canadian Space Agency in addition to those specified above in (a) and (b) must be specifically accepted by the CSA prior to publication.

The Contractor must obtain and use a high resolution printed or electronic copy of the CSA's corporate identity logo and seek advice on its application, by contacting the Project Authority, mentioned in section 7.5.2 of this contract.

3. COMMUNICATION ACTIVITY COORDINATION PROCESS

The contractor must coordinate with the CSA's Directorate of Communications and Public Affairs all Communication Activities pertaining to the present contract. To this end, the contractor must:

- a. As soon as the Contractor intends to organize a Communication Activity, send a Notice to the CSA's Directorate of Communications and Public Affairs. The Communications Notice must include a complete description of the proposed Communication Activity. The Notice must be in writing in accordance with the clause Notice included in the general conditions applicable to the contract. The Communications Notice must include a copy or example of the proposed Communication Activity.
- b. The contractor must provide to the CSA any and all additional document in any appropriate format, example or information that the CSA deems necessary, at its entire discretion to correctly and efficiently coordinate the proposed Communication Activity. The Contractor agrees to only proceed with the proposed Communication Activity after receiving a written confirmation of coordination of the Communication Activity from the CSA's Directorate of Communications and Public Affairs.
- c. The Contractor must receive beforehand the authorization, approval and written confirmation from the CSA's Directorate of Communications and Public Affairs before organizing, proceeding or hosting a communication activity.

Solicitation No. - N° de l'invitation
9F063-160953/B
Client Ref. No. - N° de réf. du client
9F063-16-0953

Amd. No. - N° de la modif.
File No. - N° du dossier
MTB-6-39409

Buyer ID - Id de l'acheteur
MTB575
CCC No./N° CCC - FMS No./N° VME

ANNEX "A"

STATEMENT OF WORK

The Statement of Work, appended to the bid solicitation package, is to be inserted at this point and forms part of this document.

Solicitation No. - N° de l'invitation
9F063-160953/B
Client Ref. No. - N° de réf. du client
9F063-16-0953

Amd. No. - N° de la modif.
File No. - N° du dossier
MTB-6-39409

Buyer ID - Id de l'acheteur
MTB575
CCC No./N° CCC - FMS No./N° VME

ANNEX "B"

BASIS OF PAYMENT

SCHEDULE OF MILESTONES

The schedule of milestones for which payments will be made in accordance with the Contract is as follows:

Milestone No.	Deliverable	Firm Amount	Delivery Date
1	Specify		
2	Specify		
3	Specify		
Etc			

Total Firm Price CAN \$ _____
(Taxes Extra, if applicable)

ATTACHMENT 1 TO PART 3

TECHNICAL AND MANAGERIAL BID PREPARATION INSTRUCTIONS

3A.1. Technical and managerial bid

The details provided in this Attachment complement the information introduced in paragraph 3.1 of Part 3: *Bid Preparation Instructions*.

The Bidder should present the information about the Technical and Managerial Bid for each Priority Technology in the following order:

1. Title / Project Identification Page (see 3A.2);
2. Executive Summary (see 3A.3);
3. Table of Contents (see 3A.4);
4. Project Definition and Plan (see 3A.5);
5. Bid Appendices (see 3A.6)

The structure of the Technical and Managerial Bid, and its subsections, are described below. Some of the subsection headings are followed by numbers in brackets. These numbers represent the Evaluation Criteria (see Table 4A.1 of Attachment 1 to Part 4) that are applicable to that specific section/subsection for each bid submitted by a Bidder.

3A.2 Title/Project Identification Page

The first page of the each bid submitted should state the following information.

- a) The Request For Proposal file number (Space Technologies 9F063-160953/B);
- b) The company's name and address;
- c) The title of the proposed Work (the use of acronyms in the title is discouraged, unless they are described);
- d) The Priority Technology (PT) addressed by the bid (refer to Part 2, Table 1: *List of Priority Technologies*);
- e) The current and targeted TRL (up to TRL 5) of the proposed technology (refer to Annex A, Appendix A-1 Technology readiness Levels (TRLs) for TRL descriptions); and
- f) A short extract from the Executive Summary (maximum **7 lines**) of the bid. The technology development being proposed and its relevance to targeted Priority Technology list should be described.

3A.3 Executive Summary

The Bidder should provide an Executive Summary. The Executive Summary is a stand-alone document suitable for public dissemination, for example, through the CSA web site. The Executive Summary should not exceed two pages in length (8.5" x 11") and should highlight the following elements:

- a) Work objectives;
- b) Main innovations;
- c) TRL development;
- d) Technical risks;
- e) Major milestones and deliverables; and
- f) Impact on the proposed technology and the associated targeted Future Mission(s).

Bidder shall provide the Executive Summary in soft copy with the only acceptable format: MS Word, PDF or HTML in a separate unprotected file and not contain any proprietary markings.

3A.4 Table of Contents

The table of contents should be formatted such that its headings are linked to their respective location in the bid for ease of reference when using the bid's Soft copy version.

3A.5 Project Definition and Plan

This section should describe the project and plan as outlined in the following subsections.

3A.5.1 Understanding the technology (Evaluation Criterion 1)

(see section 4A.3.1 Criterion 1 Understanding the technology of Attachment 1 to Part 4)

This criterion assesses the degree to which the bid exhibits an understanding of the fundamental concepts of the technology, of its associated systems level design tradeoffs and of its usage in the proposed application. In order to do the assessment, the Bidder should demonstrate a detailed understanding as well as broaden the fundamental concepts.

The understanding can be demonstrated by description of the overall problem and solution proposed by the Bidder, an overview of the background context, such as results of literature searches, prior development, state-of-the-art, and a general description of the expected improvement, results and benefits, based on the technical objectives described in Annex A, Appendix A-5: *List of Priority Technologies and associated specific statement of works*.

3A.5.2 Team Experience and Capability (Evaluation Criterion 2)

(see section 4A.3.2 Criterion 2 Team Experience and Capability of Attachment 1 to Part 4)

This criterion assesses the combined technical capability and experience of the key project Scientists/Engineers identified to carry out the work as well as the qualifications and experience of the Project Manager. In order to do the assessment, the Bidder should:

- Provide an overview of its organisation. It should cover the following elements: the nature and structure of the Bidder's organization; the level of Canadian ownership; the location, size and general description of the plant facility; the size and composition of staff; the principal product or field of endeavour; the annual business volume and general nature of the company's client base; and a list of any applications for funding from other Government sources and/or Government contracts received for similar and/or related work. This section should identify the location where the Work will be performed.
- Identify the key members of the project's technical and management teams and state their specific roles, qualifications and experience for the work involved. The Bidder should include an organization chart that illustrates the structure of the proposed project team. The project manager's track record in past projects must be detailed. Detailed resumes should be provided into an Appendix to Section I of the bid. Names of back-up personnel for key positions should also be included.
- In line with one of the priorities of the Government aiming at encouraging Canadians to develop science, technology, engineering and math (STEM) related skills to prepare them for the jobs of tomorrow, to obtain the maximum score, it will be essential for the bidder to involve at least one student to perform science, technical, engineering and/or mathematical (STEM) tasks.

3A.5.3 Implementation Plan (Evaluation Criterion 3)

(see section 4A.3.3 Criterion 3 Implementation Plan of Attachment 1 to Part 4)

The Bidder should present an Implementation Plan that will effectively and efficiently direct the project to a successful completion. The Implementation Plan's presentation must be based on the recognized management tools most applicable to the proposed project, such as a scope planning (Work Breakdown Structure), and schedule development charts (Gantt, Program Evaluation and

Review Technique -PERT, etc). Equivalent Bidder-developed, project-tailored tools/charts are also acceptable, provided that the information is complete.

3A.5.3.1 Work Breakdown Structure and Work Package Definition

This Implementation Plan subsection should define and specify the scope of Work to be executed according to the requirements of the Statement of Work, Contract Deliverables and Meetings (Annex A). Work Breakdown Structure (WBS) is a recognized scope definition technique, while Work Packages (WP) stem from the WBS. The WBS should flow down to a low enough level and the associated WP should be defined in sufficient depth in order for the Bidder to demonstrate the methodology that will be followed to perform the project.

Each WP should focus on specific activities that will form the total Work and, as a minimum, should define and describe the specific work to be carried out. It should also indicate: the person responsible, the WP's associated levels-of-effort and required resources, the schedule (start and finish dates), and the associated inputs and deliverable or output.

As a guideline, Figure 3A.1 presents a fictitious example of a WBS, while Table 3A.1 presents a fictitious example of a Work Package Definition Sheet. For each work packages the Bidder should provide a detailed statement of work and list the associated resources.

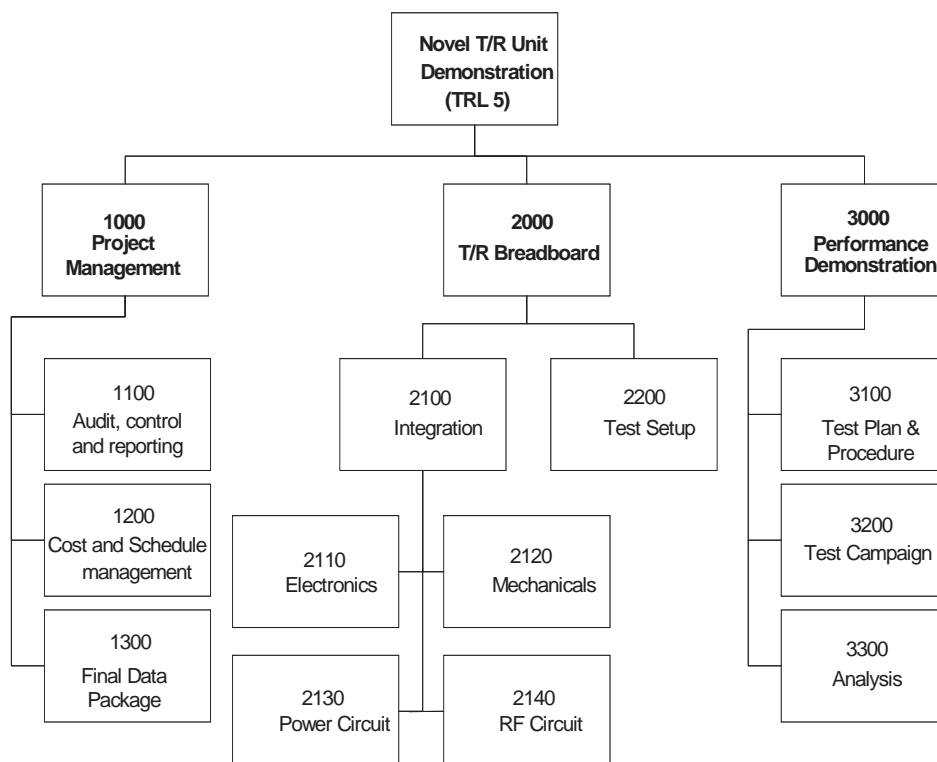


Figure 3A.1: Example of a Work Breakdown Structure

Project: T/R Unit Demonstration		
Work Pack Title:	TEST SETUP	WBS Ref: 2200
Sheet: 1 of 1	WP Estimated Value:	Do not indicate \$ value in Section I of the bid, indicate value only in Section II
Scheduled Start: T0 + 2 weeks	Accountable Manager:	Resource A
Scheduled End: T0 + 12 weeks	Resources:	Resource A, Resource B, Resource C
Estimated Effort: 80 hours		
<u>Objectives:</u>		
<ul style="list-style-type: none"> Deliver a functional test setup for the T/R unit 		
<u>Inputs:</u>		
<ul style="list-style-type: none"> Test plan and procedure Unit drawings Unit Interface Control Documents 		
<u>Tasks:</u>		
<ul style="list-style-type: none"> Review input documentation Define requirements Produce initial concept Design test setup Fabricate test setup Commission and debug 		
<u>Outputs and Deliverables:</u>		
<ul style="list-style-type: none"> Fully functional T/R unit test setup Test setup log manual Test setup user manual 		

Table 3A.1: Example of Work Package Definition Sheet

3A.5.3.2 Personnel Allocation

This Implementation Plan subsection should include a Responsibility Assignment Matrix (RAM) showing the level-of-effort for each individual team member or sub-contractor that has been allocated to each WP. The matrix should identify each individual by name and organisation, and provide the estimated time (number of hours or days) required to complete each task. Also, the RAM should identify the role of the individual, either being the accountable person for the WP (A), or being a participant (P). Bidders must provide letters of intent from involved sub contractors or major contributors to the project. As a guideline, Table 3A.2 presents a fictitious example of a RAM. The RAM should be presented in both the technical bid and the financial bid.

WBS Number	Work Package Title	Resource A		Resource B		Resource C		Total
1.1	Project Management	A	200	P	25	P	25	250
1.2	Literature Survey	A	25	P	100	-	0	125
1.3	Requirements	P	50	A	100	P	100	250
1.4	Design	P	100	A	100	P	150	350
1.5	Build	-	0	P	200	A	150	350
1.6	Test and Analysis	A	100	P	200	P	200	500

P : Participant

A : Accountable

Total

475

725

625

1825

Table 3A.2: Example of Responsibility Allocation Matrix (RAM)

3A.5.3.3 Technical Risk Assessment/Analysis

The Bidder should provide an assessment of the technical risks/uncertainties involved as well as the major assumptions upon which the work is based. In particular, this subsection should address any performance risks that pertain to the new technology. The risks should be identified and a Risk Mitigation Plan, that would include contingency plans, alternatives or other means of limiting adverse impacts of risks being realized, should be provided. As a guideline, Table 3A.3 presents a fictitious example of a Technical Risk Assessment Matrix, while Table 3A.4 presents an example of a Project Risk Profile Matrix.

Risk Event 1 (R1)	Limited availability of key documents	
Probability	Low	1/20 Past experience demonstrates important number of different sources for patents and articles covering this subject
Consequence to project	Low	\$5 000 - \$10 000 Cost growth Schedule delays
Risk Assessment	Low	\$250 - \$500 (R < 5% of overall project value, \$250K)
Mitigation Plan	Secure at least 2 sources for each type of document	
Contingency Plan	Use second source	

Table 3A.3: Example of a Technical Risk Assessment Matrix

Probability			
High			R2
Medium			
Low	R1		
	Low	Medium	High
	Consequence		

Table 3A.4: Project Risk Profile Matrix

It is understood that in order to develop advanced technologies, a certain amount of technical risk should be assumed. The extent to which higher technical risks are acceptable depends upon how well they have been identified, defined, assessed, planned for, and managed once realized. If the technical risks are poorly defined, or the risk mitigation is inadequately planned, then the project's evaluation score is likely to diminish.

3A.5.3.4 Managerial Risk Assessment

This Implementation Plan subsection should provide an assessment of the managerial risks involved, provide a Risk Mitigation Plan and identify critical issues that may jeopardize the successful completion of the Work within cost and schedule constraints. As a guideline, Table 3A.5 presents a fictitious example of a Managerial Risk Assessment Matrix. Additionally, Table 3A.6 presents an example of a Project Risk Profile Matrix.

Risk Event 2 (R2)	Late delivery of test equipment	
Probability	High	1/3 Past experience with provider demonstrated poor respect of schedule
Consequence to project	High	\$110 000 (cost of securing optional test facility) Significant cost growth Significant schedule delays
Risk Assessment	High	\$55 000 High (R > 25% of overall project value)
Mitigation Plan	Identify and secure equivalent equipment in immediate geographical region Ensure equipment will be available for needed time frame Memo of understanding with facility key managers	
Response Plan	Secure equipment with MOU Confirm time frame options with facility	

Table 3A.5: Example of a Managerial Risk Assessment Matrix

Probability			
High			R2
Medium			
Low	R1		
	Low	Medium	High
	Consequence		

Table 3A.6: Example of a Project Risk Profile Matrix

3A.5.3.5 Milestones and Deliverables

This Implementation Plan subsection should contain a definition of the milestones and describe in details all expected deliverables, including hardware, software, and relevant documentation (refer to Annex A for more details). When appropriate, the milestones and deliverables should contain all elements identified in the SOW (Table A-2 of Annex A and specific SOWs) and should relate to the corresponding WP definition in a manner enabling clear monitoring of progress (see paragraph 3A.5.3.1)

3A.5.3.6 Schedule

The Bidder should provide a project timetable that relates tasks, milestones and deliverables. A Gantt chart and/or PERT chart should be used to illustrate the schedule. The schedule should show significant details for events associated with achievement of major tasks, milestones and deliverables. Linkage between activities should also be identified in the schedule. For planning purposes, use a project start date of January 2018.

3A.5.3.7 Performance Evaluation Criteria (PEC)

The Bidder should establish technical conditions and criteria to be met for each TRL targeted in the project as well as a list of objectively measurable or binary (yes/no) Performance Evaluation Criteria (PEC). These will be reviewed at the kick off meeting and serve to determine which criteria will be used for the work authorization decision and determine project success at the final review meeting.

3A.5.3.8 Project Control System

This Implementation Plan subsection should outline the methods and systems to be used to control and report on the various aspects of project (e.g. tasks, schedules, and costs for the Work). Additionally, the Project Control System should be capable of reporting the amount of work per WBS item for each individual on a monthly basis.

3A.5.3.9 Background Intellectual Property and Foreground Intellectual Property

This subsection should identify and describe all Background Intellectual Property (BIP) that is required to conduct and/or support the Work and all Foreground Intellectual Property (FIP) expected to arise from the proposed Work. BIP and FIP element should be described in sufficient detail so as to be clearly distinguishable. The expected format to provide this information is as per Tables 3A.7 and 3A.8.

Solicitation No. - N° de l'invitation
9F063-160953/B
Client Ref. No. - N° de réf. du client
9F063-16-0953

Amd. No. - N° de la modif.
File No. - N° du dossier
MTB-6-39409

Buyer ID - Id de l'acheteur
MTB575
CCC No./N° CCC - FMS No./N° VME

1 BIP ID#	2 Project Element	3 Title of the BIP	4 Type of IP	5 Type of access to the BIP required to use/improve the FIP	6 Description of the BIP	7 Reference documentation	8 Origin of the BIP	9 Owner of the BIP
Provide ID # specific to each BIP BIP element brought to the project e.g. BIP- CON-99 where CON is the contract acronym	Describe the system or sub system in which BIP is integrated (e.g. camera, control unit, etc)	Use a title that is descriptive of the BIP element integrated to the work	Is the BIP in the form of an invention, trade secret, copyright, design?	Describe how the BIP will be available for Canada to use the FIP(e.g. BIP information will be incorporated in deliverable documents, software will be in object code, etc)	Describe briefly the nature of the BIP(e.g. mechanical design, algorithm, software, method, etc)	Provide the number and fill title of the reference documents where the BIP is fully described, The reference document must be available to Canada. Provide patent# for Canada if BIP is patented.	Describe circumstances of the creation of the BIP Was it developed from internal research or through a contract with Canada? If so, provide contract number.	Name the organization that owns the BIP. Provide the name of the subcontractor if not owned by the prime contractor.

Table 3A.7: Disclosure of Background Intellectual Property (BIP) expected to be required for the Contract

1 FIP ID #	2 Project Element	3 Title of FIP	4 Type of FIP	5 Description of the FIP	6 Reference documentation	7 BIP used to generate the FIP	8 Owner of the FIP	9 Patentability
Enter an ID # specific to each FIP element e.g.FIP- CON-99 where CON is the contract acronym	Describe the system or sub- system for which the FIP element was developed (e.g. a camera, ground control, etc)	Use a title that is descriptive of the FIP element.	Specify the form of the FIP e.g. invention, trade secret, copyright, industrial design	Specify the nature of the FIP e.g. software, design, algorithm, etc?	Provide the full title and number of the reference document where the FIP is fully described. The reference document must be available to Canada	BIP referenced in table 1 e.g. BIP- CON-2, 15	Specify which organization owns the FIP e.g. Contractor, Canada* or Subcontractor. Provide the name of the subcontractor if not owned by the prime contractor. Provide reference to contract clauses that support FIP ownership. Provide reference to WPDs under which the technical work has been performed.	In the case where the IP is owned by Canada, indicate with an "X", any IP elements described is patentable and complete Table 3 only for this IP.

Table 3A.8: Disclosure of the Foreground Intellectual Property (FIP) expected to be developed under the Contract

Use of graphical representations that include block diagrams is encouraged in order to demonstrate the relationships between the various elements of the BIP and the FIP. The BIP and the expected FIP will be reviewed at the Kick-Off Meeting, and updated at the end of the contract.

Bidder's realizations that are software oriented and propose to improve upon existing software programs/applications will be required to adhere to supplemental general conditions 4002 (Software Development or Modification Services) and 4003 (Licensed Software).

3A.5.4 Feasibility Of Proposed Solution In Meeting The Technical Objectives (Evaluation Criterion 4) (see section 4A.3.4 Criterion 4 Feasibility Of Proposed Solution In Meeting The Technical Objectives, of Attachment 1 to Part 4)

The criterion assesses the overall feasibility of the proposed technical approach and the degree to which the solution will satisfy the technical objectives. In order to do the assessment, the bid should:

- Clearly describe the proposed solution in terms of its physical characteristics, functionality and performance. When applicable, the foreseen concept of operation should be introduced.
- Describe the physical principles under which the solution operates.
- Described critical design and fabrications steps.
- Clearly state the degree to which the solution satisfies the technical objectives sought in the specific statements of work.

3A.6. Bid Appendices

3A.6.1 Appendices Required with the Bid

The following item should be addressed in individual appendices as part of the bids:

- a) List of Acronyms: All the acronyms used in the Section I: Technical and Managerial Bid, should be explained;
- b) Resumes: The bid should include resumes of the proposed resources and these should be appended to Section I: Technical and Managerial Bid;
- c) Relevant Technical Papers Published by Team Members: Only literature that is relevant and that would be useful to support the bid;
- d) List of Contacts: The list of contacts should be appended to Section I: Technical and Managerial Bid, in a format suitable for distribution and should include all the Bidder's points-of-contacts involved in the bid development and/or during the Contract;

The following example format should be used:

Role	Name	Telephone	E-Mail
Project Manager			
Project Engineers/Head Investigator			
Contractor's Representative			
Claims(Invoicing) Officer			
Communications (for press release)			
Etc.			

Table 3A.9: Bidder's List of Contacts

Solicitation No. - N° de l'invitation
9F063-160953/B
Client Ref. No. - N° de réf. du client
9F063-16-0953

Amd. No. - N° de la modif.
File No. - N° du dossier
MTB-6-39409

Buyer ID - Id de l'acheteur
MTB575
CCC No./N° CCC - FMS No./N° VME

-
- e) Letters of intent: Letters of intent to participate must be provided by all sub-contractors or co-contributors to the project;
- f) Bidder's criteria Substantiation: For each of the applicable evaluation criteria, provide the substantiation and summarized cross-reference(s) to the bid.

Solicitation No. - N° de l'invitation
9F063-160953/B
Client Ref. No. - N° de réf. du client
9F063-16-0953

Amd. No. - N° de la modif.
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CCC No./N° CCC - FMS No./N° VME

ATTACHMENT 2 TO PART 3
ELECTRONIC PAYMENT INSTRUMENTS

The Bidder accepts to be paid by any of the following Electronic Payment Instrument(s):

- ☐ VISA Acquisition Card;
- ☐ MasterCard Acquisition Card;
- ☐ Direct Deposit (Domestic and International);
- ☐ Electronic Data Interchange (EDI);
- ☐ Wire Transfer (International Only);
- ☐ Large Value Transfer System (LVTS) (Over \$25M)

ATTACHMENT 1 TO PART 4

POINT RATED EVALUATION CRITERIA

4A.1. TECHNICAL AND MANAGEMENT CRITERIA AND RATINGS

The Bidder must achieve the minimum score requirements as indicated in Table 4A.1: *List of Evaluation Criteria and Associated Ratings*. The bid will be evaluated according to the point-rated criteria as specified in Table 4A.1 and as described in section 4A.3: *Evaluation Criteria and Benchmark Statements*

Section 4A.3 "Evaluation Criteria and Benchmark Statements" of the current attachment contains a series of evaluation criteria, each supported by a set of 5 benchmark statements, where each corresponds to percentage of the maximum point rating.

As an example, the maximum point rating for the *Team Experience and Capability* criterion is 15 points. If a Bid receives a "75" for this criterion in the evaluation process, the score attributed will be:

$$75\% \text{ of } 15 \text{ points} = 11.25 \text{ points (score)}$$

Table 4A.1 identifies:

- a) The maximum point rating assigned to each criterion;
- b) The minimum point rating required for the criterion #4: *Feasibility of proposed solution in meeting the technical objectives*;
- c) The maximum point rating possible for the overall technical score; and
- d) The minimum point rating required for the overall technical score.

Technical Evaluation Criteria and Ratings		
	Max. Ratings	Minimum required
1. Understanding the technology	15	N/A
2. Team Experience and Capability	15	N/A
3. Implementation Plan	30	N/A
4. Feasibility of proposed solution in meeting the technical objectives	40	20
Overall Technical Score	100	70

Table 4A.1: - List of Evaluation Criteria and Associated Ratings

4A.2. BIDDER'S CRITERIA SUBSTANTIATION

The Bidder is requested to provide a substantiation (supporting evidence), which should be submitted as an appendix to their Section I (see section 3A.6.1: *Appendices required with the bid* of Attachment 1 of Part 3: *Technical and Managerial Bid Preparation Instruction*).

For each of the applicable evaluation criteria, provide the substantiation and summarized cross-reference(s) to the bid.

The substantiation should be concise yet sufficiently comprehensive to ensure that the evaluators get a good overall appreciation of the bid's merit relative to the specific evaluation criterion. Cross-references to appropriate sections of the bid should be provided and the essence of the referenced information should be summarised in the substantiation.

For convenience, a Substantiation Table is provided in Table 4A.2 below. Enter each evaluation criterion section number, and the substantiation. It is expected that approximately half a page should be sufficient to make the Bidder's case for the rating chosen in the substantiation column.

Company:	
Project Title:	
Development of enabling space technologies	
Criteria	
Substantiation	
<i>Ex.: 1</i> <i>(criterion number)</i>	<i>Understanding the technology - It is expected that 300 words or so should be sufficient to make your case.</i>

Table 4A.2: Substantiation Table

4A.3. EVALUATION CRITERIA AND BENCHMARK STATEMENTS

The evaluation criteria benchmark statements are used by the evaluators as guidelines to justify their score. Bidders should use them to appropriately focus the relevant information to be provided.

4A.3.1 CRITERION 1: UNDERSTANDING THE TECHNOLOGY

This criterion assesses the degree to which the bid exhibits an understanding of the fundamental concepts of:

**the technology;
the technology's associated systems level design tradeoffs;
the technology's usage in the proposed application.**

Score Benchmark Statements

0	The bid does not exhibit an understanding of the fundamental concepts.
25	The bid demonstrates only a limited understanding of the fundamental concepts.
50	The bid demonstrates a general understanding of the fundamental concepts.
75	The bid demonstrates a detailed understanding of the fundamental concepts.
100	The bid broadens the review of technological concepts involved as well as of the associated systems level design tradeoffs and of the technology's usage in its application.

4A.3.2 CRITERION 2: TEAM EXPERIENCE AND CAPABILITY

This criterion assesses the combined technical capability and experience of the key project Scientists/Engineers identified to carry out the work as well as the qualifications and experience of the Project Manager.

Score Benchmark Statements

0	The bid does not demonstrate that the proposed team has technical capability and experience with closely related technologies.
25	The bid demonstrates that the proposed team is missing key technical capability and has limited experience with closely related technologies. The bid does not substantiate that the project manager has a track record of having successfully completed projects of similar scope and complexity to that required for this project.
50	The bid demonstrates that the proposed team has technical capability and experience with closely related technologies, but some capabilities are weak to form a comprehensive team. The project manager has a moderate track record of successfully having managed projects of a scope and complexity similar to that required for this project.
75	The bid demonstrates that the proposed team has worked with closely related technologies of comparable scope and complexity. The proposed team possesses all the technical capabilities and experience required to perform the Work. The project manager has a moderate track record of success in executing and managing projects of a scope and complexity similar to that required for this project.
100	The bid clearly substantiates that the proposed team is highly experienced in developing closely related technologies of comparable scope and complexity. The proposed team possesses all the technical capabilities required to perform the Work. The project manager has a successful track record in executing and managing projects of a scope and complexity similar to that required for this project. The bid also involves at least one student to perform science, technical, engineering and/or mathematical (STEM) tasks.

4A.3.3 CRITERION 3: IMPLEMENTATION PLAN

This criterion evaluates the project's underlying methodology and the thoroughness of the Implementation Plan. The plan will be evaluated for its completeness, credibility, effectiveness and efficiency.

The Implementation plan required content is specified in Section 3A.5.3 of Attachment 1 of Part 3.

Score Benchmark Statements

0	The bid has no concrete Implementation Plan and thereby instills no confidence that the project will successfully meet the project objectives.
25	The bid does not provide an adequate Implementation Plan as more than one of the elements are missing or are improperly addressed. Consequently, doubts remain regarding the likelihood of the project achieving successful completion.
50	The bid provides an Implementation Plan with some elements improperly addressed. Consequently, the likelihood of achieving successful completion is marginal OR the plan reveals serious inefficiencies.
75	The bid provides a credible Implementation Plan with all elements covered. Conditions and criteria to be met for each TRL are defined and elaborated. Consequently, the likelihood of achieving successful completion is good. The plan demonstrates a somewhat efficient implementation approach.
100	The bid provides a coherent and comprehensive Implementation Plan with all elements covered. Conditions and criteria to be met for each TRL are well defined and elaborated. The plan instills confidence that the project will achieve successful completion. The plan demonstrates an efficient implementation approach.

4A.3.4 CRITERION 4: FEASIBILITY OF PROPOSED SOLUTION IN MEETING THE TECHNICAL OBJECTIVES

The criterion assesses the overall feasibility of the proposed technical approach and the degree to which the solution will satisfy the technical objectives.

MINIMUM SCORE OF 50 REQUIRED

Score Benchmark Statements

0	The feasibility of the proposed solution or the capability to satisfy the objectives is not demonstrated.
25	The proposal presents a solution which is unlikely to meet the technical objectives.
50	The proposal presents an adequate solution that can meet the technical objectives.
75	The proposal presents a credible solution that will likely meet the technical objectives.
100	The proposal presents a sound and convincing solution that can most likely meet the technical objectives.

ATTACHMENT 1 TO PART 5

FEDERAL CONTRACTORS PROGRAM FOR EMPLOYMENT EQUITY – CERTIFICATION (For requirements estimated at \$1,000,000 and above, Applicable Taxes included)

I, the Bidder, by submitting the present information to the Contracting Authority, certify that the information provided is true as of the date indicated below. The certifications provided to Canada are subject to verification at all times. I understand that Canada will declare a bid non-responsive, or will declare a contractor in default, if a certification is found to be untrue, whether during the bid evaluation period or during the contract period. Canada will have the right to ask for additional information to verify the Bidder's certifications. Failure to comply with any request or requirement imposed by Canada may render the bid non-responsive or constitute a default under the Contract.

For further information on the Federal Contractors Program for Employment Equity visit [Employment and Social Development Canada \(ESDC\) – Labour's](#) website.

Date: _____ (YYYY/MM/DD) (If left blank, the date will be deemed to be the bid solicitation closing date.)

Complete both A and B.

A. Check only one of the following:

- ☐ A1. The Bidder certifies having no work force in Canada.
- ☐ A2. The Bidder certifies being a public sector employer.
- ☐ A3. The Bidder certifies being a [federally regulated employer](#) being subject to the [Employment Equity Act](#).
- ☐ A4. The Bidder certifies having a combined work force in Canada of less than 100 permanent full-time and/or permanent part-time employees.

A5. The Bidder has a combined workforce in Canada of 100 or more employees; and

- ☐ A5.1. The Bidder certifies already having a valid and current [Agreement to Implement Employment Equity](#) (AIEE) in place with ESDC-Labour.

OR

- ☐ A5.2. The Bidder certifies having submitted the [Agreement to Implement Employment Equity \(LAB1168\)](#) to ESDC-Labour. As this is a condition to contract award, proceed to completing the form Agreement to Implement Employment Equity (LAB1168), duly signing it, and transmit it to ESDC-Labour.

B. Check only one of the following:

- ☐ B1. The Bidder is not a Joint Venture.

OR

Solicitation No. - N° de l'invitation
9F063-160953/B
Client Ref. No. - N° de réf. du client
9F063-16-0953

Amd. No. - N° de la modif.
File No. - N° du dossier
MTB-6-39409

Buyer ID - Id de l'acheteur
MTB575
CCC No./N° CCC - FMS No./N° VME

-
- () B2. The Bidder is a Joint venture and each member of the Joint Venture must provide the Contracting Authority with a completed annex Federal Contractors Program for Employment Equity - Certification. (Refer to the Joint Venture section of the Standard Instructions)

ANNEX A

STATEMENT OF WORK

A.1 SPACE TECHNOLOGY DEVELOPMENT PROGRAM BACKGROUND

The Space Technology Development Program (STDP) mandate is to formulate, implement and manage contracted out research and development (R&D) projects in response to identified needs. Its objectives are to develop and demonstrate strategic technologies that have a strong potential for reducing technical uncertainties for future Canadian space activities.

The STDP will therefore support the development of technologies to meet the current and future needs of the Canadian Space Program.

A.2 OBJECTIVES

The objective of this Statement of Work (SOW) is to enable the development of 2 Space Technologies that are in line with the Canada Space Agency's (CSA) priorities and mission roadmaps. For every Priority Technology (PT) listed herein (see APPENDIX A-5 of ANNEX A), the work solicited is the development and advancement of these technologies up to potentially TRL 5 (Technology Readiness Levels), (see APPENDIX A-1 of ANNEX A) to reduce technical uncertainties and support approval and implementation of specific potential future space missions of interest to Canada.

A.3 SCOPE

This document provides the requirements and deliverables for projects selected to develop and advance technologies that are critical for the approval and implementation of potential or planned future Canadian space missions.

A.4 PRIORITY TECHNOLOGIES

Priority Technologies are those that have been established by the CSA as the critical or strategic technologies to be developed to meet the objectives of the CSA. The contracts to be awarded are to respond to one of the Priority Technologies Specific Statement of Work detailed in APPENDIX A-5 of ANNEX A.

A.5 DOCUMENT CONVENTIONS

A number of sections in this document describe controlled requirements and specifications and therefore the following verbs are used in the specific sense indicated below:

- a) "Shall" is used to indicate a mandatory requirement;
- b) "Should" indicates a goal or preferred alternative rather than a requirement. Such goals or alternatives are to be treated on a 'best efforts' basis, and are subject to verification as requirements are. The actual performance achieved shall be included in the appropriate verification report, whether or not the performance goal is achieved;
- c) "May" indicates an option;

- d) “Will” indicates a statement of intention or fact, as does the use of present indicative active verbs other than those listed at a-c above.

A.6 GENERIC TASK DESCRIPTION

This section presents the potential activities that might take place during typical STDP projects and are deemed appropriate within the required TRL range. Tasks will vary for different projects according to targeted TRLs and may include, but are not limited to, the standard project activities listed below in Table A-1: Guideline of Activities. Contractor should use the following guideline table to select the appropriate required activities in order to satisfy the conditions for the targeted TRLs. Technology Readiness Levels (TRLs) describe the standard language of the maturation process for technology development and evolution. TRLs are described in APPENDIX A-1 of ANNEX A.

List of Activities
Project Management *
1. Meetings
▪ Progress Monitoring
▪ Finance Management
▪ Reporting
▪ Preparation of Final Data Package
▪ Risk Management
▪ Configuration management
Sub-Contractor Management
▪ Procurement Plan
Needs Analysis
2. Mission Definition
▪ Definition of Mission Requirements
▪ Environment Definition
3. Technology Drivers and Constraints
▪ Requirements
Obtain Current Mission Documentation, and Technology Requirements
Define further Technology Requirements in terms of functional and performance characteristics
Conceptual Design
▪ Functional Analysis and Allocation
▪ Develop Operations and Development Concepts
▪ Cost Estimates
▪ Schedule Estimates
▪ Risk Analysis
▪ System Studies and Trades
▪ Identify Driving Requirements and Associated Risks
▪ Modeling and Prototyping
Design and Development Plan
Analysis
Simulation
Documentation / technical writing

Concept Design Review
Preliminary Design Review
Critical Design Review
Breadboard Development Plan
Algorithm Development
Define System Failure Modes
Failure Modes Effects and Analysis
Assembly processes development
Process and Test Documentation
Test Data Preparation
Evaluation of Performance
Test System Development
Component test
Acceptance test
Stand-alone functional test
Test procedures and reports
Develop formal specifications and interface control
Fabrication
Assembly and Test
Integration, Testing, Verification & Validation
Compliance
Field Trials and Demonstrations

* CSA considers that nominal project management effort should not exceed 15% of total effort.

Table A-1: Guideline of Activities

A.7 CONTRACT DELIVERABLES AND MEETINGS

This section reviews and describes the contract deliverables and meetings.

Figure A-1 is a guideline, which provides a master Milestone Schedule for typical contract duration of twelve (12) months. The figure highlights a sample schedule for the major meetings and deliverables.

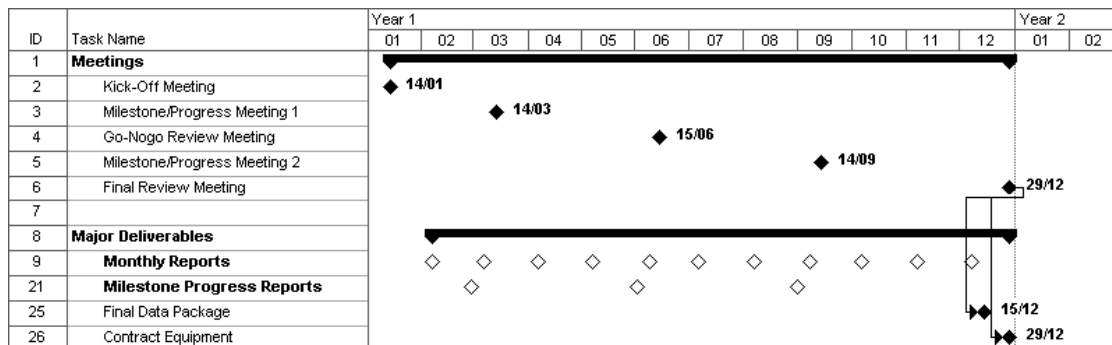


Figure A-1: Sample Meetings and Deliverables Master Schedule

Table A-2 contains the list of meetings, expected items to be covered during those meetings, and the associated contract deliverables. In addition to the mandatory deliverables (CDRL 1 to 16), Priority Technology specific deliverables are identified in APPENDIX A-5 of ANNEX A All applicable deliverables should be clearly identified in the bid.

CDRL No.	Deliverable	Due Date	Version
1	Meeting Agendas	Meeting – 2 week	Final
2	Kick-off Meeting Presentation	Meeting – 1 week	Final
3	Quarterly or Milestone/Progress Review Meeting Presentation	Meeting – 2 week	Final
4	Final Review Meeting Presentation	Meeting – 2 week	Final
5	Meeting Minutes	Meeting + 1 week	Final
6	Action Items Log (AIL)	Meeting + 1 week	Final
7	Monthly Progress Reports	7 th of each Month	Final
8	Milestone/Progress Technical Report	Meeting – 2 weeks	Final
9	Disclosure of Intellectual Property	End of contract – 2 weeks	Final
10	Executive Report	End of contract – 2 weeks	Final
11	Final Milestone/Progress Technical Report	End of contract – 2 weeks	Final
12	Prototypes *	At Final Review Meeting	Final
13	Equipment (purchased under the contract)	At Final Review Meeting	Final
14	Software	Meeting – 2 weeks	Final
15	Government Furnished Equipment/Data	At contract end	Final
16	Final Data Package	Final review meeting + 1 week	Final
17	Asset Declaration Form – Prototypes and Equipment (APPENDIX A-4 to ANNEX A)	End of contract – 2 weeks	Final

Table A-2: Schedule of Contract Items

* The decision regarding the actual delivery of any prototype is to be made by the CSA upon completion of each contract. Unless the contractor is specifically instructed otherwise, prototypes are, by default, deliverables.

A.7.1 DOCUMENTATION, REPORTING AND OTHER DELIVERABLES

This section contains the lists of deliverables and describes their respective content and format. All documents shall be typed and all diagrams shall be clearly drawn and labeled. The Contractor shall submit an electronic copy of each of the deliverable documents.

Each electronic file shall be named in a meaningful manner so as to be easily identified. No specific format is imposed. However, the following element should be considered to ease the identification of the contents in a wider context:

1. Contract reference number;
2. Short project name or acronym
3. Nature of the document (e.g., progress report)
4. Version and/or date

Non-Disclosure

The documents will not be placed in the public domain, except for the Executive Report (see A.7.1.3). The Contractor shall indicate the following proprietary notices:

On the cover:

© Contractor, 20XX

RESTRICTION ON USE, PUBLICATION OR DISCLOSURE OF PROPRIETARY INFORMATION

This document is a deliverable under contract No. _____. This document contains information proprietary to *Contractor*, or to a third party to which *Contractor* may have legal obligation to protect such information from unauthorized disclosure, use or duplication. Any disclosure, use or duplication of this document or any of the information contained herein for other than the specific purpose for which it was disclosed is expressly prohibited except as Canada may otherwise determine. When the Intellectual Property (IP) is disclosed for government purposes, Canada will take every effort to protect information that is proprietary.

On all internal pages:

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A.7.1.1 MONTHLY PROGRESS REPORT

On a monthly basis, no later than the seventh (7th) of each month, the contractor shall provide monthly progress reports. It is requested that an electronic copy of this report be sent to the Project Authority (PA) and the Contracting Authority (CA). Acceptable electronic formats are: MS Word, PDF and HTML. Refer to Section A.7.1 for instructions on how to name electronic documents. Monthly Reports are used by the PA to monitor the work on a monthly basis, these reports should be kept as brief as possible but should discuss the progress of the work and should include, but not be limited to, the following information:

- Statement indicating whether or not the project is on schedule and, if not, an explanation for any delays and/or a recovery plan. The report shall include an updated schedule showing progress of work and modifications, if any;

- Statement indicating whether or not the project is within budget and, if not, an explanation for the deviation from the budget and a proposed recovery plan. The report shall include an updated cash flow table showing, for each activity/milestone/Work Package, with start and end dates as well as actual cash flow with actual start and end dates;
- Brief summary of the technical progress of the work for each work package, including:
 - Description of major items developed, purchased or constructed during the reporting period, and
 - List of internal engineering reports produced during the reporting period;
- Summary of the proposed work for the following month, including:
 - Description of major items to be purchased during the next reporting period, including any software packages;
- Summary of problems encountered, their impact on the project and the subsequent solutions proposed or effected; and
- Trip reports for each conference attended or facilities visited in the course of this contract (and only if funded by the contract).

An overall assessment of the project health shall be provided at the start of each report. The aim is to have an overview of the project status.

The following information should be included in the following format:

Project Element	Status	Trend	Comment
Cost	Green	↑	
Schedule	Green	↓	
Results / PEC	Red	↔	
Programmatic	Yellow	↑	

The first column identifies the project performance metrics to be assessed, namely **Project Element**. The four metrics to assess are:

- Cost,
- Schedule,
- Results against Performance Evaluation Criteria (PEC), and
- Programmatic.

The Cost, Schedule and Results/PEC metric are quantitative indicators, while the Programmatic metric is qualitative.

The second column of the table is the status for each project element.

The following table provides a definition of the different status with respect to the first three Project Elements.

Status Indicator	Interpretation		
	Cost	Schedule	Technical
Green	On or under planned project total budget	On or ahead of baseline schedule	Meets Performance Evaluation Criteria (PEC)
Yellow	Between 0 and 5% overrun	Between 0 and 5% behind schedule	Does not meet PEC but has approved recovery plan
Red	Greater than 5% overrun	Greater than 5% behind	Does not meet PEC and does not have approved recovery plan

As for the Programmatic element, the status is evaluated based on the status of the three other elements. Although the Programmatic metric takes into account Cost, Schedule and Results/PEC indicators, it is mostly influenced by the most critical element at that point in time in the project.

The third column is an assessment of the trend the Project metric. The choices are:

Trend Indicator	Interpretation
↑	The status has improved since the last review
↓	The status has worsened since the last review
↔	The status has not changed since the last review

The Fourth column is to provide the opportunity to comment the status and trend of the project element or to provide a general statement.

A.7.1.2 MILESTONE/PROGRESS TECHNICAL REPORTS

The Contractor shall submit to the PA, TA and CA at least two (2) weeks prior to the due date of Milestone and/or Progress Review Meetings, a draft Milestone and/or Progress Report. The PA will review the report and may request changes, as appropriate. The Contractor will then submit the revised version.

The Milestone and/or Progress Report, which shall be protected, is to contain a complete description of the work undertaken and results obtained. As such it should include all pertinent technical documents that support engineering, fabrication and/or testing tasks. It

should also include an updated version, if applicable, of the Technical and Managerial Plans initially submitted. Moreover, it shall provide sufficient details of the work performed to date to enable the PA and TA to perform a full and accurate progress evaluation.

The description of the work undertaken and the results obtained should include:

- Review of technical results and accomplishments;
- Assessment of results with respect to the PEC provided in the bid (supported with the necessary design documents, engineering drawings, test plans, test results and the like);
- A clear identification of the technology advancements required to meet the objectives;
- A detailed description of all equipment purchased during this period;
- All other Contractor's findings prior to the milestones; and
- Changes to the team, Work Breakdown Structure (WBS), level-of-effort, schedule, resource assignment matrix,

A.7.1.3 EXECUTIVE REPORT

The Executive Report will be placed in the public domain (e.g., CSA's library, publication and/or website, to promote the transfer and diffusion of space technologies). The report shall not exceed ten (10) pages. Any confidential information concerning potential spin-off and commercialization, or any information that would constitute a public disclosure of the FIP should be placed in the Technical Report.

A recommended structure for the Executive Report is as follows:

1. Covering page (as per APPENDIX A-2 to ANNEX A);
2. Introduction;
3. Technical Objectives;
4. Approach / Project Tasks;
5. Accomplishments;
6. Technology:
 - a) Description / Status of Technology (Initial TRL, Targeted TRL and Actual TRL at completion),
 - b) Innovative Aspects, and
 - c) Application Fields
7. Business Potential, Benefit and Impact on Company;
8. Ownership of Intellectual Property; and
9. Publications / References.

The CSA and the Contractor, or others designated by them, have the right to unrestricted reproduction and distribution of the Executive Report. The report shall include the following proprietary notice ("Owner of FIP" being either the CSA or the Contractor):

Copyright ©20XX "Owner of FIP"

Permission is granted to reproduce this document provided that written acknowledgement to the "Contractor name" or the Canadian Space Agency is made.

A.7.1.4 TECHNICAL REPORT

The report shall contain a detailed account of all work performed under the contract. This will enable a full and accurate evaluation of the work by the PA. The report should include, as appropriate, the following:

- a) Covering page (as per APPENDIX A-2 to ANNEX A);
- b) Executive Summary;
- c) Background information and references to relevant documentation;
- d) Review of results and accomplishments;
Where applicable, the following items should be included:
 - A summary of the literature search, with copies of the main publications supplied in an appendix (without infringing upon any copyrights),
 - The system requirements specification and the interface requirements specification,
 - Feasibility studies and identification of technological risks, alternatives approaches, and trade-off analysis results,
 - Design documents,
 - Implementation documents,
 - Test plan and procedures, and
 - Concept demonstration results;
- e) Assessment of results with respect to the Performance Evaluation Criteria. This should support a statement qualifying and/or quantifying three aspects:
 - Performance: the project successfully met and/or exceeded none/few/some/most or all the Performance Evaluation Criteria
 - Impact: the project identified none/few or several potential and/or actual impacts/benefits
 - Success: the project has none/some or significant potential of becoming, or already is, a success story
- f) Technology Readiness Assessment (TRL reached);
- g) Detailed description of all equipment purchased during this period;
- h) All other Contractor findings;
- i) Recommendations including the potential for any further R&D of a follow-on nature;
- j) Conclusion;
- k) Supporting tables, technical drawings and figures;
- l) Any additional relevant information deemed important by the Contractor.

A.7.1.5 CONTRACTOR DISCLOSURE OF INTELLECTUAL PROPERTY

At the end of the contract, a list and descriptions of all BIP required for CSA use of the FIP shall be provided at the Final Review Meeting. A list and description of all FIP resulting from project work shall also be provided. Furthermore, the Contractor will complete and submit as a stand-alone document entitled "Contractor Disclosure of Intellectual Property", provided in APPENDIX A-3 of ANNEX A. The Contractor shall submit an electronic copy of the Contractor Disclosure of Intellectual Property.

A.7.1.6 PROTOTYPES AND EQUIPMENT

All prototypes developed during the Contract shall be disclosed to Canada and reviewed by the PA who will advise on their final disposal and/or delivery. Unless and until the

contractor is specifically instructed otherwise, prototypes, samples and remaining consumables are, by default, deliverables.

The Contractor should also maintain a list of all non-consumable items procured or fabricated under the contract and/or provided by the government. The Contractor shall complete and submit the Asset Declaration Form found in APPENDIX A-4 of ANNEX A. The Contractor will be notified as to how the assets (equipment) should be handled after the PA and TA have reviewed the list.

A.7.1.7 SOFTWARE

The Contractor shall provide an electronic copy of all Contractor documents describing the software development cycle, including user, maintenance and operation manuals. The developed software shall also be provided in the form of well-documented source code in computer compatible format, with run-time libraries and executable files.

A.7.1.8 FINAL DATA PACKAGE

The Final Data Package is an assembly of final versions of all identified deliverables, technical and programmatic documents, plans and specifications, schematics, part lists, software and engineering data developed during the project. Such package shall be delivered at the end of the contract.

A.7.2 MEETINGS

As per Table A-3 below, the Contractor will schedule and co-ordinate with all the relevant stakeholders the following meetings:

- Kick-Off Meeting,
- Milestone Review Meetings,
- Progress Review Meetings,
- Work Authorization Meeting,
- Technical Interchange Meeting, and
- Final Review Meeting.

Meeting	Date	Location
Kick-off Meeting (KOM)	No later than 2 weeks After Contract Award (ACA)	Contractor's premises
Milestone Review Meetings (MRM)	At least every 4 months or when specified in specific statement of work	At CSA's premises unless otherwise specified in specific statement of work
Progress Review Meetings (PRM)	To be held if the maximum interval between Milestone reviews exceeds 4 months	Teleconference
Work Authorization Meeting (WAM)	At the Contract Mid-point. May be held before if deemed critical/relevant. Occurs concurrently with a regular milestone review meeting	According to the regular milestone review meeting location
Technical Interchange Meeting (TIM)	Variable	Teleconference
Final Review Meeting (FRM)	End of Contract	CSA's premises

Table A-3: Meetings and Decision Schedule

For all meetings, the Contractor will:

- Suggest the meeting content and deliver the suggested meeting agenda to the PA and the TA at least ten working days before the meeting;
- Deliver to the PA and the TA, all required reports and technical documents relating to the work about which the meeting is about;
- Record the minutes of the meeting; and
- Deliver one (1) electronic copy of the minutes of the meeting to the PA within five working days after the meeting.

In support of the project meetings, viewgraphs and supporting presentation materials should be prepared. One (1) electronic copy should be presented to the PA. Documented video materials should be prepared by the Contractor along with the supporting visual presentation material to support any demonstration of the technology. A copy of the supporting visual material should be delivered to the PA.

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

The PA and the TA reserve the right to invite additional knowledgeable people (Public Servants or others under Non-disclosure Agreement) to any meetings. Key Contractor personnel involved in the work under review will attend the following meetings.

The exact location, date and time of the various Meetings will be mutually agreeable to by the PA and the Contractor, while meeting Section A.7.2 MEETINGS.

A.7.2.1 KICK-OFF MEETING

Within two weeks of the contract award (or at a date mutually agreeable to by the PA and the Contractor) a Kick-Off Meeting (KOM) shall be held to:

- Submit and review the proposed **Performance Evaluation Criteria (PEC)**. This is a list of criteria that will be used throughout the project to evaluate the Contractor's technological progress. It should be provided in the Contractor's bid, but in any case shall be presented for acceptance at the KOM.
- Review contract deliverables;
- Review the requirements of the work;
- Review the work schedules;
- Review risk assessment and mitigation plan;
- Review Work Breakdown Structure and Work Packages;
- Review capability to deliver work packages at agreed cost and schedule;
- Discuss the BIP and review the provided list;
- Discuss the expected FIP and review the provided list (review Disclosure of FIP issues);
- Review basis of payment, and claim format;
- Review reporting requirements;
- Discuss any licensing issues; and
- Meet the personnel assigned to the work.

A.7.2.2 MILESTONE AND PROGRESS REVIEW MEETINGS

Milestone and Progress Review Meetings will be held periodically throughout the life of a Contract to provide formal opportunities for face-to-face information exchanges as well as for progress monitoring discussions and decision making. Nominally, a Milestone Review Meeting will be held at the end-point of each milestone. Between milestones, Progress Review Meetings should also be held if the maximum interval between Milestone reviews exceeds 4 months. These meetings will be scheduled by the Contractor and can be held by teleconference (unless specified otherwise in the specific statement of work of ANNEX A-5).

The Milestone Meetings and Progress Review Meetings are intended to provide an opportunity for the Contractor, the PA, the TA, and other invited attendees to review and discuss the following in detail:

- The contents of the Milestone and/or Progress Report;
- The current % of completion and accomplishments;
- The technical work of each task;
- The performance results with respect to the PEC;
- Discuss Work Authorization Decisions by CSA, if applicable;
- Discuss relevant results achieved;
- Project management issues; and
- Other items as deemed appropriate.

A.7.2.3 WORK AUTHORIZATION MEETING AND DECISIONS

A Milestone or Progress Review Meeting will also serve as a Work Authorization Meeting to be held approximately mid-way through the Contract (i.e., when approximately 50% of the contract value has been reached). This Work Authorization Meeting will serve as a basis for a decision to be made about whether or not to proceed with the follow-on activities of the Contract. This decision will be based primarily on the review of the achieved PEC in comparison with the PEC accepted at the Kick-Off Meeting and/or as revised at previous Milestone or Progress Review Meetings.

A Work Authorization decision will also be taken at each Government Fiscal Year end (March 31st) if there is no Work Authorization Meeting or no Final Review Meeting scheduled in the month of March. This decision will be based on availability of Government funding at that time.

A.7.2.4 TECHNICAL INTERCHANGE MEETING

The Technical Interchange Meetings are meetings occurring on a recurring or sporadic basis with the specific intent to discuss matter of technical nature (mainly). These are particularly suitable for activities that require higher degree of coordination between the Contractor and CSA due to the need for quick practical or technical decisions during the design or construction phases.

These meetings are required only when indicated in the specific statement of work of ANNEX A-5, but can be proposed by the Contractor in any other cases, as deemed appropriate.

A.7.2.5 FINAL REVIEW MEETING

The Final Review Meeting will be held at the end of the contract. The specific intent of this meeting will be to discuss in detail the results obtained (as compared to the PEC agreed-upon at the KOM) and the proposed follow-on activities.

The Final Review Meeting is intended to provide an opportunity for the Contractor, the PA, the TA, and other invited attendees to review and discuss in detail:

- The contents of the Final Data Package;
- The Executive and Technical Reports;
- Contractor Disclosure of Intellectual Property;
- Meeting presentation material;
- Prototypes, technical drawings, hardware, software, equipment, as applicable
- Asset declaration form; and
- Other items as deemed appropriate.

A.7.3 FORMS

The Report Documentation Page (see APPENDIX A-2 of ANNEX A) should be included in both the Executive Report and Technical Report.

Also, the Disclosure of Intellectual Property (APPENDIX A-3 of ANNEX A) shall be completed and submitted by the Contractor to reflect the actual status at the end of the contract.

The Contractor shall complete and submit the Asset Declaration Form in APPENDIX A-4 of ANNEX A, for which CSA will issue inventory bar codes at the end of the contract. The Contractor will be notified as to how the assets (prototypes and equipment) should be handled after the PA and TA have reviewed the list.

List of Appendices

APPENDIX A-1	Technology Readiness Levels (TRLs)
APPENDIX A-2	Report Documentation Page
APPENDIX A-3	Contractor Disclosure of Intellectual Property
APPENDIX A-4	Asset Declaration Form - Prototypes and Equipment
APPENDIX A-5	List of Priority Technologies and associated specific statement of works

APPENDIX A-1
TECHNOLOGY READINESS LEVELS (TRLs)

Source: RD-1 (CSA-ST-GDL-0001 Revision A - Technology Readiness Assessment Guidelines)

Readiness Level	Definition	Explanation
TRL 1	Basic principles observed and reported	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development.
TRL 2	Technology concept and/or application formulated	Once basic principles are observed, practical applications can be invented and R&D started. Applications are speculative and may be unproven.
TRL 3	Analytical and experimental critical function and/or characteristic proof-of-concept	Active research and development is initiated, including analytical / laboratory studies to validate predictions regarding the technology.
TRL 4	Component and/or breadboard validation in laboratory environment	Basic technological components are integrated to establish that they will work together.
TRL 5	Component and/or breadboard validation in relevant environment	The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment.
TRL 6	System/subsystem model or prototype demonstration in a relevant environment (ground or space)	A representative model or prototype system is tested in a relevant environment.
TRL 7	System prototype demonstration in a space environment	A prototype system that is near, or at, the planned operational system.
TRL 8	Actual system completed and "flight qualified" through test and demonstration (ground or space)	In an actual system, the technology has been proven to work in its final form and under expected conditions.
TRL 9	Actual system "flight proven" through successful mission operations	The system incorporating the new technology in its final form has been used under actual mission conditions.

Table A-1-1: Definition of Technology Readiness Levels

APPENDIX A-2


Canadian Space Agency Agence spatiale canadienne	REPORT DOCUMENTATION PAGE	
Report Date:		
Title:		
Author(s):		
Performing Organization(s) Name and Address(es):		
Contract # and Title:		
Sponsoring Agency Name(s) and Address(es): Canadian Space Agency 6767 Route de l'Aéroport Saint-Hubert, Québec, Canada J3Y 8Y9 Tel: (450) 926-4800 Scientific Authority: Project Manager:		
Abstract:		
Key Words:		
Supplementary Notes:		
Distribution/Availability:		

Table A-2-1: Template for Report Documentation Page

APPENDIX A-3
Contractor Disclosure of Intellectual Property

Instructions to the Contractor

Identification

The Contractor shall respond to the 7 following questions when Foreground Intellectual Property (FIP) is created under the Contract with the CSA.

1. Contractor Legal Name:
2. Project Title supported by the Contract:
3. CSA Project Manager of the Contract:
4. Contract #:
5. Date of the disclosure:
6. Will there be Contractor's Background Intellectual Property brought to the project:
 - ☐ Yes_ Complete Table A-3-1 attached (Disclosure of Background Intellectual Property)
 - ☐ No
7. For Canada's owned IP, are there any IP elements that, to your opinion, would benefit from being patented by Canada?
 - ☐ Not applicable, FIP resides with the Contractor
 - ☐ Yes_ Complete Table A-3-3 attached (Canada's Owned Additional Information)
 - ☐ No

<i>For the Contractor</i> <hr style="border: 0; border-top: 1px solid black; margin: 10px 0;"/> <i>Signature</i>	 <hr style="border: 0; border-top: 1px solid black; margin: 10px 0;"/> <i>Date</i>
<i>For the CSA Project Manager</i> <hr style="border: 0; border-top: 1px solid black; margin: 10px 0;"/> <i>Signature</i>	 <hr style="border: 0; border-top: 1px solid black; margin: 10px 0;"/> <i>Date</i>

BIP

- At the end of the Contract, the Contractor shall review and update the BIP disclosure (Table A-3-1) when applicable before closing of the Contract. Only the BIP elements that were used to develop the FIP elements should be listed.

FIP

- At the end of the Contract, the Contractor shall complete Table A-3-2 (Disclosure of the FIP developed under the Contract).
- If Canada is the owner of the FIP and identifies some FIP elements that would benefit from being patented by Canada, the Contractor shall also complete Table A-3-3 (Canada's Owned FIP Additional Information).
- The Contractor shall sign below and deliver the completed Contractor Disclosure of Intellectual Property to the CSA Project Authority of the Contract for his/her approval before closing the Contract.

General Instructions for BIP and FIP tables

- Tables shall be structured according to the CSA IP form provided.
- Each IP element shall have a unique ID # in order to easily link the elements of the different tables.
- Titles of IP elements shall be descriptive enough for project stakeholders to get a general idea of the nature of the IP.
- Numbers and complete titles of reference documents shall be included.

<u>Definitions</u>
<u>Intellectual Property (IP)</u> : means any information or knowledge of an industrial, scientific, technical, commercial artistic or otherwise creative nature relating to the work recorded in any form or medium; this includes patents, copyright, industrial design, integrated circuit topography, patterns, samples, know-how, prototypes, reports, plans, drawings, Software, etc.
<u>Background Intellectual Property (BIP)</u> : IP that is incorporated into the Work or necessary for the performance of the Work and that is proprietary to or the confidential information of the Contractor, its subcontractors or any other third party.
<u>Foreground Intellectual Property (FIP)</u> : IP that is first conceived, developed, produced or reduced to practice as part of the Work under the Contract.

Table A-3-1. Disclosure of Background Intellectual Property (BIP) brought to the project by the Contractor

1 BIP ID#	2 Project Element	3 Title of the BIP	4 Type of IP	5 Type of access to the BIP required to use/improve the FIP	6 Description of the BIP	7 Reference documentation	8 Origin of the BIP	9 Owner of the BIP
Provide ID # specific to each BIP element brought to the project e.g. BIP- CON-99 where CON is the contract acronym	Describe the system or sub system in which BIP is integrated (e.g. camera, control unit, etc)	Use a title that is descriptive of the BIP element integrated to the work	Is the BIP in the form of an invention, trade secret, copyright, design?	Describe how the BIP will be available for Canada to use the FIP(e.g. BIP information will be incorporated in deliverable documents, software will be in object code, etc)	Describe briefly the nature of the BIP(e.g. mechanical design, algorithm, software, method, etc)	Provide the number and fill title of the reference documents where the BIP is fully described, The reference document shall be available to Canada. Provide patent# for Canada if BIP is patented.	Describe circumstances of the creation of the BIP Was it developed from internal research or through a contract with Canada? If so, provide contract number.	Name the organization that owns the BIP. Provide the name of the subcontractor if not owned by the prime contractor.

Table A-3-2. Disclosure of the Foreground Intellectual Property (FIP) developed under the Contract

1 FIP ID #	2 Project Element	3 Title of FIP	4 Type of FIP	5 Description of the FIP	6 Reference documentation	7 BIP used to generate the FIP	8 Owner of the FIP	9 Patentability
Enter an ID # specific to each FIP element e.g. FIP-CON-99 where CON is the contract acronym	Describe the system or sub-system for which the FIP element was developed (e.g. a camera, ground control, etc)	Use a title that is descriptive of the FIP element.	Specify the form of the FIP e.g. invention, trade secret, copyright, industrial design	Specify the nature of the FIP e.g. software, design, algorithm, etc?	Provide the full title and number of the reference document where the FIP is fully described. The reference document shall be available to Canada	BIP referenced in table A-3-1 e.g. BIP-CON-2, 15	Specify which organization owns the FIP e.g. Contractor, Canada* or Subcontractor. Provide the name of the subcontractor if not owned by the prime contractor. *If Canada is the owner of the FIP, complete Table A-3-3 below Provide reference to contract clauses that support FIP ownership. Provide reference to WPDs under which the technical work has been performed.	In the case where the IP is owned by Canada, indicate with an "X", any IP elements described is patentable and complete Table A-3-3 only for this IP.

Table A-3-3. Canada's Owned FIP Additional Information

1 FIP ID #	2 Title of FIP	3 Aspects of FIP that are novel, useful and non obvious	4 Limitations or drawback of the FIP	5 References in literature or patents pertaining to the FIP	6 Has the FIP been prototyped, tested or demonstrated? (e.g. analytically, simulation, hardware)? Provide results	7 Inventor(s)	8 Was the FIP disclosed to other parties?
ID# should be same as corresponding FIP element in Table A-3-2	Title of FIP should be same as corresponding FIP element in Table A-3-2	How is the FIP addressing a problem (useful) and what is thought to be novel in this solution (novel)?	Describe the limitations of present apparatus, product or process	Provide references in published literature or patents relating to the problem or subject if any.	Describe briefly how the process, product or apparatus performed during testing or simulation. Provide reference document # where the performance is compiled if applicable.	Provide name and coordinates of the person(s) who created the FIP	Has any publication or disclosure of the FIP or any of its elements been made to third parties? If so, provide when, where and to whom.

APPENDIX A-4
ASSET DECLARATION FORM - PROTOTYPES AND EQUIPMENT

Equipment Declaration: The Contractor shall fill out the following form so as to identify all equipment procured under this contract.

Equipment #	Equipment description	Inventory #	Acquisition Value	Currency	Acquisition date	Manufacturer	Country	Model #	Serial #

Table A-4-1: Equipment Declaration Form

Prototype List: The Contractor shall provide a list of all prototypes developed under this contract.

Prototype Name	Prototype description

Table A-4-2: Prototype Declaration Form

The decision regarding the delivery of any prototype is to be made by the CSA at the end of each contract completion.

Note: Canada reserve the right not to request compensation or replacement of government-furnished equipment (GFE) if the use of the said equipment is an integral part of the proposed research and development study or work.

APPENDIX A-5

LIST OF PRIORITY TECHNOLOGIES AND ASSOCIATED SPECIFIC STATEMENT OF WORKS

PT #	Priority Technology Title
PT 1	Focal Plane Array for Coastal & Inland Water Color Hyperspectral Imager
PT 2	Breadboard of Next Generation Coastal and Inland Water Color Imaging Spectrometer

Table A-5-1: List of Priority Technologies

Priority Technology 1 (PT-1)

**Focal Plane Array for Coastal &
Inland Water Color
Hyperspectral Imager**

PT-1: Focal Plane Array for Coastal & Inland Water Color Hyperspectral Imager

1. List of Acronyms

CSA	Canadian Space Agency
COCI	Coastal Ocean Color Imager
CHROMA	Configurable Hyperspectral Readout for Multiple Applications
DDR	Detailed Design Review
FOV	Field-of-View
FPA	Focal Plane Array
FWHM	Full Width at Half Maximum
GFE	Government Furnished Equipment
GSD	Ground Sampling Distance
GUI	Graphical User Interface
KoM	Kick-off meeting
MCT	Mercury Cadmium Telluride
MTF	Modulation Transfer Function
NASA	National Aeronautics and Space Administration
NRL	Naval Research Laboratory
OCI	Ocean Color Imager
PACE	Plankton, Aerosol, Cloud, ocean Ecosystem
PDR	Preliminary Design Review
ROIC	Read-Out Integrated Circuit
SCA	Sensor Chip Assembly
VNIR	Visible-Near Infrared
WAM	Work Authorization Meeting

2. Applicable documents

This section lists the documents that are required for the bidder to develop the proposal. The applicable documents listed below can be obtained from the following File Transfer Protocol (FTP) sites:

AD No.	Document Number	Document Title	Rev. No.	Date
AD-1	CSA-ST-GDL-001	CSA Technology Readiness Levels and Assessment Guidelines ftp://ftp.asc-csa.gc.ca/users/TRP/pub/TRRA/	Rev. C	March 31, 2017
AD-2	CSA-ST-FORM-001	Technology Readiness and Risk Assessment (TRRA) Worksheet (PDF)	Rev. F	March 31, 2017

AD No.	Document Number	Document Title	Rev. No.	Date
		ftp://ftp.asc-csa.gc.ca/users/TRP/pub/TRRA/		
AD-3	CSA-ST-RPT-0003	Technology Roadmap Worksheet (Excel) ftp://ftp.asc-csa.gc.ca/users/TRP/pub/TRRA/	Rev. A	February 3, 2014

3. Reference documents

This section lists documents that provide additional information to the bidder, but are not required to develop the proposal.

RD No.	Document Number	Document Title	Rev. No.	Date
RD-1	PMBOK Guide	A Guide to the Project Management Body of Knowledge	5th Edition	2013
RD-2	CSA-ST-FORM-003	Critical Technology Element (CTE) Identification Worksheet (Excel) ftp://ftp.asc-csa.gc.ca/users/TRP/pub/TRRA/	Rev. A	Mar 11, 2014
RD-3	CSA-ST-FORM-0004	Technology Readiness and Risk Assessment Summary Template ftp://ftp.asc-csa.gc.ca/users/TRP/pub/TRRA/	Initial Release	March 31, 2017
RD-4	CSA-SE-STD-0001	CSA Systems Engineering Technical Reviews Standard ftp://ftp.asc-csa.gc.ca/users/TRP/pub/TRRA/	Rev. A	Nov 7, 2008
RD-5	CSA-SE-PR-0001	CSA Systems Engineering Methods and Practices ftp://ftp.asc-csa.gc.ca/users/TRP/pub/TRRA/	Rev. B	Mar 10, 2010

4. Background

Canada has extensive coastlines and inland water bodies that offer great value for food supply, commerce, transportation, and tourism/recreation. However, they are under increasing pressure from direct human activities and are experiencing unprecedented change from modifications to our climate. Understanding and quantifying the physical, biogeochemical and ecological processes that occur within our natural waters are critical components of regional water resource management, from protecting and monitoring water quality, nearshore/wetland habitats, fisheries

and aquaculture, public health, to navigation and shipping, security, oil spill/pollution event response, and impacts from episodic flood and storm events.

Current ocean color satellites (e.g. MODIS and Sentinel-3), with their 300 m to 1 km ground sampling distance (GSD), cannot provide accurate information in the last few kilometers next to the shore or for the large number of medium to small size water bodies (≤ 10 's of km²). In order to meet the Canadian government users' needs for higher spatial and spectral resolution data to support enhanced monitoring of our coastal environment and freshwater resources, the Canadian Space Agency (CSA) has awarded Canadian industry a contract to undertake a Phase 0 concept study for a proto-operational hyperspectral microsatellite mission for coastal and inland water monitoring, which is referred to as WaterSat. The Phase 0 study concluded in March 2015 and demonstrated that it is feasible to build a Canadian water color hyperspectral microsatellite with a 100 m GSD and 300 km swath covering a spectral range of 400-1000 nm at 10 nm spectral sampling interval.

Recently the CSA and the US Naval Research Laboratory (NRL) have teamed up to bring together their strengths in optical payload development and remote sensing of coastal waters. An innovative mission concept for a high performance next generation water color hyperspectral payload, referred to as Coastal Ocean Color Imager (COCI), has been developed in a joint payload concept study. The COCI payload is optimized for observation of coastal and inland waters in the ultraviolet, visible and near infrared parts of the spectrum (from 360 to 910 nm) with a nominal spectral sampling 5 nm, 100 m GSD over a 240 km swath and high Signal-to-Noise Ratio (SNR) of 950:1. It can map the whole of Canada near-weekly up to 200 nautical miles of shore and is capable of 2-day re-look for emergency response or more frequent revisit of priority targets in Canada using a pointing system.

Since the focal plane array (FPA) is the primary driver for imaging system design defining its resolution, sensitivity and image quality, large format high resolution array detectors are a key enabling technology for the hyperspectral instrument. After having completed the trade-off analysis of detector options the COCI joint study team has selected Teledyne's visible FPA technology as a baseline for the COCI imaging spectrometer. The FPA architecture consists of the CHROMA (Configurable Hyperspectral Readout for Multiple Applications) CMOS integrated circuit flip-chip hybridized to HyViSI™ silicon PIN visible detector. The array format is 1280×480 pixels with 30µm pixel pitch. Although the selected detector technology has been qualified to TRL6 for another mission, the performance requirements of COCI (such as SNR of 950:1 with 100m GSD) are very demanding that requires sensor technology adaptation through detailed characterization and optimization of operation conditions to achieve key parameters including quantum efficiency, dark current, read noise, dynamic range and linearity.

The goal of this project is an experimental demonstration of achieving mission-critical performance parameters with an advanced silicon hyperspectral FPA. The results of image sensor characterization will be used for optimization of manufacturing, packaging, alignment, testing, qualification, and integration of flight FPAs as well as for overall optical system optimization, development of readout electronics, data handling and thermal and power management systems of hyperspectral imagers.

This project will elevate technical readiness level for FPA technology that will be integrated in the full instrument and can be used for a future Canadian WaterSat mission or as Canadian contribution to upcoming international ocean color satellites, such as NASA's Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission.

5. Targeted Missions

This technology development is targeted for the Coastal Ocean Color Imager (COCI), a high performance next-generation water color hyperspectral payload for a future Canadian water color satellite or considered as a Canadian payload contributed to an upcoming international Ocean Color mission, such as NASA's PACE mission. Future earth observation and planetary missions as well as rover payloads will benefit from high TRL FPA solution ready for integration in the instrument.

6. Scope of Work

The scope of work defined here complements *Section A.6 Generic Task Description* of Annex A. The goal of this project is to raise the TRL of hyperspectral FPA to TRL 4 to mitigate the risk associated with adoption of mission critical technology for flight. This requires the development of a detailed procurement specification, evaluation of the state-of-the-art technology with focus on application-specific performance, operability, and flight qualification requirements, procurement of flight representative detectors and extensive characterization in a laboratory environment (TRL4) using functionally representative commercial readout electronics. Specific tasks have been defined with respect to the project work as follows:

1. Assessment studies to develop a scientifically relevant and technically achievable specification for a silicon focal plane array (FPA) based on the COCI instrument requirements.
2. Assessment studies of current FPA manufacturing capabilities including design, fabrication, packaging, order sorting filtering, testing and flight qualification. Critical assessment of what changes in acceptable specifications for flight-rated detectors is needed to meet COCI instrument requirements. Develop mutually agreeable acceptance criteria.
3. Development of a specification of the FPA packaging that is compatible with the COCI spectrometer. Development of a specification of the read-out electronics that is compatible with both the FPA and the downstream data electronics in COCI mission context. Summarize the findings in a Detector Technology Roadmap report identifying technical milestones, development schedule and associated costs.
4. Procurement of two flight representative and fully-operational FPAs consisting of Teledyne's 1280 x 480 silicon HyViSI™ (Hybrid Visible Silicon Imager) arrays hybridized to the CHROMA readout with a growth path for production of flight FPA. Delivery of the operating arrays shall be no later than 12 months post award the contract. Options with this procurement concern the flight representative packaging and order sorter filters.
5. Laboratory characterization of FPAs. The characterization shall yield measurements of the most relevant properties such as quantum efficiency, gain, read noise, dark current, linearity, and operability over a wide range of operational variations such as temperature, readout mode and post-processing electronic architecture.
6. Development of experimental test-beds to exercise the focal planes under simulated observation conditions to verify operational protocols, mitigate or calibrate undesirable characteristics and determine relevant selection criteria for engineering and flight qualified devices.
7. Data reduction and analysis of the characterization results to demonstrate the feasibility of achieving performance requirements of COCI.
8. Identification of the operating conditions needed to reach sensor performance targets. For example, electronic integration time control may be necessary to be able to make optimum

- use of the available light and the pixel full well capacity which in many cases is at the limits of the sensor technology due to the high SNR requirements.
9. Assessment of the Read-out Electronics (ROE) architecture. Specifically, examine if an application specific integrated circuit (ASIC) can be used for FPA control and data acquisition. Develop requirements for a ROE that is compatible with both the FPA and the COCI electronics. Produce a preliminary specification of the interface between the FPA and payload controller electronic unit. The ROE shall be compatible with the baseline instrument electronics unit and its capabilities in order to avoid later redesigns of either or both electronics and to consider the possible impact of the instrument electronics on the FPA/ROE performances and functions.
 10. Trade-off analysis with regard to the proper FPA architecture, size, mass, power and thermal control in space-based environments. Development of requirements for flight FPA including cooling, packaging and alignment.
 11. Summarize the results in the final report identifying the parameters which selected detector technology currently meets and will meet with further optimization of FPA packaging, cooling and proximity electronics and data processing.
 12. Conduct a Technology Readiness and Risk Assessment (TRRA) per detailed in the following Section.

7. Technology Readiness and Risk Assessment

The Contractor shall conduct a Technology Readiness and Risk Assessment (TRRA) of key technologies foreseen to be used in the proposed system in accordance with the requirements of CSA Technology Readiness and Risk Assessment Guidelines (AD-1). Some tailoring is proposed to this process for small projects such as STDP R&D contracts.

Towards the beginning of the contract (i.e. preliminary design):

- The Contractor shall identify the Product Breakdown Structure (PBS) for the system (instrument or payload). The PBS is used to give an overall context, as such the scope of the PBS may include technologies that go beyond the scope of the current SOW and present a forward looking view of the entire project that will eventually be matured for future missions. For STDP R&D projects, the level of detail needed is typically less than for mission phases. The PBS can be presented as a bulleted list, or as a graphical concept diagram. The number of items expected in a PBS for STDP R&D projects is between 2 and 5 elements. The Contractor shall get agreement on the PBS from CSA.
- The Contractor and CSA will agree on a target TRL value to use in the TRRA assessment, the recommended value is TRL6. The TRRA target TRL shall not be confused with the target TRL of the current technology development efforts described in this SOW. The TRRA target TRL will be used in the assessment and planning efforts for the overall system, while the target TRL of this particular contract represents the increment in maturity of one or many elements in one particular contract.
- The Contractor shall identify the list of Critical Technologies Elements (CTE) and provide a narrative justification why a technology is deemed critical or not critical. For convenience, the evaluation criteria for criticality are provided in the form of an excel worksheet (RD-2) however alternate formats may be used. The list of critical technologies will be used as an input to the prioritization process of future STDP investments. Typically, for STDP R&D projects the number of critical technologies is not expected to be greater than 5 CTEs. The Contractor shall get agreement on the

list of critical technologies from CSA. Identification of the targeted missions would also be necessary before criticality can be assessed.

Towards the middle of the contract (detailed design):

- The Contractor shall conduct a detailed assessment of each critical technology (CTE) using the Technology Readiness and Risk Assessment Worksheet (AD-2).

Towards the end of the contract (final review):

- The Contractor shall provide a narrative TRRA Final report in accordance with DID-0014 (please refer to section 12). For convenience, a TRRA Short Summary Template (RD-3) is provided to facilitate this effort.
- The Contractor shall also provide an excel version of the Development Plan using the provided Excel Technology Roadmap (TRM) Worksheet (AD-3). This information will be injected into CSA investment planning tools.

The purpose of the TRRA is to fully understand where we are technologically towards creating this system, and what the technology path to flight looks like, its different phases, and the cost and schedule to implement. The intent is to provide the CSA the necessary information used in strategic planning.

8. Functional characteristics and performance requirements

Table 7.1 lists the specifications of the COCI payload developed in the CSA/NASA joint study. The requirements for the FPA shall be based on these specifications.

Table 7.1 Specifications of the COCI payload

Parameter	Threshold Value	Note
Orbit	675 km	
FOV	19.6°	In cross-track direction
Swath width	240 km	Can be achieved by two sub-swaths
Ground sampling distance (GSD)	100 m at nadir	
Spectral Range	360 nm to 910 nm	350 nm to 1000 nm as a goal
Spectral sampling interval (SSI)	1.25 nm	Native instrumental SSI
Number of spectral bands	440	Before binning
Nominal spectral sampling	5.0 nm	After binning
Smile	< 0.1 SSI	
Keystone	< 0.1 pixel	
Stray light	1.0%	
Polarization sensitivity	< 3.0% < 0.2%	without depolarizer with depolarizer
Peak signal-to-noise ratio	950	@550 nm, 100m GSD, 10nm SSI and 5% albedo

Minimum signal-to-noise ratio	300	From 360 nm to 700 nm
Saturation level	85%	Maximum scene
Mass	< 30 kg	
Volume	0.24 m ³	
Power	65 W	

The mandatory requirements for the FPAs are listed below:

[FPA-001] FPA architecture

For the COCI instrument, all arrays shall use Teledyne's CHROMA (Configurable Hyperspectral Readout for Multiple Applications) architecture using the HyViSI hybrid silicon PIN visible detector technology.

[FPA-002] Spectral response

Flight representative FPAs fabricated for this project shall provide coverage of visible wavelength region that will mean response from 350 to 1000 nm.

[FPA-003] FPA format and pixel pitch

All FPAs shall have the area format of 1280 × 480 pixels and 30 μm pixel pitch.

[FPA-004] FPA frame readout time

All FPAs shall conform to the CHROMA-1280 standards of 16.8 μs row readout time providing full-frame rate (480 rows) of 125 Hz and half-frame rate (240 rows) of 250 Hz. Readout modes: snapshot, integrate-while-read.

[FPA-005] Full well capacity

Full well capacity shall be 1M electrons

[FPA-006] Read noise

Read noise shall be less than 110 electrons.

[FPA-007] Environmental requirements

Flight representative FPAs shall be space qualifiable by design, process and tests and capable to withstand environmental requirements for a space mission (vibration, thermal, vacuum, radiation).

FPA testing

[FPT-001] Facilities and GFE

The Contractor shall have facilities (or access to facilities) equipped for testing large state-of-the-art FPAs including dewars for characterization over a broad range of temperatures, illumination sources, control, readout and data acquisition electronics, specialized data processing and analysis software, etc.

In order to facilitate the development of the test set-up, data collection and analysis the Contractor will be supplied with one CHROMA-1280 Read-Out Integrated Circuit (ROIC), one partially operating FPA sensitive in the shortwave infrared wavelength region and one set of focal plane

electronics as the Government Furnished Equipment (GFE). The assets shall be returned to CSA upon completion of work.

ITAR

[ITA-001] ITAR Compliance

The CHROMA FPAs are under US ITAR restriction. The Contractor shall follow the procedures to meet the requirements of ITAR regulations.

9. Targeted TRL

The targeted TRL for this technology development is TRL 4 within the contract period.

10. Specific Deliverables

The deliverables defined here complement *Section A.7 Contract Deliverables and Meetings* of Annex A.

Table 9.1: Specific Deliverables

ID	Due Date	Deliverable	Type
D1	M2	FPA specification	Technical Document/Report
D2	M2	ROIC test plan	Technical Document/Report
D3	M3	Manufacturing plan / specifications imposed on vendors	Technical Document/Report
D4	M4	ROIC test report	Technical Document/Report
D5	M5	Test Plans and as run test procedures	Technical Document/Report
D6	M6	Two flight representative FPAs	Hardware
D7	M6	End-Item Data Package with each FPA delivery	Technical data and analysis
D8	M6	Certificate of Conformance with each FPA delivery	Technical data and analysis
D9	M6, M7	FPA test reports	Technical data and analysis
D10	M8	Final Report	Technical Document/Report

Travel

It is anticipated that the majority of meetings and technical interchanges shall either be electronic or at the Contractor's facility. FPA procurement/manufacturing readiness review meeting and FPA acceptance meetings will require in person attendance by Contractor, NRL, NASA and CSA representatives and travel to Teledyne.

Reviews

- (i) Manufacturing Readiness Review (MRR)

Contractor shall conduct a Manufacturing Readiness Review (MRR) to review the processes and procedures to be used in the fabrication of flight representative sensor chip assemblies (SCAs). The review will be conducted prior to the growth of the first detector layers in the program.

(ii) Test readiness review (TRR)

CSA/NASA/NRL will conduct TRR to review the testing procedures that will be used by the Contractor and Teledyne to satisfy the testing requirements of the project.

(iii) FPA Acceptance Review

CSA/NASA/NRL will conduct the FPA Acceptance Review where the final buyoff for delivery of the flight representative FPA's takes place. At the FPA Acceptance Meeting the following documentation shall be delivered:

- (A) Certificate of Conformance
- (B) End Item Data Package consisting of the following:
 - 1. Non-conformance reports
 - 2. Certificate of cleanliness certification
 - 3. Test plan/procedures
 - 4. Test reports consisting of the following data:
 - All QE results
 - CDS noise and total noise
 - Dark current
 - Full well capacity
 - Power dissipation
 - Transimpedance gain
 - Linearity
 - Interconnect percentage
 - Number of pixels meeting operability definition
 - Cross talk
 - 5. FPA Dimensional Data
 - 6. Requirement Verification Matrix

11. Schedule & Milestones

The anticipated duration of this technology development is 18 months. A suggested schedule appears in Table 10.1. An alternative schedule can be proposed with a maximum duration of 24 months.

Table 10.1 – Schedule & Milestones

Milestones	Description	Completion	Venue
M1	Kick-off meeting (KoM)	KOM	Contractor
M2	FPA specification review (PDR) ROIC test plan review	KOM + 1 month	Telecon
M3	FPA Procurement Manufacturing readiness review	KOM + 2 months	Teledyne
M4	ROIC test results review	KOM + 4 months	Telecon
M5	Test Readiness review (TRR)	KOM + 8 months	Contractor
M6	FPA Acceptance review	KOM + 12 months	Teledyne
M7	FPA Test results review	KOM + 16 months	Telecon
M8	Final review meeting (FR)	End Date - 2 weeks	CSA

12. Data Items Descriptions (DIDs)

This section lists DID(s) applicable to this specific Priority Technology.

DID-0014 – TRRA Final Report for Small Projects

DID Issue: IR

Date: 2017-03-31

PURPOSE:

Technology development activities (i.e. STDP) serve to reduce technological risks and help position industry or academia for future missions. The Technology Readiness and Risk Assessment (TRRA) activity is used to identify high risk items that require further technology development.

The investment planning teams at CSA use the TRRA final report to help determine which risk mitigation activities should be undertaken in the next round of funding

PREPARATION INSTRUCTIONS:

This report may be combined with other deliverables such as a final report. This Report should contain at least the following information

Section 1: Introduction and Business Case

This first section should contain a high level executive summary of the technology and its potential for development, suitable for public dissemination (through social media for example). The principal target audience is CSA executives and policy makers, who may not be entirely familiar with the technology or its applications. The summary should be in a simple easy to understand language. The summary should focus largely on potential mission outcomes (e.g., detection of organics on Mars) rather than engineering implementation details (e.g., LIBS/Rahman sensor). The section could also discuss alignment with government priorities because it will be used as input in the development of a business case for future investments.

Section 2: Summary of TRRA Results

The TRRA process consists of several steps including the identification and assessment of critical technologies that represent a higher degree of risk for the mission. This section will describe the technological components of the instrument or payload, provide a list of the critical elements, and their associated risk metrics (R&D3, TNV, dTRL*TNV¹). This section will also provide a recommendation for future technology development, and could discuss specific technical requirements of concern and the plan to meet them.

In order to assist the CSA in continuing the development of this technology, the contractor shall also provide a brief outline of the scope and key requirements to reach the next TRL level. This information is intended to be used in the crafting of subsequent development should CSA pursue this technology.

Section 3: Path to Flight

This section will provide a wider context for the technology development efforts needed to prepare the technology for a future mission. The goal is to identify future potential missions, and the schedule drivers that drive the technology development needs. The development plan should explain the proposed sequencing of technology development over STDP contract or mission

¹ The TRRA Summary Template (CSA-ST-FROM-0004 IR) can be used for this purpose.

phases and their TRL progression. The investment plan should provide notional budget estimates suitable for high level planning purposes. The identification of potential technology demonstration activities (and platforms) should also be discussed, if appropriate. Historical reference for past technology development contracts or contribution should also be cited.

Priority Technology 2 (PT-2)

Breadboard of Next Generation Coastal and Inland Water Color Imaging Spectrometer

PT-2: Breadboard of Next Generation Coastal and Inland Water Color Imaging Spectrometer

1. List of Acronyms

CSA	Canadian Space Agency
COCI	Coastal Ocean Color Imager
CHROMA	Configurable Hyperspectral Readout for Multiple Applications
DDR	Detailed Design Review
FOV	Field-of-View
FPA	Focal Plane Array
FWHM	Full Width at Half Maximum
GFE	Government Furnished Equipment
GSD	Ground Sampling Distance
GUI	Graphical User Interface
KoM	Kick-off meeting
MCT	Mercury Cadmium Telluride
MTF	Modulation Transfer Function
NASA	National Aeronautics and Space Administration
NRL	Naval Research Laboratory
OCI	Ocean Color Imager
PACE	Plankton, Aerosol, Cloud, ocean Ecosystem
PDR	Preliminary Design Review
ROIC	Read-Out Integrated Circuit
SSI	Spectral sampling interval
VNIR	Visible-Near Infrared
WAM	Work Authorization Meeting

2. Applicable documents

This section lists the documents that are required for the bidder to develop the proposal. The applicable documents listed below can be obtained from the following File Transfer Protocol (FTP) sites:

AD No.	Document Number	Document Title	Rev. No.	Date
AD-1	CSA-ST-GDL-001	CSA Technology Readiness Levels and Assessment Guidelines ftp://ftp.asc-csa.gc.ca/users/TRP/pub/TRRA/	Rev. C	March 31, 2017

AD No.	Document Number	Document Title	Rev. No.	Date
AD-2	CSA-ST-FORM-001	Technology Readiness and Risk Assessment (TRRA) Worksheet (PDF) ftp://ftp.asc-csa.gc.ca/users/TRP/pub/TRRA/	Rev. F	March 31, 2017
AD-3	CSA-ST-RPT-0003	Technology Roadmap Worksheet (Excel) ftp://ftp.asc-csa.gc.ca/users/TRP/pub/TRRA/	Rev. A	February 3, 2014

3. Reference documents

This section lists documents that provide additional information to the bidder, but are not required to develop the proposal.

RD No.	Document Number	Document Title	Rev. No.	Date
RD-1	PMBOK Guide	A Guide to the Project Management Body of Knowledge	5th Edition	2013
RD-2	CSA-ST-FORM-003	Critical Technology Element (CTE) Identification Worksheet (Excel) ftp://ftp.asc-csa.gc.ca/users/TRP/pub/TRRA/	A	Mar 11, 2014
RD-3	CSA-ST-FORM-0004	Technology Readiness and Risk Assessment Summary Template ftp://ftp.asc-csa.gc.ca/users/TRP/pub/TRRA/	Initial Release	March 31, 2017
RD-4	CSA-SE-STD-0001	CSA Systems Engineering Technical Reviews Standard ftp://ftp.asc-csa.gc.ca/users/TRP/pub/TRRA/	Rev. A	Nov 7, 2008
RD-5	CSA-SE-PR-0001	CSA Systems Engineering Methods and Practices ftp://ftp.asc-csa.gc.ca/users/TRP/pub/TRRA/	Rev. B	Mar 10, 2010
RD-6		A Spaceborne Coastal and Inland Water Color Hyperspectral Imager, IGARSS 2017 paper ftp://ftp.asc-csa.gc.ca/users/STDP/pub/RFP14/		2017

4. Background

Canada has extensive coastlines and inland water bodies that offer great value for food supply, commerce, transportation, and tourism/recreation. However, they are under increasing pressure from direct human activities and are experiencing unprecedented change from modifications to our climate. Understanding and quantifying the physical, biogeochemical and ecological processes that occur within our natural waters are critical components of regional water resource management, from protecting and monitoring water quality, nearshore/wetland habitats, fisheries and aquaculture, public health, to navigation and shipping, security, oil spill/pollution event response, and impacts from episodic flood and storm events.

Current ocean color satellites (e.g. MODIS and Sentinel-3), with their 300 m to 1 km ground sampling distance (GSD), cannot provide accurate information in the last few kilometers next to the shore or for the large number of medium to small size water bodies (≤ 10 's of km²). In order to meet the Canadian government users' needs for higher spatial and spectral resolution data to support enhanced monitoring of our coastal environment and freshwater resources, the Canadian Space Agency (CSA) has awarded Canadian industry a contract to undertake a Phase 0 concept study for a proto-operational hyperspectral microsatellite mission for coastal and inland water monitoring, which is referred to as WaterSat. The Phase 0 study concluded in March 2015 and demonstrated that it is feasible to build a Canadian water color hyperspectral microsatellite with a 100 m GSD and 300 km swath covering a spectral range of 400-1000 nm at 10 nm spectral sampling interval.

Recently the CSA and the US Naval Research Laboratory (NRL) have teamed up to bring together their strengths in optical payload development and remote sensing of coastal waters. An innovative mission concept for a high performance next generation water color hyperspectral payload, referred to as Coastal Ocean Color Imager (COCI), has been developed in a joint payload concept study (results published in RD-6). The COCI payload is optimized for observation of coastal and inland waters in the ultraviolet, visible and near infrared parts of the spectrum (from 360 to 910 nm) with a nominal spectral sampling 5 nm, 100 m GSD over a 240 km swath and high Signal-to-Noise Ratio (SNR) of 950:1. It can map the whole of Canada near-weekly up to 200 nautical miles of shore and is capable of 2-day re-look for emergency response or more frequent revisit of priority targets in Canada using a pointing system.

The Canadian COCI, with its spatial and spectral resolution not currently available from existing water color satellites, can be used for a future Canadian WaterSat mission or as Canadian contribution to upcoming international ocean color satellites, such as NASA's Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission.

This project is to i) elevate technical readiness level for Canadian water color imaging spectrometer technology, and ii) de-risk key technical issues of the Canadian COCI payload raised in the joint study.

5. Targeted Missions

This technology development is targeted for the Coastal Ocean Color Imager (COCI), a high performance next-generation water color hyperspectral payload for a future Canadian water color satellite or considered as a Canadian payload contributed to an upcoming international Ocean Color mission, such as NASA's PACE mission. Future earth observation and planetary missions as well as rover payloads will benefit from the high TRL spectrometer solution developed for integration in the instruments.

6. Scope of Work

The scope of work defined here complements *Section A.6 Generic Task Description* of Annex A.

The scope of this contract is to design, build and test in laboratory conditions a portable breadboard Dyson (or modified Dyson) water color imaging spectrometer system including fore-optics, spectrometer, detector array, readout electronics, controller, operating software and GUI. The water color imaging spectrometer shall be a pushbroom hyperspectral imaging sensor operating in spectral region of 360-910nm. The R&D efforts to be carried out shall be as follows:

1. Based on the specifications (Table 8.1) of the COCI payload developed in the CSA/NASA joint study, design a high performance Dyson water color imaging spectrometer and a spaceborne fore-optics (telescope) that meets the specifications of the COCI payload. Trade-offs shall be conducted to better achieve the performance.
2. Build a breadboard of the high performance Dyson water color imaging spectrometer to implement the design.
3. Perform laboratory test and characterization of the breadboard to demonstrate that it has achieved the performance defined by the specifications in Table 8.1 and document the testing results in the test report.
4. Conduct a Technology Readiness and Risk Assessment (TRRA) per detailed in the following Section.

The following scope is non mandatory and relates to the goal requirements identified in the Functional characteristics and performance requirements Section:

5. Design and build a telescope suitable for airborne assessment of the breadboard.
6. Ruggedize the breadboard sustaining for airborne flight environment;
7. Conduct airborne assessment to demonstrate and validate the functionality and performance of the breadboard.

7. Technology Readiness and Risk Assessment

The Contractor shall conduct a Technology Readiness and Risk Assessment (TRRA) of key technologies foreseen to be used in the proposed system in accordance with the requirements of CSA Technology Readiness and Risk Assessment Guidelines (AD-1). Some tailoring is proposed to this process for small projects such as STDP R&D contracts.

Towards the beginning of the contract (i.e. preliminary design):

- The Contractor shall identify the Product Breakdown Structure (PBS) for the system (instrument or payload). The PBS is used to give an overall context, as such the scope of the PBS may include technologies that go beyond the scope of the current SOW and present a forward looking view of the entire project that will eventually be matured for future missions. For STDP R&D projects, the level of detail needed is typically less than for mission phases. The PBS can be presented as a bulleted list, or as a graphical concept diagram. The number of items expected in a PBS for STDP R&D projects is between 2 and 5 elements. The Contractor shall get agreement on the PBS from CSA.
- The Contractor and CSA will agree on a target TRL value to use in the TRRA assessment, the recommended value is TRL5. The TRRA target TRL shall not be confused with the target TRL of the current technology development efforts described in this SOW. The TRRA target TRL will be used in the assessment and planning efforts for the overall system, while the target TRL of this particular contract represents the increment in maturity of one or many elements in one particular contract.
- The Contractor shall identify the list of Critical Technologies Elements (CTE) and provide a narrative justification why a technology is deemed critical or not critical. For convenience, the evaluation criteria for criticality are provided in the form of an excel worksheet (RD-2) however alternate formats may be used. The list of critical technologies will be used as an input to the prioritization process of future STDP investments. Typically, for STDP R&D projects the number of critical technologies is not expected to be greater than 5 CTEs. The Contractor shall get agreement on the list of critical technologies from CSA. Identification of the targeted missions would also be necessary before criticality can be assessed.

Towards the middle of the contract (detailed design):

- The Contractor shall conduct a detailed assessment of each critical technology (CTE) using the Technology Readiness and Risk Assessment Worksheet (AD-2).

Towards the end of the contract (final review):

- The Contractor shall provide a narrative TRRA Final report in accordance with DID-0014 (please refer to section 13). For convenience, a TRRA Short Summary Template (RD-3) is provided to facilitate this effort.
- The Contractor shall also provide an excel version of the Development Plan using the provided Excel Technology Roadmap (TRM) Worksheet (AD-3). This information will be injected into CSA investment planning tools.

The purpose of the TRRA is to fully understand where we are technologically towards creating this system, and what the technology path to flight looks like, its different phases, and the cost and schedule to implement. The intent is to provide the CSA the necessary information used in strategic planning.

8. Functional characteristics and performance requirements

Table 8.1 lists the specifications of the COCI payload developed in the CSA/NASA joint study.

The design of the breadboard shall be based on these specifications.

Table 8.1 Specifications of the COCI payload

Parameter	Threshold Value	Note
Orbit	675 km	
FOV	19.6°	In cross-track direction
Swath width	240 km	Can be achieved by two sub-swaths
Ground sampling distance (GSD)	100 m at nadir	
Spectral Range	360 nm to 910 nm	350 nm to 1000 nm as a goal
Spectral sampling interval (SSI)	1.25 nm	Native instrumental SSI
Number of spectral bands	440	Before binning
Nominal spectral sampling	5.0 nm	After binning
Smile	< 0.1 SSI	
Keystone	< 0.1 pixel	
Stray light	1.0%	
Polarization sensitivity	< 3.0% < 0.2%	without depolarizer with depolarizer
Peak signal-to-noise ratio	950	@550 nm, 100m GSD, 10nm SSI and 5% albedo
Minimum signal-to-noise ratio	300	From 360 nm to 700 nm
Saturation level	85%	Maximum scene
Mass	< 30 kg	
Volume	0.24 m ³	
Power	65 W	

8.1 Focal Plane Array (FPA)

The CSA/NASA joint study has selected a baseline Focal Plane Array for the COCI imaging spectrometer. The selected FPA is Teledyne 1280×480 format HyViSI™ (Hybrid Visible Silicon Imager) with CHROMA (Configurable Hyperspectral Readout for Multiple Applications) architecture, which was developed for ground-based, airborne and space-based visible-infrared imaging spectrometers.

For this STDP project, CSA will provide to the Contractor two FPAs of Teledyne 1280×480 format Mercury Cadmium Telluride (MCT) with CHROMA operating in visible to shortwave infrared bands (0.4 – 2.5 μm) with the Read-Out Integrated Circuit (ROIC) as a Government Furnished Equipment (GFE) to be integrated in the breadboard. The provided FPAs will be the same as the selected Teledyne 1280×480 format HyViSI™ with CHROMA, except the photo sensitivity layer will be MCT (HgCdTe) rather than Si, which were purchased in a previous government contract.

The GFE FPAs also include FPE with SYNC, ROIC development cable, cold and hot cables, and DVD with Teledyne data. An order-sorting-filter for VNIR (0.4 – 1.0 μm) has been integrated into one of the FPAs. Coolers for the GFE FPAs are not included.

Below are specs of the Teledyne CHROMA MCT FPA

- 1) Array formats: 1280×480 pixels
- 2) Spectral range: 350-2500 nm
- 3) Pixel pitch: 30×30 µm
- 4) Full well capacity: 1M electrons
- 5) Readout noise: 110 electrons
- 6) Readout mode: Snapshot, integrate-while-read
- 7) Dynamic range: 9000:1
- 8) Frame readout time scales with number of rows read out; row readout time is 16.8 µsec;
- 9) Full-frame rate (480 rows) is 125 Hz,
- 10) Half-frame rate (240 rows) is 250 Hz

[FPA-001] GFE MCT FPAs

The breadboard imaging spectrometer system shall be designed and built for being integrated with the GFE MCT-CHROMA FPAs.

The GFE MCT-CHROMA FPAs are the currently available representative FPAs to the selected baseline Focal Plane Arrays for the COCI imaging spectrometer, although their photo sensitivity layer is HgCdTe (MCT) rather than Si.

Canada is currently planning procurement of the HyViSI-CHROMA FPAs under a separate contract (PT1). In the event that these HyViSI-CHROMA FPAs become available before the end of this PT2 contract, Canada will consider the integration of the HyViSI-CHROMA FPAs into the breadboard system. Depending of the timing and impacts of such change, Canada will consider amending the contract to address the change, including :

- The necessity to procure coolers
- Labour associated with replacing the FPAs
- Carrying new tests

[FPA-002] ITAR Compliance

The GFE FPAs are under US ITAR restriction. The contractor shall follow the procedures to meet the requirements of ITAR restriction.

[FPA-003] Coolers of MCT FPAs

The MCT FPAs shall be cooled to operate in the required temperature specified by the manufacturer.

If it is necessary to procure coolers, the Contractor shall obtain approval from CSA prior to proceeding with this procurement. In case the HyViSI-CHROMA FPAs are available soon enough, this procurement may be unnecessary and Canada may elect to waive. The cost of these items shall be listed separately in the financial bid.

8.2 Water Color Imaging Spectrometer System (SY)

[SY-001] Design and build an imaging spectrometer system

Based on the specifications a water color imaging spectrometer system shall be designed and a breadboard that implements the design shall be built. The breadboard imaging spectrometer system shall be portable and shall include all of its packaging including the enclosure.

Technical trades off shall be made within the context of meeting the specifications listed in Table 8.1 and with an understanding of the impact the spectrometer design may have on COCI payload performance (e.g. SNR, polarization sensitivity, stray light, etc.), engineering budgets (e.g. mass, power, volume, heat, etc.) and other payload components and subsystems.

A Dyson (or modified Dyson) imaging spectrometer shall be selected in order to obtain better optical throughput and compactness. The imaging spectrometer system shall have superior stray light control and low polarization sensitivity for achieving better radiometric accuracy, thinner lenses for low-mass, athermalization, greater back focal length to allow for easy slit and FPA integration and alignment. The developed imaging spectrometer system shall allow for SWIR bands to be included in a later phase for more accurate atmospheric correction.

[SY-002] Ground Sampling Distance

The ground sampling distance (GSD) in cross-track and along track direction shall be 100m or better when the imaging spectrometer is at a low Earth orbit of altitude 675 km in nadir view.

[SY-003] Spatial resolution

The spatial resolution in both cross-track and along-track directions shall be less than or equal to 1.2 times GSD at the Full Width at Half Maximum.

[SY-004] Field-of-View

The imaging spectrometer system shall have a Field-of-View (FOV) in cross-track direction greater than or equal to 19.6 degrees to cover a ground swath of 240km when the flight model is at a low Earth orbit of altitude 675 km.

[SY-005] Swath width

The breadboard imaging spectrometer system including the fore-optics and spectrometer(s) shall cover a ground swath of 240km or wider. In other word, the breadboard system shall be capable of generating hyperspectral images with the number of usable pixels in a cross-track line of at least 2400 pixels when the GSD is 100m.

The full swath can be achieved by two sub-swaths with overlapping given the constraint of the number of pixels of available FPAs. The imaging spectrometer system can consist of either two identical spectrometer channels to cover the full swath, or two separate identical spectrometers and their common fore-optics.

[SY-006] Dynamic range and saturation

The dynamic range of the imaging spectrometer shall be such that the instrument reaches 85% of the maximum when imaging a bright scene (e.g. snow, assuming a 100% albedo) and shall not saturate in presence of sun glint.

[SY-007] Polarization sensitivity

The polarization sensitivity of the imaging spectrometer system shall be smaller than 3% when a depolarizer is not included, and shall be less than 0.2% when a depolarizer is included.

In the design of the imaging spectrometer, a trade-off study should be performed to optimize the performance of the imaging spectrometer with the key components that have large contribution to polarization, such as grating (ruled gratings vs. holographic gratings).

[SY-008] Stray light

The stray light of the imaging spectrometer system shall be smaller than 1.0%.

In the design of the imaging spectrometer, a trade-off study should be performed to optimize the performance of the imaging spectrometer with components that have large contribution to stray light, such as grating (ruled gratings vs. holographic gratings).

[SY-009] Spectral range

The spectral range of the imaging spectrometer shall be 360 nm – 910 nm. The goal spectral range should be 350 nm – 1000 nm.

[SY-010] Spectral sampling interval

The instrument's native spectral sampling interval (SSI) shall be equal to 1.25 nm. The nominal spectral sampling shall be 5.0 nm.

The nominal spectral sampling shall be achieved by binning the native SSIs by a factor of 4. A narrow native SSI helps reduce the saturation of the detectors for bright scene and provides more options for finally transmitted spectral sampling to better meet users' need.

[SY-011] Spectral resolution

The Full Width at Half Maximum (FWHM) of the spectral response to a monochromatic source shall be less than or equal to 1.2 times nominal spectral sampling for all samples.

[SY-012] Peak signal-to-noise ratio

The peak SNR of the water color imaging spectrometer system shall be better than or equal to 950:1 @ 550 nm, with 10nm spectral sampling, 100m GSD and 5% albedo at 675 km orbit.

[SY-013] Minimum signal-to-noise ratio

The minimum SNR of the water color imaging spectrometer system shall be better than or equal to 300:1 within the spectral range 360 nm - 700 nm, with 10 nm spectral sampling, 100m GSD and 5% albedo at 675 km orbit.

[SY-014] Modulation Transfer Function (MTF)

The total MTF (including FPA) shall be > 0.3 @ Nyquist frequency and the optical design shall minimize the MTF variation across the spectral bands and spatial dimension.

[SY-015] Spectral distortion

The spectral distortion (smile) of the water color imaging spectrometer shall be less than or equal to $0.1 \times \text{Spectral Sampling Interval (SSI)}$.

[SY-016] Spatial distortion

The spatial distortion (keystone) of the water color imaging spectrometer shall be less than or equal to 0.1 pixels or $0.1 \times \text{GSD}$.

[SY-017] Digitization

The digitized data shall be at least 14-bit.

[SY-018] Controller, software and GUI

The breadboard imaging spectrometer system shall be delivered with data acquisition equipment and acquisition software (see [SY-024] below), e.g. focal plane electronics, controller electronics, computer and frame grabber, instrument software to digitize, store and display spectral imagery acquired by the imaging system via a GUI. The data rate of the recording equipment shall be compatible with the output data rate of the imaging system. The data recording capacity shall be capable to store data collected over typical airborne collection duration (up to 2 hours). This information shall be included in the user manual.

[SY-019] Structure and mechanics

The breadboard imaging spectrometer system shall have necessary opto-mechanics, thermals and structures to support the required mechanical, thermal and structural functions of the system that is portable.

[SY-020] Mass

The mass of the imaging spectrometer system including fore-optics, imaging spectrometers and electronic controller shall be < 30kg.

[SY-021] Volume

The volume of the imaging spectrometer system including fore-optical, spectrometer and electronic controller shall be smaller than 0.24m³.

[SY-022] Power consumption

The power consumption of the imaging spectrometer system shall be <65W.

[SY-023] Test and characterization in laboratory

The breadboard water color imaging spectrometer system shall be characterized and tested in laboratory conditions. This laboratory characterization and testing shall include:

1. Preparing Test Plan and Procedures
2. Assessing SNR (Peak & Min)
3. Assessing MTF
4. Assessing Spatial resolution
5. Assessing Spectral resolution
6. Assessing Polarization sensitivity
7. Assessing Stray light
8. Assessing Smile
9. Assessing Keystone
10. Assessing Dynamic Range and saturation at 85% maximum
11. Preparing Test Report

Given the fact that the GFE MCT-CHROMA FPAs (see Section 8.1) are expected to be used as the representatives to the selected HyViSI-CHROMA FPAs, some of the parameters listed in SY-023 might not achieve the performance intended with the specifications of Table 8.1.

[SY-024] Calibration in laboratory

The breadboard water color imaging spectrometer system shall be calibrated in laboratory conditions in order to produce the calibration parameters of the imaging system for being used to generate imagery in at-sensor radiance units versus wavelength, including radiometric and geometric calibration software. This information shall be included in the user manual. The lab calibration shall include:

1. Gain
2. Offset
3. Dark current
4. Non-uniformity
5. Strips
6. Spectral calibration
7. Integrate these parameters into the acquisition software (see [SY-018])

Given the fact that the GFE MCT-CHROMA FPAs (see Section 8.1) is expected to be used as the representatives to the selected HyViSI-CHROMA FPAs, some of the parameters listed in SY-024 might not achieve the performance intended with the specifications of Table 8.1.

[SY-025] Ruggedization for airborne assessment (GOAL)

The breadboard imaging spectrometer system should be ruggedized such that the system should meet the vibration and shock environment specifications for small aircrafts (including turbo-propellers), as specified in MIL-STD-810 F (Methods 514.5 and 516.5) or RTCA DO-160E.

[SY-026] Airborne assessment (GOAL)

The developed breadboard water color imaging spectrometer should be assessed in field onboard an aircraft typically used for aerial photography to demonstrate and validate all the functionalities and the performance of the breadboard imaging spectrometer system specified by requirements [SY-001] - [SY-022].

8.3 Fore Optics (FO)

[FO-001] Fore optics

The fore optics of the water color imaging spectrometer system to be deployed in orbit of 675 km shall be designed and verified to ensure that all the imaging system requirements ([SY-001 to SY-024]) and the specifications listed in Table 8.1 will be met.

[FO-002] Fore optics for airborne assessment (GOAL)

The fore optics of the breadboard water color imaging spectrometer system for airborne flight test with a GIFOV of 0.25 mrad (This corresponds to 1 m GSD @ 4000 m altitude) should be designed, built and assembled with the spectrometer(s) to form an airborne water color imaging spectrometer system.

8.4 Facilities and Capability

The contractor shall have capability and facilities (or access to facilities) equipped for design, building, assembly and integrating, and characterization of airborne/spaceborne imaging spectrometers at instrument level.

9. Verification

Table 9.1 presents the verification methods that shall be used to verify the requirements in this SOW. All requirements shall be verified by one or more of the following verification methods:

- 1) Analysis (including simulation);
- 2) Review of design;
- 3) Demonstration;
- 4) Inspection; and
- 5) Test.

These methods are described below:

Analysis

Verification by analysis is carried out for those quantitative (parameters with numerical values) performance requirements that cannot be verified (or do not need to be) by any form of direct measurement. The analysis should be based on test data as far as possible, such as: extrapolating measured as built performance to end-of-life performance; combining test data from a series of lower level measurements to determine the performance of the integrated assembly. Analysis may be used in conjunction with test or by itself as the verification method for a given parameter.

Appropriate analysis methodologies (mathematical modelling, similarity analysis, simulation, etc.) shall be selected on the basis of technical success and cost effectiveness in line with the applicable verification strategies. Similarity analysis with an identical or similar product shall provide evidence that new applications characteristics and performance are within the limits of the precursor qualified design, and shall define any difference that may dictate complementary verification stages.

Review of Design

Review of design shall be used where review of design concepts and, in general, lower-level documentation records is involved, i.e.: where compliance of the design to the requirements is apparent simply from the review of the lower level design itself. For example, if a requirement is for a parallel redundant pin in a connector, this can be entirely verified by reviewing the design of the connector. This activity is normally performed through the review of design documents and/or drawings.

Demonstration

A requirement that is of an operational or functional nature and is not quantified by a specific measurable parameter may be verified by demonstration. This form of verification is used for yes/no types of requirements that can be verified by some form of measurement; that is to demonstrate that the equipment performs the required function or to verify characteristics such as human factors engineering features, services, access features, transportability, etc.

Inspection

Verification by inspection is only done when testing is insufficient or inappropriate. This method of verification is for those requirements that are normally performed by some form of visual inspection. This would include examination of construction features, workmanship, labelling, envelope requirements, review of certificates, compliance with documents and drawings, physical conditions, etc.

Test

A requirement may be verified by test alone if the form of the specification is such that the requirement can be directly measured and the performance is not expected to change over the duration of the mission life. If the performance of the parameter is likely to degrade over the

mission, due to aging, radiation, etc., then test may only be used as a verification method in conjunction with one of the other methods defined above.

Table 9.1: Verification Methods

Requirement	Name	Method	Note
A: Analysis, RoD: Review of Design, D: Demonstration, I: Inspection, T: Test			
[SY-001]	Design and build an imaging spectrometer system	A, RoD, T	
[SY-002]	Ground sampling distance	RoD, T	At 675 km altitude
[SY-003]	Spatial resolution	RoD, T	At 675 km altitude
[SY-004]	Field-of-View	RoD, T	
[SY-005]	Swath width	RoD, T	
[SY-006]	Dynamic range and saturation	RoD, T	
[SY-007]	Polarization sensitivity	RoD, T	
[SY-008]	Stray light	RoD, T	
[SY-009]	Spectral range	RoD, T	
[SY-010]	Spectral sampling interval	RoD, T	
[SY-011]	Spectral resolution	RoD, T	
[SY-012]	Peak Signal-to-noise ratio	RoD, T	
[SY-013]	Minimum Signal-to-noise ratio	RoD, T	
[SY-014]	Modulation Transfer Function	RoD, T	
[SY-015]	Spectral distortion (smile)	RoD, T	
[SY-016]	Spatial distortion (keystone)	RoD, T	
[SY-017]	Digitization	RoD, T	
[SY-018]	Controller, software and GUI	I, D	
[SY-019]	Structure and mechanics	A, RoD	
[SY-020]	Mass	RoD, I	
[SY-021]	Volume	RoD, I	
[SY-022]	Power consumption	RoD, T	
[SY-023]	Test and characterization in laboratory	T, I, D	
[SY-024]	Calibration in laboratory	T, I, D	
[SY-025]	Ruggedization for airborne assessment	RoD, D	if implemented
[SY-026]	Airborne assessment	RoD, D	if implemented
[FO-001]	Fore optics	RoD, A	
[FO-002]	Fore optics for airborne assessment	RoD, T, D	if implemented
[FPA-001]	GFE MCT FPAs	I, D	
[FPA-002]	ITAR Compliance	I, D	
[FPA-003]	Coolers of MCT FPAs	I, D	

10. Targeted TRL

The targeted TRL for this technology development is TRL 5 within the contract period.

11. Specific Deliverables

The deliverables defined here complement *Section A.7 Contract Deliverables and Meetings* of Annex A.

Table 11.1 Specific Deliverables

ID	Due Date	Deliverable	Type
D1	M2	Contract Implementation plan	Technical Document/Report
D2	Each milestones	Compliance Matrix	Technical Document/Report
D3	M2	Preliminary Design Document	Technical Document/Report
D4	M3	Procurement Plan and specifications, including 1. Dyson or modified Dyson blocks; 2. Gratings; 3. Fore-optics.	Technical Document/Report
D5	M4	Detailed Design Document	Technical Document/Report
D6	M4	Interface Control Documents	Technical Document/Report
D7	M5	Test Plan and Procedure	Technical Document/Report
D8	M6	Test Report	Technical Document/Report
D9	M6	Breadboard imaging spectrometer system suitable for airborne test and associated hardware (if applicable)	Hardware
D10	M7	Software code	Software
D11	M7	User Manual	Technical Document
D12		Equipment (purchased under the contract)	Hardware
D13	M7	Final Report	Technical Document/Report

12. Schedule & Milestones

The anticipated duration of this technology development is 18 months. A suggested schedule appears in Table 12.1. An alternative schedule can be proposed with a maximum duration of 24 months that maintains a Work Authorization Meeting at the Detailed Design phase.

Table 12.1 – Schedule & Milestones

Milestones	Description	Completion	Venue
M1	Kick-off meeting (KoM)	KOM	Contractor
M2	Preliminary Design Review (PDR)	KOM + x months	Telecon
M3	Procurement Review	KOM + x months	Telecon

M4	Detailed Design Review (DDR) Work Authorization Meeting	KOM + x months	CSA
M5	Lab Test Readiness Review (TRR)	KOM + x months	Contractor
M6	Airborne Test Readiness Review (if applicable)	KOM + x months	Telecon
M7	Final Review meeting (FR)	KOM + x months	CSA

13. Data Items Descriptions (DIDs)

This section lists DID(s) applicable to this specific Priority Technology.

DID-0014 – TRRA Final Report for Small Projects

DID Issue: IR

Date: 2017-03-31

PURPOSE:

Technology development activities (i.e. STDP) serve to reduce technological risks and help position industry or academia for future missions. The Technology Readiness and Risk Assessment (TRRA) activity is used to identify high risk items that require further technology development.

The investment planning teams at CSA use the TRRA final report to help determine which risk mitigation activities should be undertaken in the next round of funding

PREPARATION INSTRUCTIONS:

This report may be combined with other deliverables such as a final report. This Report should contain at least the following information

Section 1: Introduction and Business Case

This first section should contain a high level executive summary of the technology and its potential for development, suitable for public dissemination (through social media for example). The principal target audience is CSA executives and policy makers, who may not be entirely familiar with the technology or its applications. The summary should be in a simple easy to understand language. The summary should focus largely on potential mission outcomes (e.g., detection of organics on Mars) rather than engineering implementation details (e.g., LIBS/Rahman sensor). The section could also discuss alignment with government priorities because it will be used as input in the development of a business case for future investments.

Section 2: Summary of TRRA Results

The TRRA process consists of several steps including the identification and assessment of critical technologies that represent a higher degree of risk for the mission. This section will describe the technological components of the instrument or payload, provide a list of the critical elements, and their associated risk metrics (R&D3, TNV, dTRL*TNV²). This section will also provide a recommendation for future technology development, and could discuss specific technical requirements of concern and the plan to meet them.

In order to assist the CSA in continuing the development of this technology, the contractor shall also provide a brief outline of the scope and key requirements to reach the next TRL level. This information is intended to be used in the crafting of subsequent development should CSA pursue this technology.

Section 3: Path to Flight

This section will provide a wider context for the technology development efforts needed to prepare the technology for a future mission. The goal is to identify future potential missions, and the schedule drivers that drive the technology development needs. The development plan should explain the proposed sequencing of technology development over STDP contract or mission phases and their TRL progression. The investment plan should provide notional budget estimates

² The TRRA Summary Template (CSA-ST-FROM-0004 IR) can be used for this purpose.

suitable for high level planning purposes. The identification of potential technology demonstration activities (and platforms) should also be discussed, if appropriate. Historical reference for past technology development contracts or contribution should also be cited.
