RFP 9F045-17-0348

Canadian Space Agency

ANNEX A

STATEMENT OF WORK (SOW)

Space Weather Socioeconomic Impact Study on Canadian Infrastructure

Date: August 2017

Canadian Space Agency | Agence Spatiale Canadienne

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TABLE OF CONTENTS

PAGE

1 INTRODUCTION

1.1 SCOPE

The scope of this statement of work (SOW) is to identify and assess the risks and potential impacts relating to space weather events in Canada and to compare with best practices internationally. Potential impacts of space weather will be evaluated for different levels of activity and compared with the cost of mitigation measures.

1.2 BACKGROUND

Canada's Sovereignty and Security is an element of Canada Space Policy Framework. There is an increasing recognition world-wide that Space Weather Monitoring and Forecast is required to protect space assets, ground assets and ultimately human lives against risks originating in space. For example, the 59th session Report of the Committee on the Peaceful Uses of Outer Space https://cms.unov.org/dcpms2/api/finaldocuments?Language=en&Symbol=A/71/20 includes the following guideline on p. 63 of the report:

> *17.7 States should undertake an assessment of the risk and socioeconomic impacts of adverse space weather effects on the technological systems in their respective countries. The results from such studies should be published and made available to all States and used to inform decision-making relating to the long-term sustainability of outer space activities, particularly with regard to mitigating the adverse impacts of space weather on operational space systems.*

Space weather events can have a significant impact on Canada's critical infrastructure essential to national security, economy and the health of Canadians including the electrical grid, the transportation networks and space systems (satellites and their ground facilities). Concerns have risen over the years as a result of the complexity of critical infrastructure and our dependency to technology. As a northern country, Canada's infrastructure and activities are particularly vulnerable to space weather events, but the risks on our country have not been assessed and the possible impacts have not been quantified. While the Sun has generally behaved in the same way for as long as we have observed it, the increasing reliance on modern technology puts Canada more and more at risk as this technology can often be disrupted by space weather. The biggest storm on record was in 1859 and perturbed the telegraph network, the only "modern" communication technology at the time. The same event could have happened a 100 years before without anyone noticing. If that type of event was to happen nowadays, we could expect severe disturbances in our GNSS networks, power networks, satellite infrastructure that could take years to recover from.

In 2013, the United Kingdom generated an exhaustive study concluding that their infrastructure are at risks and underlining the importance to maintain current mitigation strategies and the development of new approaches.

The same year, the United States followed through with a more focused study which identified the risk of losing critical space weather observing and forecasting capabilities and the necessity to maintain their space-based and ground-based observing systems. In April 2015, they released a draft U.S. Space Weather Strategy identifying six strategic goals to enhance the integration of existing national efforts and add new capabilities. No such strategy has been established yet in

Canada although some discussions and workshops were conducted between Federal Departments and DND in the context of the definition of their space surveillance program.

One of the objectives of the proposed study is to support the development of a Canadian space weather strategy that would ensure that all reasonable means are in place to deal with the security issues and that the investment made is commensurate with the importance of the subject. The first step towards these goals is therefore to assess the cost and impacts of space weather, to size the importance of the problem in Canada;

The requirements provided in this SOW are to establish that basis of knowledge for space weather to ensure Canada's risk management strategy is appropriate. Note that DND capacity and vulnerabilities with respect to space weather are excluded from the scope of this contract for security reasons.

1.3 DOCUMENT CONVENTIONS

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

a) “Shall” or “Must” is used to indicate a mandatory requirement;

b) “Should” indicates a goal or preferred alternative. Such goals or alternatives must be treated as requirements on a best efforts basis, and verified as for other requirements. The actual performance achieved must be included in the appropriate verification report, whether or not the goal performance 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.

In the following, the term 'Contractor' is used to describe the team that will conduct the study, which could be a mixed team drawn from Canadian Industry, Universities or Research Institutes.

2 DOCUMENTS

2.1 APPLICABLE DOCUMENTS (AD)

There are no applicable documents to this contract

2.2 REFERENCE DOCUMENTS (RD)

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

Table 2.2-1: Reference Documents

RD No.	Document Number	Document Title	Rev. No.	Date
RD-1.	PMBOK Guide	A Guide to the Project Management Body of Knowledge	4th Ed.	2008
RD-2.	CSA-SE-STD-0001	CSA Systems Engineering Technical Reviews Standard	Rev. A	2008-11-7
RD-3.	CSA-ST-GDL-0001	CSA Technology Readiness Levels and Assessment Guidelines	I.R.	January 2009
RD-4.	http://www.tbs-sct.gc.ca/emf-cag/business-rentabilisation/bcg-gar/bcg-gar-eng.pdf	Business Case Guide (Treasury Board of Canada Secretariat)	NA	2009
RD-5.	http://www.sciencedirect.com/science/article/pii/S0273117715002252	Understanding space weather to shield society: A global road map for 2015–2025 commissioned by COSPAR and ILWS	Advances in Space Research 55 (2015) 2745–2807	2015
RD-6.	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/449593/BIS-15-457-space-weather-preparedness-strategy.pdf	Space Weather Preparedness Strategy - Gov.uk	2.1	July 2015

RD No.	Document Number	Document Title	Rev. No.	Date
RD-7.	http://www.raeng.org.uk/publications/reports/space-weather-full-report	Extreme space weather: impacts on engineered systems and infrastructure	ISBN 1-903496-95-0	2013
RD-8.	http://www.nap.edu/catalog/12507/severe-space-weather-events-understanding-societal-and-economic-impacts-a	Severe Space Weather Events--Understanding Societal and Economic Impacts : A Workshop Report	ISBN: 0-309-12770-X	2008
RD-9.	https://www.lloyds.com/~/media/lloyds/reports/emerging%20risk%20reports/solar%20storm%20risk%20to%20the%20north%20american%20electric%20grid.pdf	Solar storm Risk to the north American electric grid	NA	2013
RD-10.	https://cms.unov.org/dcpms2/api/finaldocuments?Language=en&Symbol=A/71/20	Report of the Committee on the Peaceful Uses of Outer Space Fifty-ninth session		June 2016
RD-11.	http://onlinelibrary.wiley.com/doi/10.1002/2014SW001095/full	Extreme Space Weather Impact: An Emergency Management Perspective		August 2014
RD-12.	http://onlinelibrary.wiley.com/doi/10.1002/swe.20092/pdf	A survey of customers of space weather information		June 2013

3 REQUIREMENTS

3.1 GENERAL

The Contractor must manage the project to effectively achieve project performance, scope, quality, cost and schedule requirements of this SOW. The Contractor must provide the management, technical leadership and support necessary to ensure effective and efficient performance of all project efforts and activities.

The Contractor must report project costs, schedule, technical, performance and risks issues as defined herein.

3.2 OBJECTIVES

The study objectives are given in Table 3.2-1. The objectives are further classified as Primary (must be achieved in the course of activities) and Secondary (some work is needed but preliminary or partial answers to be fully addressed in future activities are acceptable).

Table 3.2-1 High-level study objectives

ID	Objectives	Remarks
OBJ-GEN-01	Assess and quantify the risks and socioeconomic impact of various space weather threats such that CSA and its partners can identify short-term and long term priorities.	Primary
OBJ-GEN-02	Identify priority areas for future technology roadmaps.	Secondary
OBJ-GEN-03	Organize workshops where stakeholders (Canadian government, industry and Academia) gather and exchange on the findings	Primary
OBJ-SW-01	Review current efforts to detect, warn and mitigate space weather events on Canada's infrastructure.	Primary
OBJ-SW-02	Assess the current resilience of Canadian critical infrastructure to different levels of space weather disturbances	Secondary
OBJ-SW-03	Evaluate the cost of space weather as reliance on technology increases	Primary

3.3 DETAILED TASKS

Some elements of this study may require primary data collection, whereas other elements may rely on data and analysis performed by the CSA and/or its partners. The following tasks may not need to be implemented sequentially as presented here. The Contractor shall present the proposed sequence as part of the management proposal. The contractor may propose to combine or give more or less emphasis to some Tasks in the following sub-sections depending on awareness, past activities and team experience, as long as the main study objectives are met.

TASK-SW-1: Literature review on previous space weather socioeconomic impact studies, extracting conclusions and consequences to Canada based on at least RD-5 to RD-12.

TASK-SW-2: Review/document the roles and responsibilities of the various Canadian organizations involved in space weather (as a service provider or client). Writing of a document on the space weather related activities in Canada.

TASK-SW-3: Develop a set of indicators to assess socioeconomic impacts of space weather on Canadian activities (government and commercial) and proposition of a methodology for measurement. The list of indicators and the methodology must be validated with CSA at a mid-term review.

TASK-SW-4: Prepare a questionnaire to be answered by Canadian Space Weather stakeholders, requesting identification of the respondent, evaluating their knowledge of space weather activities in Canada, space weather-related training needs, and requesting an estimated impact to their organization for different levels of space weather activity, either directly affecting their activities, or affecting critical infrastructure they rely on to be productive. More details are given in the DID-0100 section of Appendix B.

TASK-SW-5: A web version of the questionnaire will be produced, to be hosted on a server provided by the contractor, to facilitate the collect of information. The web-based questionnaire will include all the same questions as defined in TASK-SW-4, and will log the entries in a database, which can be exported as a Microsoft Excel-readable spreadsheet for analysis.

TASK-SW-6: Gather survey data. The contractor will deploy the web version of the questionnaire and make the site known to the target audience. The contractor will ensure the key stakeholders have responded and that the website is performing as required.

TASK-SW-7: Assess the impact and risk. Using existing documentation and data collection results, the contractor shall perform an impact analysis of different level of space weather activity, for different types of space weather events (i.e. geomagnetic storms, solar energetic particles, solar flares, perhaps radio bursts. These results must be quantified in **constant dollars figure** but estimates in some cases are acceptable. More details are given in DID-0200 section of Appendix B.

TASK-SW-8: Identify mitigation strategies/needs for a higher resilience to space weather events in Canada. The contractor must describe (and quantify where possible) the users that would benefit from the proposed activities and how much benefits in dollar figure where possible the new activities will provide. The contractor must also identify (based on examples from task 1 or 2 for instance) new Canadian users who could benefit from activities in the space weather program.

TASK-SW-9: Organize a consultation/workshop/event allowing stakeholders (Canadian government, industry and Academia) to exchange on the conclusions from the survey, and recommend areas of improvement.

TASK-SW-10: Produce the Final Report detailing the entire survey, findings, the analysis of each task must be included and detailed. Conclude on the benefits of developing space weather activities in Canada and recommend future activities to be developed (way-forward).

TASK-SW-11: Assess and rank the biggest knowledge gaps regarding space weather, and recommend action from Industry, Academia or Government to address these gaps.

3.4 DELIVERABLES

The deliverables for the activity are listed in Table 3.4-1.

Table 3.4-1 Deliverables

Reports and Documents	**Due Date**	**DID #**
Space Weather Impact Questionnaire (pdf and web versions)	Interim Review Meeting #1 – 2 weeks (draft) Interim Review Meeting #2 – 2 weeks (Final)	0100
Space Weather Report	Interim Review Meeting #1 – 2 weeks (draft) Interim Review Meeting #2 – 2 weeks (draft) Final Review – 2 weeks	0200
Minutes/ Presentations		
Kick-off Meeting Presentation	Meeting Date – 1 week	Contractor Format
Interim Meeting Presentation	Meeting Date – 1 week	Contractor Format
Final Review Presentation	Meeting Date – 2 week	Contractor Format
Minutes of Meetings	Meeting Date + 1 week	0005
Action Item Log for Reviews and Teleconference	Meeting Date + 1 day	0006
Final Data Package - Space Weather	2 weeks before Contract End Date	
Final Version of all documents related to Space Weather	Final Review – 2 weeks	NA
Executive Report -Space Weather	Final Review – 2 weeks	0260
BIP and FIP Disclosure Report	Interim Review Meeting #1 – 2 weeks (draft) Final Review – 2 weeks	0250
Technical Notes related to Space Weather	As required.	Contractor Format
Any spreadsheet or database or working document used for compiling results from interviews	As required.	Contractor Format

3.5 SCHEDULE

The work described in this SOW must be completed within 16 months.

3.6 MEETINGS

Table 3.6-1 lists the meetings planned for this activity.

TABLE 3.6-1 MEETINGS

Meeting	Date	Location
Kick-off Meeting	ARO + 2 weeks	CSA
Interim Review Meeting #1	ARO + 5 months	Teleconference or on site
Interim Review Meeting #2	ARO + 10 months	Teleconference or on site
Space Weather event/workshop	To be agreed upon at KOM	To be agreed upon at KOM.
Final Review Meeting	ARO + 15 months	CSA
Teleconference	As needed	Teleconference

3.7 DOCUMENTATION AND NAMING CONVENTION

Documentation, reporting and other deliverables must be according to instructions provided in Appendix B of this SOW, which also provides naming convention. Presentation material must be in Power Point format. Documents provided in Adobe PDF format must not be protected against copy of text and figures.

Documents shall be delivered in the original software application format. One electronic copy of each deliverable document shall be transferred to the CSA to the address and in the format specified in DID-0000, Appendix B. No paper copy is to be delivered.

All spreadsheet, or databases, or working documents used to compile to results and findings must be delivered in USB drive, CD-ROM or DVD-ROM format.

All documents must be provided 10 working days prior to the specified Review/Meeting unless otherwise indicated.

3.8 PROJECT MANAGEMENT REQUIREMENTS

The Contractor is responsible for establishing and maintaining a project management control system necessary to meet the requirements provided in the next sub-sections.

3.8.1 Team Organization

The Contractor must set up and maintain a project organization specific to this project. The Contractor must provide and maintain a current Project Organizational Chart showing personnel assignments by name and function, and showing subcontractor-reporting relationships.

The Contractor must nominate a Project Manager, who will be responsible for all aspects of the work carried out by the Contractor and will act as single point of contact within its project organization for communications between the Contractor and the Technical Authority (TA). In the absence of the single point of contact, the Contractor must designate an alternate to maintain continuity of communication between the Contractor and the TA.

The Contractor must also identify other key personnel who are considered essential to the performance of the contract. The Contractor must assign personnel with appropriate qualifications and experience to all posts within the project organization.

The Contractor must include, within its program management structure, the necessary leadership to effectively manage the performance of subcontractors in keeping with the project objectives.

3.8.2 Communications and Access

The Contractor must establish and maintain a close management and technical interface with CSA technical and project authorities to assure a coordinated program effort and monitoring of the total program cost, schedule and performance.

The Contractor must provide access to its plant and personnel, at mutually agreeable dates, by representatives of CSA or other organizations nominated by the CSA, for review of program status.

The Contractor must provide temporary accommodation and other facilities for the use of the CSA representatives (and the nominated attendees) visiting the Contractor's premises for reviews, meetings, audits, liaison, etc.

The accommodation must be adequate for the purposes of the visit and the facilities provided must include telephone, faxing, photocopying and Internet access.

All documentation and data generated by the Contractor for the project must be accessible to the TA for review.

3.8.3 Project Meetings

The Contractor must hold the meetings described in section 3.6. Some or all of these meetings may be attended by representatives of the CSA, and/or other organizations nominated by the CSA. Canada reserves the right to invite additional knowledgeable people (Public Servants or others under NDA) to this meetings.

All meetings will be held between the Contractor and the TA at a mutually agreeable time. The Contractor must provide formal notification of the proposed meeting date to the TA no less than 10 working days before the meeting (with the exception of the KoM where the Contractor must provide formal notification no less than 5 working days before the meeting).

For meetings held at government venues, the Contractor must inform the TA of the names of Contractor and Subcontractor attendees no less than 10 working days before each meeting.

Additional teleconferences and face-to-face review meetings may be held if necessary when mutually agreed to by the Contractor and the CSA project manager.

Meetings can be alternatively replaced by videoconference or teleconferences for cost and/or time savings and when appropriate to support the scope of the meeting.

3.8.3.1 Kick-off Meeting

Within two weeks of the contract award (or at a date mutually agreeable to by the PA, the SA and the Contractor) a Kick-Off Meeting should be scheduled by the Contractor. The Contractor should provide the meeting agenda at least five working days before the meeting. The presentation should include the following content:

- Review of contract deliverables;
- Work requirements;
- Foreground Intellectual Property (FIP) and Background Intellectual Property (BIP);
- Licensing issues if any;
- Project's funding and expected cash-flow;
- Presentation to include the required copyrights and intellectual property disclosure;
- Other items as deemed appropriate.

This meeting will be held at the Contractor Facilities or via teleconference.

All key participants under the contract, including at least one representative from each subcontractor, must attend this meeting.

3.8.3.2 Review Meetings (Payload Trade-off Review, Interim Reviews, Mission Concept Review)

During the contract, various meetings will be necessary to evaluate progress of the work. The Meetings will be held according to the schedule in Table 3.6-1. The Meetings are intended to provide an opportunity for the Contractor, the PA, the SA, and other invited attendees to review and discuss the following in detail, as necessary:

- The contents of the contract deliverables;
- The technical work of each task;
- Foreground Intellectual Property (FIP) and Background Intellectual Property (BIP);
- Discuss project management issues;
- Presentation to include the required copyrights and intellectual property disclosure;
- Other items as deemed appropriate.

The Contractor’s project manager and all key Contractor participants, including at least one representative from each Subcontractor involved in the material presented at the review must attend.

3.8.3.3 Final Review Meeting

The Final Review Meeting will be held at the Canadian Space Agency at the end of the contract. The specific intent of this meeting will be to discuss in detail the results obtained and the proposed follow-on activities. The Final Review Meeting is intended to provide an opportunity for the Contractor, the PA, the SA and other invited attendees to review and discuss the project.

- Contract deliverables;
- Foreground Intellectual Property (FIP) and Background Intellectual Property (BIP);
- Licensing issues if any;
- Final Funding and cash-flow;
- Discuss project management issues;
- Presentation to include the required copyrights and intellectual property disclosure;
- Other items as deemed appropriate

The Contractor must submit the Final Data Package 10 working days before Contract End Date; document versions must be as per the CDRL.

The Contractor's project manager, the systems engineer and all key Contractor participants, including at least one representative from each Subcontractor, must attend Final Review Meeting.

3.8.4 Agendas, Minutes and Action Item Log

The Contractor must provide a Meeting Agenda for all reviews and meetings including teleconferences and must deliver these to the TA no less than 5 working days before the meeting and must have it approved by the TA.

The Contractor must produce the minutes for all reviews and meetings including teleconferences and must deliver these to CSA no more than 5 working days after the meeting.

The Contractor must maintain a detailed Action Item Log (AIL) throughout the project to track actions resulting from all reviews and meetings including teleconferences using the following red-yellow-green stoplight method:

- 'Green' implying that the action item will be completed on-time.
- 'Yellow' implying that there exist an issue which will prevent meeting the deadline, and
- 'Red' implying that the action is past due.

Also, a chart indicating how many action items are open and how many are closed since the beginning of the project shall be produced at the meetings. The AIL must be delivered the next business day following the review or meeting (including teleconference).

3.8.5 Project Reporting

3.8.6 Documents Deliverables

The Contractor must deliver all documentation listed in the CDRL tables (Appendix A) as a minimum. The format and content of the deliverables must be in accordance with the requirements specified in the Data Item Descriptions (DIDs) (Appendix B), both the specific DID identified in the CDRL and the General Preparation Instructions, DID-0000.

Except for the documents that will remain CSA documents, the Contractor may propose documents in a contractor's format provided the purpose, scope and content equal or exceed the DID requirements. Subject to CSA approval, the content of the Contractor's document will replace the content of the document specified in the DID.

SI units must be used/supplied by the Contractor. Conversion factors must be supplied for all non-SI units used in the deliverable documents (including dates as YYYY-MM-DD).

The Contractor must obtain approval from the CSA for all CDRL Documents so indicated in the CDRL table (see Section 3.8.6.1).

3.8.6.1 Documents Delivered for Approval

The term “Approval” as used in this document and in other documents referred to herein, means written approval by CSA, of documents submitted by the Contractor. Once approved, the document is authorized for further use by CSA. The TA does not take responsibility for the validity of the data, or statements, and the Contractor is fully responsible for the content and secondary effects derived there from. The document may not be changed without the TA’s approval. No request or document for which approval is required must be acted upon or implemented by the Contractor until such approval is provided. Such requests and documents will be reviewed promptly by the TA and the necessary written approval or disapproval will be provided after their receipt by CSA. In the event of a failure by the TA to approve or disapprove the document within 15 calendar days, the documents may be deemed approved. In the event that a request or document is disapproved, the TA will advise the Contractor in writing as to the reasons for such disapproval and will define the additions, deletions or corrections that the TA deems necessary to render the request or document acceptable. Disapproved requests or documents that are subsequently amended by the Contractor and resubmitted for approval will be either approved or disapproved by the CSA.

3.8.6.2 Documents Delivered for Review

The term “Review” as used in this document and in all other documents referred to herein, means, unless specifically stated otherwise, a CSA review of the documents submitted for that purpose by the Contractor. The acceptance by the TA of a document for review shall imply that the document has been reviewed, commented on, revised as necessary, and has been determined to meet the requirements. The TA does not take responsibility for the validity of the data, or statements, and the Contractor is fully responsible for the content and secondary effects derived there from. In the event that the TA does not concur with a document submitted for review, the TA will so notify the Contractor. Such notification will include a full explanation of the reasons for the lack of concurrence and will recommend the additions, deletions or corrections that the TA deems beneficial to the needs of the project.

The Contractor is obligated to consider implementation of the changes suggested by CSA insofar as the changes are in accordance with the relevant DID in Appendix D and this SOW. If written

notification of concurrence is not provided by CSA within 15 calendar days of the receipt of the document, the document will be deemed to have been reviewed by the TA without comment.

3.8.7 Subcontract Management

The Contractor must be fully responsible for implementation and execution of all tasks, including those subcontracted to others. Whenever this is the case, the Contractor must prepare and maintain subcontract Statements of Work, technical requirements documents, etc., necessary to effectively manage the subcontractors' work. At the request of the TA, copies of subcontractor documentation must be delivered to the TA.

The Contractor must ensure that all of the relevant requirements of this Statement of Work are flowed down to the subcontract Statements of Work.

3.8.8 Product Assurance

There are no applicable product assurance requirements in this study.

3.9 INTELLECTUAL PROPERTY

The Contractor shall prepare Background and Foreground Intellectual Property (BIP and FIP) Report, identifying the BIP and FIP that will be generated in this study.

4 GOVERNMENT FURNISHED EQUIPMENT AND INFORMATION

No GFE.

APPENDICES

APPENDIX A CONTRACT DATA REQUIREMENTS LIST (CDRL)

This Appendix defines the documentation to be delivered by the Contractor.

LEGEND:

A = Approval (in the Approval Category)
CF = Contractor's format
X = Ad-hoc, as and when requested

TABLE A-1: CDRL

Title	DID No.	Approval Category
Meeting Agenda	0004	A
Minutes of Meetings	0005	A
Action Items Log (AIL)	0006	A
Report – space weather	0200	A
BIP and FIP Disclosure Report	0250	A
Executive Report (one per topic)	0260	A
Technical Notes	CF	X

APPENDIX B DATA ITEMS DESCRIPTIONS (DIDs)

DID-0000 - General Preparation Instructions

PURPOSE:

This DID describes the standard format for the preparation of deliverable project documentation. All documentation must be written in English and must be delivered in electronic format. Documentation must be prepared in the Contractor's format, however it must meet the requirements of this DID.

PREPARATION INSTRUCTIONS:

1. GENERAL INSTRUCTIONS

1.1. Electronic Copies

Electronic documents must be prepared using the most appropriate tool (Microsoft Word, Excel, MS Project, etc.); released versions must be delivered in electronic format and may be in PDF. Schedules must be submitted in Microsoft Project format. Documents must be delivered via e-mail or direct transfer (FTP). For direct transfer, a notification of the document's readiness and location on a Contractor repository must be sent.

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

WXYZ-CDRL-NUM-CIE_ContractNumber_sent2007-03-30

where:

WXYZ:	A 4-8 letter acronym of the project
CDRL-NUM:	The CDRL Identifier
CIE:	Name of the Company (no space, no hyphen)
ContractNumber:	For example: _9F028-07-4200-03
_sentYEAR-MONTH-DAY:	Date Tracking Number

Electronic documents or notifications of their availability on Contractor repositories must be sent to the e-mail address of the TA.

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

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

The USB Drive/DVD-ROM label must present the following information:

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

1.2. Electronic Documents Format

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

1.2.1. Page Numbering

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

1.2.2. Document Numbers

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

2. DOCUMENT STRUCTURE AND CONTENT

2.1. Overall

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

a) Cover/Title Page;
b) Table of Contents;
c) Scope;
d) Applicable and Reference Documents;
e) Body of Document; and
f) Appendices
g) The following property notice of all internal pages: ***Use, duplication or disclosure of this document or any of the information contained herein is subject to the Property Notice at the front of this document.***

2.2. Cover/Title Page

The title page must contain the following information:

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

- The following property notice: ***This document is a deliverable under contract no. _____. It contains information proprietary to the Crown, or to a third party to which the Crown may have legal obligation to protect such information from unauthorized disclosure, use or duplication. Any disclosure, use or duplication of this document or of any of the information contained herein for other than the specific purpose for which it was disclosed is expressly prohibited outside the Government of Canada except as the Crown may otherwise agree to in writing.***

2.3. Table of Contents

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

2.4. Scope

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

a) Identification (number, title) of the system, hardware, or software to which the document applies;

b) A brief overview of the system to which the document applies; and

c) A summary of the purpose and content of the document.

The requirements specified in the following DIDs are the minimum expected. The Contractor must include in all documents all additional information required in order to ensure that the document provided will achieve its purpose as stated in the DID.

2.5. Applicable and Reference Documents

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

2.6. Body of Document

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

2.7. Appendices

Appendices may be used to provide information published separately for convenience of document maintenance.

3. DOCUMENT REVISIONS

Changes in revised documents must be identified by a sidebar.

4. SUBMISSION OF DATA

Data must be submitted via Letter of Transmittal (or an electronic equivalent as mutually agreed by the TA and the Contractor), and acknowledged. The Letter of Transmittal will contain as a minimum, the Contract Serial Number, the CDRL Number and the Title. The

Letter of Transmittal must be forwarded by the Contractor in two copies; one copy of acknowledgement to be signed and returned to the Contractor by the recipient.

DID-0004 – Meeting Agenda

PURPOSE:

To clarify the purpose, content and timings of a meeting.

PREPARATION INSTRUCTIONS:

The meeting agendas must contain the following information, as a minimum.

1) DOCUMENT HEADER:

a) Title;

b) Type of meeting;

c) Project title, project number, and contract number;

d) Date, time, and place;

e) Chairperson; and

f) Expected duration.

2) DOCUMENT BODY:

a) Introduction;

b) Opening Remarks: CSA;

c) Opening Remarks: Contractor;

d) Review of previous minutes and all open action items;

e) Project technical issues;

f) Project management issues;

g) Other topics;

h) Review of any action items as a result of the current meeting and

i) Set or confirm dates of future meetings.

DID-0005 – Minutes of Meetings

PURPOSE:

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

PREPARATION INSTRUCTIONS:

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

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

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

The list of action items must include the following information:

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

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

DID-0006 – Action Items Log

PURPOSE:

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

PREPARATION INSTRUCTIONS:

The AIL must be in a tabular form, with the following headings in this order:

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

The date in column 8 will be the target date as long as the item is open, and the actual date once the item is closed.

DID-0100 Questionnaire on Space Weather

PURPOSE:

To Assess Canada's capabilities and vulnerabilities with respect to space weather and quantify potential impacts. The questionnaire will include all documented space weather impacts, including impact on satellites and effects uncommon in Canada such as equatorial scintillation, as Canadian industry may be affected outside of Canada, and the questionnaire may be used by other UN COPUOS member states.

PREPARATION INSTRUCTIONS:

The questionnaire shall briefly introduce the different types of space weather to the respondent, as not all industries are fully aware of the different ways space weather can impact their operations, and request a systematic evaluation of the industry's assessment of the impact of different conditions. The questionnaire shall include the option for the respondent to indicate when he doesn't know, as assessing this knowledge gap is part of this study.

The contractor is free to rearrange the sections as he sees fit as long as the content and coherence is preserved. The questionnaire can be issued incrementally, starting with high level questions to engage the respondent, and adding complexity gradually to not overwhelm the respondent and maximize the response rate.

The questionnaire shall include:

1. DID-SWQ-1. Introduction on the context of the Study
2. DID-SWQ-2. Review of space weather mechanisms and how they can impact different stakeholders. Review of space weather related activities in Canada (monitoring, forecasting, policy, research, funding, etc.)
3. DID-SWQ-3. Identification of the respondent including:
    a. Country, Name, address of the stakeholder entity represented by the respondent
    b. Name, phone number and email of the respondent
    c. Self-assessed degree of knowledge on the many aspects of space weather (may include a free-form box to capture specific knowledge gaps)
    d. Disclosure permissions: permission to associate the name of the company with the collected data.
    e. Identification/assessment of technologies the operations rely on, including as a minimum,
        i. Utilities
        ii. GNSS services (location and timing)

iii. Transportation services

iv. Terrestrial communication services, including HF, UHF, Cellular, cable, fiber optics..

v. Banking and trading

vi. Satellites services

Below is an example of the types of table that could be used to collect the information on the reliance on technology of the respondent's organization.

Space Weather caused Disturbance	**Describe the level of service that is required by your organization**	**Duration after which this becomes problematic**	**Impact on your industry**	**Estimated direct cost**	**Estimated indirect cost**
Loss of power from your main provider					
Loss of GNSS positioning service					
Loss of GNSS Timing					

4. DID-SWQ-4. Freehand assessment by the respondent of his organizations' sensitivity to space weather, including impacts from average space weather up to large event, space weather support needs, including the type and precision of forecasts that is required to be actionable, adequacy of mitigation methods.

5. DID-SWQ-5. Cost (and other metrics) assessment for specific different levels of disturbances, for all known types of space weather disturbance. Each type of space weather disturbance will be assessed for at least 3 orders of magnitude of amplitude, including a very large/worst case. For example:

Disturbance	**Amplitude**	**Duration for which this becomes problematic**	**Impact on your industry**	**Estimated direct cost**	**Estimated indirect cost**
Magnetic field orientation change	0.1 degree				
Magnetic field orientation change	1 degree				
Magnetic field orientation change	10 degree				

GNSS Positioning deviation	1 m				
GNSS Positioning deviation	10 m				
GNSS Positioning deviation	100 m				
GNSS Positioning deviation	Loss of signal				

a. Impact on your industry will be evaluated using a selection including at least None, Low, High, Not Known, Private information (referring to internal assessments that cannot be publicly disclosed).

b. The questionnaire shall allow for comments/voluntary input

c. Estimated cost/impact should specify if the proposed value is a minimum, maximum, range, expected value or other (time dependent, etc).

6. DID-SWQ-6. The questionnaire shall be self-explanatory so the respondent can fill it autonomously.
7. DID-SWQ-7 The questionnaire shall be available in French and in English.
8. DID-SWQ-8 The questionnaire shall include a field where a respondent can suggest other potential candidates to take the survey, and other potential effects, not described in the questionnaire (i.e. radio bursts, satellite drag etc.).

DID-0200 Report on Space Weather

PURPOSE:

To produce the socioeconomic Impact Study and report on cost of space weather to Canadian industry... The outcome will be used in support of potential future space program proposals that will ensure Canada is prepared to face space weather threats.

PREPARATION INSTRUCTIONS:

The report shall document the results of the tasks relating to the cost analysis of the assessment of space weather impacts. The contractor is free to rearrange the sections as he sees fit as long as the content and coherence is preserved. The sections of the report shall include:

1. DID-SWR-1. Introduction
2. DID-SWR-2. State of the art review of socioeconomic studies
    a. International Activities
    b. Canadian Activities towards socio-economic studies.
    c. A list of the types of space weather disturbances that affect Canadian infrastructure such as ionospheric scintillation and geomagnetically induced current, with their probability of occurrence, when available..
3. DID-SWR-3. Workshop Report (if this type of event is used),

minutes, summary and findings. Can be merged to Final Report if appropriate.

4. DID-SWR-4. A set of indicators to assess socioeconomic impacts.
5. DID-SWR-5. Risk assessment of Canada's specific vulnerabilities including as a minimum risk with respect to the following assets or infrastructures:
    a. Electric power (power plant and distribution)
    b. Major civilian infrastructures:
        i. health care institutions (hospitals, etc.);
        ii. water distribution (pumping systems, etc.);
        iii. fuel distribution (oil, gas, etc.);
        iv. banking and financial systems.
        v. emergency services (fire stations, emergency call center, etc.);
        vi. government services (military installations, legislatives offices, treasury department).
    c. Transportation:

i. road transportation
ii. railways networks;
iii. aircraft passenger and crew safety (in particular cross polar flights);
iv. nautical transportation
v. pipelines;
vi. emerging technologies (electrification of transports, self-driving vehicles, drones, internet of things, etc.)

d. Communication systems (terrestrial and satellite) Mobile and fixed
    i. copper, optic fiber, wireless, cellular, HF, L-band, satellite, etc.;

e. Satellite infrastructure
    i. navigation systems (GNSS and other relevant avionic navigation systems);
    ii. telecommunication services
    iii. satellite-acquired data services
    iv. meteorological satellites
    v. scientific satellites
    vi. military satellites

f. Others (as appropriate, the list of stakeholders will be reviewed and agreed upon).

The risk assessment shall be performed using existing documentation, data collection results, and different levels of intensity/case scenarios. The likelihood of realization of those case scenarios will be assessed separately from this contract, based on the analysis of space weather time series.

The assessment shall quantify the cost of space weather disturbances in **constant dollars figure** where possible (in some cases an estimate is acceptable), as a function of space weather intensity, using appropriate units. The direct cost to the industry from repairs and lost revenue must be assessed for different levels of space weather activity, as well as the societal cost stemming from the reduction or interruption of service, as appropriate.

All cost estimates shall be included in a spreadsheet listing the type of technology, the level of sensitivity to space weather, the failure mode, the estimated cost, direct and indirect for that type of failure.

The assessment shall include a quantitative evaluation of the risk probability (number of occurrence/year, decades, etc.) and impact (duration, extent, cost, casualties). ROM are acceptable.

The methodology for the estimates shall be properly documented (if needed in separate notes). Use of studies and models developed by International partners is acceptable as long as proper references are made and adaptation/extrapolation to the Canadian context are explained.

In case no valid methodology can be proposed within the scope of the study the contractor shall explain its assumptions and make recommendations for follow up activities to provide more accurate estimates.

6. DID-SWR-6. Mitigation strategies for different types and different levels of space weather events. The mitigation strategies should include the following elements:
    a. Possible Techniques for mitigation
    b. Effectiveness to reduce impacts
    c. Cost/Benefits analysis (i.e. cost of mitigation strategies versus spared cost).

    Note: if deemed relevant the contractor can convert the probability and impact values into a composite risk index (CRI).

7. DID-SWR-7. A review of the state of awareness of the Canadian community that can be affected by space weather, and areas of improvements through outreach, training, research, or mitigation strategies.
8. DID-SWR-8. Conclusion and Recommendations.

    The recommendations shall contain an Outline of the main elements of a Canadian space weather program, including infrastructure and services, the users that would benefit from the activities supported and how much benefits in dollar figure where possible the new activities will provide. The contractor shall also identify new Canadian users (if any) that could benefit from activities in the space weather program.
9. DID-SWR-9. Annexes.

DID-0250 – FIP and BIP Disclosure Report

PURPOSE:

To fully disclose all FIP and BIP resulting from the study.

PREPARATION INSTRUCTIONS:

The report shall include the following:

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

DID-0260 – Executive Report

PURPOSE:

To provide a summary of the work accomplished during the contract.

PREPARATION INSTRUCTIONS:

The Executive Report will be placed in the public domain (e.g. CSA's library, publication and/or website).

The report should not exceed twenty (20) pages.

The Contractor should submit an electronic copy of the Executive Report in the Final Data Package. The structure for the Executive Report is as follows:

1) Introduction;
2) Project Objectives;
3) Approach / Project Tasks;
4) Accomplishments;
5) Synthesis of recommendations
6) Ownership of Intellectual Property; and
7) 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 should include the following proprietary notice ("Owner of FIP" being either the CSA or the Contractor):

APPENDIX C ACRONYMS AND ABBREVIATIONS

ARO	After Receive Order
AD	Applicable Document
ADCS	Attitude Determination and Control Subsystem
AI	Action Items
AIL	Action Items Log
BIP	Background Intellectual Property
CA	Contract Authority
CDRL	Contract Data Requirements List
CSA	Canadian Space Agency
DID	Data Item Description
EC	Environment Canada
ESA	European Space Agency
FIP	Foreground Intellectual Property
GFE	Government Furnished Equipment
GRIP	Government Related Initiatives Program
IP	Intellectual Property
KoM	Kick-off Meeting
MCR	Mission Concept Review
OGD	Other Government Departments
PA	Product Assurance
RD	Reference Document
RT	Review Team
SOW	Statement Of Work
TA	Technical Authority
TBC	To Be Confirmed
TBD	To Be Determined
TN	Technical Note
TRA	Technology Readiness Assessment
TRL	Technology Readiness Level
TRRA	Technology Readiness & Risk Assessment
WBS	Work Breakdown Structure
WMO	World Meteorological Organization