CSA-AOM-SOW-0001

Canadian Space Agency

Statement of Work for the Arctic Observing Mission (AOM) Pre-Formulation Study Mission Design Contract

December 6th 2022

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APPROVAL

The Canadian Space Agency (CSA) has prepared this Statement of Work (SOW) for the Arctic Observing Mission (AOM) Pre-Formulation Study Mission Design Contract. Proposed changes to the baselined version of this document must be forwarded to the CSA Configuration Management (CM) Receipt Desk for evaluation and, if approved, must be incorporated into this document.

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REVISION HISTORY

Rev.	Description	Initials	Date
Draft 13	Draft for Contracts Team review	KB, MH	2022-07-11
Draft 16	Final for contract release	IJ,MH	2022-12-06
IR	Initial Release	IJ,MH	2022-12-06

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1 INTRODUCTION

1.1 SCOPE

This Statement of Work (SOW) defines Contractor's activities to refine the mission architecture for the Arctic Observing Mission (AOM) and to provide substantiated cost estimates. Building on the work previously done under the Polar Communications and Weather (PCW) mission, this work will serve to assess and to estimate the cost of options for the implementation of mission objectives. The work described in this SOW will be conducted in parallel with an assessment of the socio-economic benefits of the mission and discussions with Canadian and International partners to support the preparation of the final business case for the AOM that will be completed in 2024.

1.2 BACKGROUND

The Arctic is undergoing rapid environmental changes, requiring more monitoring for a better understanding of the involved processes. Global warming in the Arctic appears to be accelerating and projections of minimal ice cover extent in the North have been revised downward from initial projections. Environment and Climate Change Canada (ECCC) has identified the Arctic as a priority region that is significantly under-sampled, and has expressed the need for increased observations of key meteorological parameters for numerical weather and environmental predictions as well as greenhouse gases and air pollution to better monitor and understand their sources and sinks over northern regions.

Over the past years, the Canadian Space Agency (CSA) worked with ECCC and Canadian industry to develop AIM-North – a satellite mission concept that would use two satellites in a highly-elliptical orbit (HEO) to enable frequent observations of GreenHouse Gases (GHG) and Air Quality (AQ) over northern regions. In 2020 the mission scope was expanded to also include meteorological (MET) and space weather (SpWx) observations because of the high interest expressed by international partners that could contribute instruments and/or other components (e.g. launch, ground segment, etc) to the mission. While the main Canadian contribution to Arctic Observing Mission (AOM) would be a state-of-the art imaging Fourier Transform Spectrometer (iFTS) for GHG measurements, it was expected that the MET, AQ and SpWx instruments would be either procured by Canada or contributed by international partners given the heritage they have on these instruments.

The Phase 0 contract for AIM-North was completed in March 2021. The conclusion of the amended Phase 0 contract was that a mission concept similar to AIM-North (i.e. 2 satellites in HEO) with additional MET and SpWx instruments could meet most of the observations requirements expressed by the user community.

The addition of a MET instrument proposed during AIM-North Phase 0 work could simplify the design of other instruments. For example, the GHG instrument requires a dedicated camera ("cloud imager" or CI) to identify and avoid cloudy areas during measurements, a process called "intelligent pointing". If a MET instrument is available, it could provide a cloud mask (either in real-time or via ground processing) therefore eliminating the need for the dedicated cloud imager. Another example relates to the AQ instrument; if a MET instrument is available, it could provide information on aerosols targeted by the AQ instrument. This opens the possibility that a simplified

AQ instrument, primarily targeting NO_2, could meet the primary observation objectives if it works in tandem with a MET instrument.

In 2021, the National Oceanic and Atmospheric Administration (NOAA) indicated that they could consider providing a spare current-generation Advanced Baseline Imager (ABI) as a MET instrument to AOM once the replacement risk for the GOES-R series of satellites is retired in mid-2024, which could slip to 2025. However, since two MET instruments on two separate satellites are needed for continuous meteorological observations over the North, options need to be considered for the second MET instrument.

Additional considerations following the potential availability of only one MET instrument relate to potential optimization of the mission configuration. The GHG and AQ instruments require solar illumination to measure their target species, and several bands of the MET imager also require solar illumination. This provides the possibility to use one satellite on a 24-hour orbit to image primarily the Western part of the Northern hemisphere vs. the Eastern part of the Northern hemisphere as an initial implementation of the mission. Initial analyses performed by ECCC indicate that over one hemisphere a large fraction of the observation requirements could be achieved at a reduced mission cost.

The payloads instruments for AOM are now well understood and the next phase of the work consists in developing the mission and instrument requirements following consideration of the elements described above, to study in more detail the other elements of the mission, such as the satellite bus, the launcher, the ground segment and data processing, as well as properly defining the interfaces and providing more accurate cost estimates for the complete mission.

One last point to mention is the role of potential international partners with respect to the current phase of activities. For more than two years, ECCC and CSA have maintained an International Expert Working Group for AOM to discuss the mission and its implementation. The participants include individuals from NOAA, the National Aeronautics and Space Administration (NASA), the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), the European Space Agency (ESA) and Natural Resources Canada (NRCAN). Letters of interest have been received confirming their participation in the current phase of the mission. Discussions will be held during the course of the current phase and international partners will be invited to participate in the main reviews.

1.3 DOCUMENT CONVENTIONS

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

- “must” or “shall” indicates a mandatory requirement.
- “should” indicates a preferred but not mandatory alternative.
- “may” indicates an option.
- “will” indicates a statement of intention or fact.

In the following, the term 'Contractor' is used to describe the team that will conduct the study, which could be a mixed team drawn from industry, universities or research institutes.

1.4 LANGUAGE AND UNITS

As English is the standard oral and written language for design, development, operation, and utilization of space projects, the Contractor must use English for this Work, and for deliverables and exchanges with the Canadian Space Agency (CSA).

System International (SI) units must be used in all communications, deliverables, and all other exchanges with the CSA.

2 DOCUMENTS

Unless otherwise specified, in the case of conflict between this document and the documents listed below, this document must take precedence. All documents are latest version in effect at time of order.

All applicable and reference documents that are not publically available can be made available to the Bidders upon written request provided that they sign a Non-Disclosure Agreement (NDA).

2.1 APPLICABLE DOCUMENTS

The following documents of the exact issue date and revision level shown are applicable and form an integral part of this document to the extent specified herein. The documents are required for the Bidder to develop the proposal.

AD	Document Number	Revision	Title
AD-01	CSA-SE-STD-0001	B	Systems Engineering Technical Review Standards
AD-02	CSA-ST-GDL-0001	D	CSA Technology Readiness and Risk Assessment Guidelines
AD-03			Deleted
AD-04			Deleted
AD-05	CSA-ST-FORM-0003	B	Critical Technology Element (CTE) Identification Criteria Worksheet
AD-06	CSA-ST-RPT-0003	A	Technology Roadmap worksheet
AD-07	ECCC-AOM-URD-0001	2.1	Weather and Related Earth Observation Needs over the Arctic – AOM User Requirements Document
AD-08	ECCC-AOM-URD-0002	1.1	Greenhouse gas and Air Quality AOM User Requirements Document
AD-09			Deleted
AD-10	CSA-SE-PR-0001	C	Systems Engineering Methods and Practices
AD-11	CSA-SMA-RD-0008	IR	Generic Product Assurance Requirements (PAR) – Class B
AD-12	Policy on Service and Digital- Canada.ca (tbs-sct.gc.ca)		Policy on Service and Digital ISBN: 978-0-660-31822-6
AD-13	CSA-MM-ID-0002	current	CSA Station RF ICD

AD	Document Number	Revision	Title
AD-14	CSA-MM-ID-0003	current	CSA Generic Interface document that covers scheduling, realtime and postpass interface to CCMEO SXGT
AD-15	MMCSA-ML0001 MMCSA-CD0001	current	CRAMS Interface

2.2 REFERENCE DOCUMENTS

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

RD	Document Number	Revision	Title
RD-01	PMBOK Guide	6th Ed.	A Guide to the Project Management Body of Knowledge
RD-02	PCW-SP-52-9673	2/1	PCW Phase A Mission Requirements Document
RD-03	PCW-SP-52-9770	2/1	PCW Phase A Mission Requirements Document – URD/MRD Requirements Traceability Report
RD-04			Deleted
RD-05			Deleted
RD-06			Deleted
RD-07			Deleted
RD-08	CSA-AOM-TN-0001	IR	CSA Technical Note for AOM Radiation Environment
RD-09			Deleted
RD-10	SAM.gov	N/A	GEO-XO RFI package
RD-11	CSA-PCW-SG-0001	A	PCW Meteorological Requirements Specification
RD-12			Deleted
RD-13			Deleted
RD-14	Cost Estimating Handbook | NASA	4.0	Cost Estimating Handbook | NASA
RD-15			Deleted
RD-16			Deleted

RD	Document Number	Revision	Title
RD-17	ITSG-33	2012	IT Security Risk Management: A Lifecycle Approach (Annex 1 and 2)
RD-18	ISO24113:2019	2019	Space Debris Mitigation Requirements
RD-19	S.C. 2005, c.45	2005	Remote Sensing Space Systems Act (RSSSA)
RD-20	GOES-R Series ABI Scan Modes Information | GOES-R Series		Advance Baseline Imager Scan Mode Information
RD-21	NASA/SP-2014-3705		NASA Space Flight Program and Project Management Handbook

3 SYSTEM CONTEXT

The work is to revisit and elaborate in more detail the requirements established in the previous phase of the project. The concept to be finalized is for a mission fully compliant to all of the AOM requirements based on, but not limited to, the PCW requirements (RD-02 and RD-03), and including the MET instrument requirements and accommodation of a Space Weather instrument (please note that the Space Weather instrument consists of multiple instruments.) The update will also include a reduced capability air-quality instrument and a GreenHouse Gas (GHG) instrument considering the availability of the cloud imager via the MET instrument, and analyses of the TAP and Tundra orbits.

The work also includes the development of mission concepts for a few scenarios and the assessment of costs and development plans. Task authorizations may arise in the course of the work if additional work is required outside the current scope of the contract.

The procurement strategy for the MET instrument is not yet finalized. An existing ABI used in GEO could be contributed to this mission by an international partner.

The existing GHG instrument concept, developed in several STDP technology development activities and AIM-North Phase 0 work, was considered to be fairly mature. However, some aspects need to be investigated within the context of this SOW, including the impact of a change in detector.

The Full Capability AQ (FCAQ) instrument concept developed during AIM-North Phase 0 work was based on the Sentinel-4 UVN dispersive spectrometer, in spite of significant design differences. As discussed in Section 1, several AQ observational objectives related to aerosols could be satisfied using some visible and near infrared (NIR) bands of a MET instrument. A conceptual design for a reduced-capability air quality instrument (RCAQ) that will target NO_2 as a primary species is part of this SOW.

The AOM orbit, environment and available resources will be communicated to international partners that could contribute Space Weather (SpWx) instruments that can be hosted on the mission. A prioritization process is being agreed with the Solar-Terrestrial Science Advisory Committee to establish priorities. A first selection of possible instruments will be provided as Government Furnished Information (GFI) to the Contractor (see GFI-01 in Table 5-1).

4 WORK DESCRIPTION

4.1 GENERAL

The Contractor must manage the project to effectively achieve project performance, scope, quality, cost and schedule requirements specified by 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 monthly on progress, schedule and issues through the monthly Progress Report (CDRL PM-9).

4.1.1 Objectives

The objectives of this contract are to:

- Review and refine the mission instruments' requirements for AOM to bring it at the level of maturity sufficient to meet the entry and exit criteria of a Mission Requirement Review (MRR) as per [AD-1].
- Review and refine the payload instruments requirements considering specified orbits;
- Produce a conceptual design for a Reduced Capability Air Quality instrument;
- Develop the conceptual design of the Greenhouse Gas instrument based on the currently available detectors;
- Develop and present mission conceptual designs for four scenarios including details of the space segment, ground segment and operations concept;
- Provide cost estimates and development plans (identifying and quantifying risks as well as the project schedule for Phases leading to the Launch and Early Operation) for the four scenarios to support the preparation of the business case for Phase A;
- Develop a preliminary Systems Requirements Document.

4.2 WORK REQUIREMENTS

Four scenarios are envisioned for this mission. Each of these scenarios must be studied by the Contractor. The scenarios are described in

Table 4-1.

TABLE 4-1 MISSION SCENARIOS

Scenario	Number of satellites	Reduced Capability Air Quality instrument	Meteorological instrument	Greenhouse Gas instrument	Space Weather instrument
1	2	Yes	ABI	Yes	Yes (International Partner OR International Contribution)
2	2	No	ABI	Yes	Yes (International Partner OR International Contribution)
3	1	Yes	ABI	Yes	Yes (International Partner OR International Contribution)
4	1	No	ABI	Yes	Yes (International Partner OR International Contribution)

Each of the four scenarios must be analyzed for all requested orbits specified in Table 4-2.

4.2.1 Mission and Instruments Requirements

The objectives of the mission level work are to review previous work, and in the context of the identified candidate orbits, produce a first version of a consolidated Mission Requirements Document (MRD), as well as all Instruments Requirements Documents. This first part of the work will end with the Requirements and Orbit Review (ROR) to review the mission, instrument level and environment requirements as well as recommend an orbit for the 1-satellite and the 2-satellite scenarios. The recommended orbit may be different for the 1-satellite scenarios and for the 2-satellite scenarios.

4.2.1.1 Mission Requirements Update

The Contractor must review the mission requirements contained in the Mission Requirements Lists that were prepared for PCW ([RD-02], [RD-03]), verify that all requirements are traceable to user requirements ([AD-07], [AD-08]) (which are considered fixed at this stage of the work), and capture the details and any deficiencies in a revised Mission Requirements Document (CDRL MM-10) and in a Requirements Traceability Matrix (included as an appendix to the Mission Requirements Document) .

The Contractor must evaluate the impact of the three orbits identified in Section 4.2.1.3 on the requirements and make recommendations as to the viability of each of these orbits.

The Contractor must assume that the mission on-orbit lifetime (excluding commissioning) is fixed to ten years to ensure compatibility with the ABI instrument.

The Contractor must include in the Mission Requirements Document, the requirements relative to operations, which will form the parent requirements for the Concept of Operations document.

The Contractor must ensure that the instruments operational requirements take into account the need for solar illumination, (to be used to establish the periods and seasons of operations of each instrument) and potential use of Yaw steering for thermal and power management.

The Contractor must identify main requirements driving the cost and complexity of the mission and may suggest areas to relax some of the specifications. The Contractor should avoid TBC and TBD in the formulation of the mission requirements.”. The Contractor must identify any missing requirements that are deemed important and make suggestions for them.

In completing the Mission Requirements Document, the Contractor must ensure that operational constraints (space debris [RD-18], Remote Sensing Space Systems Act [RD-19], Security [RD-17]) and an Open Data Policy [AD-12]) are considered.

The Contractor must document proposed changes, sensitivity analyses and trade-offs relating to the Mission Requirements in Technical Notes (CDRL ENG-95a) to be provided for information to the CSA Technical Authority (TA).

This first version of the Mission Requirement Document and the associated Technical Notes will be discussed with the CSA project team at the ROR.

4.2.1.2 Instrument Requirements

The Contractor must document all requirements for each of the instruments of the payload as separate Payload Instruments Requirements Specification documents (CDRLs ENG-9a to ENG-9d). A traceability matrix to the Mission Requirements Document must be provided in an appendix in each of the Payload Instrument Requirement Specification documents. Please note that SpWx requirements definition, led by NASA/NOAA, might not be a complete specification definition.

4.2.1.2.1 Reduced Capability Air Quality Instrument Requirements

The Contractor must review the sections relating to the Air Quality instrument in [AD-08]. In the User Requirements Document (URD) for air quality there are primary and secondary species. For the reduced RCAQ instrument, the only primary species is NO_2, while all others in the Ultraviolet (UV) become secondary. The aerosols and NIR are no longer requirements on the reduced RCAQ instrument but covered via MET instrument and GHG instrument respectively .

From the requirements expressed in [AD-08], the Contractor must produce the RCAQ Instrument Requirements Specification document (CDRL ENG-9a) utilizing the reduced requirements that target NO_2 as a primary species and present it at the ROR. The RCAQ instrument should be capable of observing the other secondary species in the UV, as goals.

The Contractor must report on the impact on the RCAQ instrument concept and observation performance requirements when considering all three orbits as specified in section 4.2.1.3 and present the results at the ROR.

4.2.1.2.2 GHG Instrument Requirements

The observational requirements are defined in [AD-08]. The Contractor must produce the GHG Instrument Requirements Specification document (CDRL ENG-9b) based on the requirements in [AD-08] and present it at the ROR.

The Contractor must report on the impact on the GHG instrument concept and observation performance requirements when considering all three orbits as specified in section 4.2.1.3 and present the results at the ROR.

4.2.1.2.3 MET Instrument Requirements

The L3Harris' ABI has been targeted as the meteorological instrument to be integrated in the AOM mission.

The Contractor must review the MET requirements in [AD-07] and produce a MET Instrument Requirements Specification document (CDRL ENG-9c) and present it at the ROR.

The Contractor must report on the impact on the MET instrument observation performance requirements when considering all three orbits as specified in section 4.2.1.3 and present the results at the ROR. The CSA and ECCC will analyze the impact and decide whether to modify the observation requirements if required to accommodate the chosen orbit(s) following the ROR.

4.2.1.2.4 Space Weather Instruments Interface Requirements

The Space Weather Instruments will be provided by external partners based on both Canada's and partner's requirements. The Contractor must review the Space Weather Interface requirements in GFI-01 (Table 5-1) and produce a Space Weather Instrument Interface Requirements Specification document (CDRL ENG-9d) and present it at the ROR.

4.2.1.3 Orbit Selection and Analysis

The purpose of the orbit selection and analysis is to study the advantages of the TAP and Tundra orbits and make a selection based on the possible scenarios to realize the mission, i.e. different scenarios could use different orbits.

The Contractor must calculate the Right Ascension of the Ascending Node (RAAN) and insertion time of the selected orbits to meet the following specifications:

- One apogee is at a longitude of 95° W.
- Apogee on August 15, 2032 is at noon local time.

The other orbital elements of the selected orbits are given in Table 4-2 Candidate Orbits:

TABLE 4-2 CANDIDATE ORBITS

Orbit	Semi-major axis (km)	eccentricity	Inclination (deg)	Argument of perigee(deg)
TAP	32175	0.50	64.435	270
Tundra 1	42163	0.30	64.435	270
Tundra 2	42163	0.22	64.435	270

The Contractor must consider in the orbit analyses, as a minimum, the following perturbations:

- Earth oblateness,
- Lunisolar gravitational perturbations,
- Solar radiation pressure;

The Contractor must analyze the environmental specifications of the orbits, including, but not limited to solar eclipses, radiation environment and thermal environment.

The Contractor must analyze the coverage at beginning of image acquisition, mid-point and apogee based on the following constraints

- Area of interest,
- Viewing zenith angle <u>for each instrument</u>
- Solar zenith angle <u>for each instrument</u>

The analyses must be repeated for each month of the year as a minimum to identify the useful periods of operations. CSA and ECCC will be available to provide further information on the observation constraints.

The Contractor must provide the analyses for two areas of Interest: the Arctic ([RD-02] and [RD-03]) and the Western Arctic Hemisphere centered at a longitude of 95° W. The Contractor must provide analyses for the relevant number of apogees, depending on the orbit. The Contractor must ensure that the analyses take the need for solar illumination into account.

The Contractor must report the results in CDRL ENG-113 (Orbit Model, Analysis and Selection) and CDRL ENG-114 (Orbit Determination and Control Model Analysis). The Contractor must present the results at the ROR to support a decision on the selected orbit scenarios to continue the work.

The Contractor must assume that different orbit may be selected for each scenario. The Contractor must ensure that requirements produced in the following work packages encompass all scenarios (i.e. provide a worst-case envelope).

4.2.1.4 GHG Instrument Detector

The purpose of the GHG instrument detector work is to select a detector for the GHG instrument, so that the Contractor will be able to start the work on the GHG instrument conceptual design after the ROR.

The Contractor must confirm the GHG instrument detector specifications using the detector guidelines to be provided as GFI-03, per Table 5-1.

The Contractor must perform a survey and comparative analyses of state-of-the-art high-speed Focal Plane Arrays (FPA) that can be used as the detectors of the GHG instrument. The Contractor must assess which device technologies are most promising for use in space given the radiation environment for a highly elliptical orbit. Noise performance, operability, operating temperature and temperature dependence of the key performance parameters must be included in the comparative analysis.

The results of the FPA selection are critical for the iFTS instrument design development, the CSA must share under a Non Disclosure Agreement (NDA) the conclusions of the detector selection process with the instrument development team working under a different parallel CSA contract. At the same time, appropriate information from the parallel instrument design development contract may need to be shared with the Contractor under an NDA.

The Contractor may conclude up to two different types of FPA that meet the requirements of the four spectral bands (e.g. one for the NIR and another for the 3 SWIR bands, or another combination). The Contractor must also conduct an analysis of pixel binning options for the FPA detectors. The possibility of raw observations with small pixels that are binned (e.g. 2x2 or 3x3) to obtain ground pixels that meets the ground instantaneous field of view (GIFOV) (e.g. ≤4x4 km2) and SNR/precision requirements would be advantageous from an applications perspective, since it would not exclude the possibility of special observations using the unbinned, higher resolution and lower SNR/precision observations. However, other technical and performance implications of pixel binning on the baseline observing scenario and instrument design must be thoroughly considered.

The Contractor must define requirements and prepare the specification for the detector for the work on the GHG Instrument concept.

The Contractor must prepare and send Request for Quotations (RFQs) out to suppliers for the GHG instrument detector.

The Contractor must evaluate quotes from suppliers in terms of technical characteristics, ability to meet the project needs, work to be performed, total cost including an engineering model and flight model(s), all applicable taxes and shipping charges. In addition to the technical performance specification, the capability to design and manufacture space-qualified devices and ability to meet the delivery schedule must be assessed.

The Contractor must identify current manufacturing capabilities including design, production, packaging, test, flight heritage, export control issues and justification for the selection of the detector supplier(s). Legal restrictions (such as ITAR, EAR, TAA, etc.) associated with the access to data from a particular vendor and procurement of each GHG Instrument detector technology must be evaluated and included in the detector options analysis and presented to CSA at the ROR.

The Contractor must prepare a Technical Note with recommendation for selected technology and supplier and submit it to CSA for approval (CDRL ENG-95b) at the ROR. The Contractor must summarize the findings in the report identifying technical milestones, development schedule and potential costs. The Contractor must develop mutually agreeable selection criteria and recommend a detector to be further advanced.

The Contractor must complete this task on schedule before ROR as it is critical for The Instruments Conceptual Design Review (ICDR) activities. Following the ROR, the Contractor must integrate the conclusions on the detector selection process into the GHG Instrument Concept Design document (CDRL MM-11a).

4.2.1.5 Requirements and Orbit Review

The Contractor must hold a ROR with the CSA Technical Team to present an initial release version of CDRLs MM-10, ENG-9a, ENG-9b, ENG-9c, ENG-9d, ENG-113, ENG-114, ENG-95a and ENG-95b. The documentation must be made available to the CSA Technical Team at least 15 working days prior to the ROR.

Following the ROR, an update of CDRLs MM-10, ENG-9a, ENG-9b, ENG-9c, ENG-9d and ENG-95b must be submitted to the CSA TA for approval within 20 working days. The CSA TA will confirm the requirements and the GHG Instrument Detector to be used in no more than 15 working days after they are received from the Contractor. The CSA TA may change this mission requirement baseline based on a recommendation of the Contractor or CSA project team to reflect the evolution of the mission architecture during the course of the work. The Mission Requirements confirmed by the CSA TA must be considered the baseline for the remainder of the work.

4.2.2 Instruments Conceptual Design

4.2.2.1 GHG Instrument Development

The Contractor must prepare an initial release of the GHG Instrument Concept Design document (CDRL MM-11a) based on the requirements developed in section 4.2.1.2.2 and present it at the ICDR. The report must provide an update of the GHG system performance and key engineering budgets for the orbit(s) chosen at the ROR.

Based on the detector selected after the ROR, the Contractor must develop the GHG instrument parameters. The Contractor must calculate the system performance prediction accordingly.

The Contractor must confirm that the baseline design is flexible and adaptable to accommodate various alternative detector options identified during the ROR while meeting the mission and instrument requirements and overall system configuration parameters.

The iFTS instrument requires an onboard calibration sub-system. This sub-system will include a solar diffuser for solar calibration, a window for lunar calibration and one or more onboard calibration light sources (lamps / LEDs), with the number of onboard sources determined based on their expected stability and longevity and the target mission lifetime.

The Contractor must assume that the GHG instrument will have the ability to operate with "Intelligent pointing", in which the pointing locations are determined based on cloud masks derived from the meteorological imager.

During the STDP activities for a GHG instrument, it appeared that the pointing accuracy for this instrument could be difficult to maintain over the long integration time required for observation. The Contractor must include a context camera for geolocation correction in the GHG instrument concept and take it into account in the geolocation accuracy budget and data rates budget. The requirements for the context camera are listed as GFI-04 (see Table 5-1) and will be provided to the Contractor.

The selected instrument architecture (type of instrument, optical front-end, telescope, scanning mechanism) must be presented in the GHG Instrument Conceptual Design document (CDRL MM-11a).

The GHG instrument development must be advanced to include at least the following items:

- detailed product tree
- optical design,
- performance analysis,
- compliance assessment,
- first order opto-mechanical design,
- detailed resource estimates (mass, power, volume, data rates),
- assessment of impact on space segment / bus (such as geolocation and pointing accuracy and stability, data storage, peak and average power, cloud imager, etc.),

- assessment of impact on ground segment (such as data volume, storage, data processing, etc.),
- thermal analyses including device operational conditions, such as pixel rate and frame rate,
- on-board radiometric calibration subsystem with the number of onboard sources determined based on their expected stability and longevity and the target mission lifetime and minimally including:
  - a solar diffuser for solar calibration,
  - a window for lunar calibration,
  - one or more onboard calibration light sources (lamps / LEDs).

The Contractor must prepare a first breakdown of the instrument error budget including as a minimum: pointing accuracy, SNR, spectral accuracy, spatial resolution, and optical distortions. The level of details in the instrument error budget must be sufficient to ensure that there is a traceable flow down between the instrument parameters and the estimated product accuracy and precision. The instrument error budget must ensure compliance to the requirements and provide reasonable margins to account for the uncertainty in future design phases.

4.2.2.2 Reduced Capability Air Quality (RCAQ) Instrument

The RCAQ instrument must provide relatively high spectral resolution over a relatively wide band and scan the Arctic and neighboring regions from HEO. Based on the heritage of similar space borne instruments, it is foreseen that a grating spectrometer operating in push broom mode is the most likely instrument concept candidate; in the following, the word *spectrometer* applies to any instrument type that could be relevant.

The Contractor must review the accuracy of the different products visible in TAP and Tundra orbits (refer to Section 4.2.1.3) and assess if the RCAQ instrument can provide the expected information on NO_2, aerosols and other trace gases.

The Contractor must review the air quality observing requirements for trace gases. The NO_2 observing requirements goal and threshold are retained, while all other trace gases can now be considered secondary species, and aerosol and solar induced fluorescence can be considered out of scope.

The Contractor must produce an initial release of an RCAQ Instrument Conceptual Design document (CDRL MM-11b) based on the requirements developed in section 4.2.1.2.1 and present it at the ICDR.

The Contractor must identify existing spectrometer types and scanning mechanisms that could be proposed. Pros and cons of the different spectrometer types must be described to justify the selected instrument architecture.

The Contractor must optimize spectral and spatial resolutions as well as radiometric accuracy to provide the desired product accuracy and precision and produce a compact RCAQ instrument design to achieve a mass not exceeding 100 kg with margin.

The compact RCAQ instrument design must not result in the total target cost of more than $70 M CAD for the first RCAQ flight instrument over all phases, including contingency. The total target cost over all phases for two flight units of the RCAQ instrument should not exceed $100M CAD.

The selected instrument architecture (type of spectrometer, optical frond-end, Detector/FPA, telescope, scanning mechanism) must be presented in the RCAQ Instrument Conceptual Design document (CDRL MM-11b).

The Contractor must elaborate on the initial concept of the instrument. The level of detail must be sufficient to assess compliance to the requirements and identification of the main elements to build it. The RCAQ instrument definition must minimally include the following:

- detailed product tree,
- optical design,
- electronic block diagram,
- performance analysis,
- requirements compliance assessment,
- key performance estimates,
- first order opto-mechanical design,
- detailed resource estimates (mass, power, volume, data rates, field of view, thermal),
- assessment of impact on space segment / bus (such as geolocation and pointing accuracy and stability, data storage, peak and average power, cloud imager, etc.),
- assessment of impact on ground segment (such as data volume, storage, data processing, etc.).
- calibration.

The Contractor must finalize the proposed concept for the instrument with a level of detail sufficient to:

- Ensure compliance to observation requirements;
- Prepare detailed engineering budgets;
- Identify key technologies and long-lead items to produce a detailed development plan that can be costed with confidence in the following work packages.

The Contractor must prepare a first breakdown of the instrument error budget including as a minimum: pointing accuracy, SNR, spectral accuracy, spatial resolution, and optical distortions. The level of details in the instrument error budget must be sufficient to ensure that there is a traceable flow down between the instrument parameters and the estimated product accuracy and precision. The instrument error budget must ensure compliance to the mission requirements and provide reasonable margins to account for the uncertainty in future design phases.

The Contractor must perform all analyses using the orbital scenarios selected by CSA after the ROR.

4.2.2.3 RCAQ and GHG Technology Development Plan

The Contractor must identify the critical technology items for the RCAQ and GHG instruments and the required technology development to bring each element of the RCAQ and GHG to the proper TRL as defined in Table 4-3 [AD-02]. The Contractor must capture this information in the GHG Instrument Technology Development Plan (CDRL MM-7a) and the RCAQ Technology Development Plan (CDRL MM-7b) to be presented at the ICDR.

The GHG Instrument Technology Development Plan (CDRL MM-7a) and the RCAQ Instrument Technology Development Plan must include functional and performance requirements, and a roadmap (mapping TRL to a timeline coordinated with the mission development schedule) for each critical technology. The development plans must be based on AD-05 and AD-06 and be sufficiently detailed to substantiate bottom-up estimates for the instrument development cost and timeline.

TABLE 4-3– MINIMUM TARGET TRL BY END OF PHASE

Phase and Review	Overall System	Element
0 – Mission Requirements Review (MRR)	3	3/4
A – System Requirements Review (SRR)	4	4/5
B – Preliminary Design Review (PDR)	4/5	5/6
C – Critical Design Review (CDR)	4/5	5/6
D - Before Flight Model (FM) manufacturing	5/6	5/6
D – Acceptance Review (AR)	8/(7 optional)	n/a
E (after launch and on-orbit commissioning)	9	n/a

4.2.2.4 Instruments Concept Design Review (ICDR)

The Contractor must hold an ICDR with the CSA Technical Team to present an initial release version of CDRLs MM-7a, MM-7b, MM-11a, MM-11b. The documentation must be made available to the CSA Technical Team at least 15 working days prior to the ICDR.

Following the ICDR, an update of CDRLs MM-7a, MM-7b, MM-11a, MM-11b must be submitted to the CSA TA for approval within 20 working days.

4.2.3 System Conceptual Design

The Contractor must produce an initial release of the System Conceptual Design document (CDRL MM-11) based on the instruments concept developed in section 0 and on the ABI and Space Weather Instruments information to be provided as GFIs (GFI-01 and GFI-02 Table 5-1). An initial release of the System Conceptual Design must be produced for the System Conceptual Design Review (SCDR).

The System Conceptual Design document must include:

- the finalized concept of the RCAQ and GHG instruments,
- the integration of the MET instrument (ABI),
- accommodation for the Space Weather instruments,
- a mission requirement compliance matrix,
- HEO orbits environment studies,
- space segment conceptual design,
- launch vehicle options,
- ground segment conceptual design,
- a preliminary concept of operations,
- high level mission architecture, design and interfaces.

4.2.3.1 Finalization of RCAQ and GHG Instruments Design and Integration

The Contractor must finalize the RCAQ and GHG instruments design as per comments received at the ICDR and update CDRL MM-11a and MM-11b accordingly. The Contractor must integrate the RCAQ and GHG instruments in the overall system conceptual design and include the final design and integration information in CDRL MM-11.

4.2.3.2 ABI Instrument Integration

The L3Harris's Advanced Baseline Imager (ABI) has been targeted as the meteorological instrument to be integrated in the AOM mission. NOAA indicated they could provide their spare ABI if they do not need it for the GOES program. As the ABI is an instrument developed and sold by L3Harris, no work related to the development of the ABI is planned under this contract. The details of the ABI will be provided as GFI-02 as per Table 5-1.

The Contractor must integrate the MET instrument design into the spacecraft configuration and include it into the different engineering budgets in the System Conceptual Design document (CDRL MM-11).

The Contractor must be aware that the ABI instrument specifications, as provided by NOAA [RD-10] will not change except for some possible adaptation for a Tundra or TAP orbit that will be communicated by CSA at the ICDR.

4.2.3.3 Space Weather Instrument(s) Accommodation

The Contractor must perform an accommodation study for the Space Weather instrument(s). The accommodation study must evaluate how the instrument(s) can be hosted on the selected bus platform at a suitable location(s) for the SpWx observations. The Contractor must first produce a spacecraft layout showing the proposed locations of the SpWx instrument(s) and submit it to the CSA TA for comments as part of CDRL MM-11 to be presented at the SCDR.

The Contractor must make a high-level assessment to determine if the hosted instrument(s) can be accommodated on the different options scenarios to be developed. A Task Authorization may be used to conduct an accommodation study on one or several sub-options if international partners have a need for more precise information.

4.2.3.4 Mission Requirements Compliance Matrix

The Contractor must provide a Mission Requirements Compliance Matrix (CDRL ENG-156) at the instrument performance level (GHG, RCAQ, ABI and SpWx) for the CSA Technical team to review at the SCDR.

4.2.3.5 Space Segment Conceptual Design

The space segment conceptual design includes the instruments and the satellite bus system.

The Contractor must document the space segment design in a Spacecraft Design Document (CDRL ENG-130). Note that the description of sub-systems must include possible options for the space segment.

The Contractor must review available spacecraft buses with suitable heritage that could be used for the mission and identify options that can be proposed to implement the mission.

The Contractor must identify available equipment with high space heritage for each sub-system in addition to the bus to produce a complete functional spacecraft including, but not limited to:

- on-board Data Storage Sub-System,
- power sub-system,
- communication sub-system,
- on-board Processing sub-system,
- payload control,
- thermal management sub-system,
- ground support equipment (identification and description),
- TT&C,
- thermal,
- orbit control system,
- attitude control System,
- launch vehicle interface.

The Contractor must take into account that the Spacecraft Telecommand and Telemetry must incorporate commercial-grade cryptography to commands and telemetry data. This requirement does not apply to science data as it will be unclassified.

The Contractor must select a minimum of two compatible spacecraft buses and document the selection in the System Conceptual Design document (CDRL MM-11) to be produced for the SCDR. The selected buses must comply to Class B Product Assurance requirements (AD-11) as applicable to Phase BCD of the project.

4.2.3.6 Launch Vehicle Options

The Contractor must prepare a list of launchers compatible with the orbits defined after the ROR for the case of a single spacecraft or dual-spacecraft launch and include the information in the System Conceptual Design document (CDRL MM-11) to be produced for the SCDR. The required information includes, but is not limited to:

- compatible launchers,
- launch location,
- maximum spacecraft mass capacity,
- fairing volume,
- orbit insertion accuracy,
- demonstrated reliability,
- frequency and availability of launch opportunities,
- approximate launch cost,
- vibration and shock environment,
- export restrictions,
- orbit insertion strategy for each orbit,
- typical payload electrical and mechanical interface,
- spacecraft configuration in launcher fairing.

For each selected launcher, the Contractor must establish the delta-v budget of the space segment for insertion to the final orbit. The budget for orbit insertion must be based on a realistic scenario for the launch trajectory to estimate the orbit insertion accuracy.

4.2.3.7 General Environment Requirements

The Contractor must review the PCW general environment requirements specifications [RD-02], the CSA Technical Note for AOM Radiation Environment [RD-08] and the NOAA GEO-XO GIRD included in the GEO-XO RFI package [RD-10]. The Contractor must make the needed modifications for the AOM context in terms of thermal, mechanical, vibration, radiation (including total dose and single events), atmospheric environments, micrometeoroid and orbital debris (MMOD), electro-static discharge, cleanliness and contamination. The Contractor must capture the results in the Environment Requirements Document for AOM (CDRL ENG-3) to be presented at the SCDR.

4.2.3.8 Ground Segment Conceptual Design

The Contractor must document the ground segment conceptual design in a Ground Segment Design Document (CDRL ENG-132), for which an initial release will be presented at the SCDR. The Contractor must develop the ground segment architecture, including:

- the Mission Operation Center (MOC), with a back-up facility,

- the antennas and communication network (for command and control and payload data downlink),
- data processing for the different instruments, up to level 1b (georeferenced data),
- data storage and dissemination.

The MOC facility must be located at the CSA headquarters in St-Hubert (SHUB), QC, Canada. The back-up facility must be located in Canada.

The MOC to Spacecraft interface must comply with CSA Multi-Mission Operation Center as specified in AD-13, AD-14 and AD-15. The system must allow the implementation of an open data policy [AD-12].

The Contractor must identify the bandwidth requirements and define the necessary communications links interfaces between the antennas and the MOC.

The Contractor must identify the bandwidth requirements and define the necessary communications links interfaces between the MOC and the Science Operation Center (SOC) for each instrument.

The main site of space flight control subsystem must be at SHUB and the backup must be in the facility proposed by the Contractor and must be located in Canada. The Contractor must complete the space flight control subsystem located at SHUB to ensure the health and safety of the space asset.

The Ground Segment (GS) must provide the necessary planning subsystem:

- The Contractor must develop the requirements for a mission planning system. The contract may assume that SpWx, RCAQ, and MET will require limited but efficient tasking while keeping the possibility of executing special tasks.
- The GHG will use intelligent pointing, based on a cloud mask derived from the MET imager data. During the Mission Design study, the Contractor must identify to CSA the recommended approach to achieve the requirement of intelligent pointing: whether via onboard processing or via downlink of MET imager data and uplink of the derived cloud mask or pointing positions of the derived cloud mask generated by the ground segment.

The Contractor must define a solution for calibration and processing of raw GHG and RCAQ data to Level 1b.

For science data, the Contractor must evaluate the link budget and suitability of X-band and Ka-band downlinks and recommend an optimal solution.

The Contractor must define the operations requirements in equipment and resources.

In preparing the ground segment update, the Contractor must ensure that key engineering budgets have been prepared as per Appendix A to properly size the communication sub-system (data throughput, number of antennas, link budgets, network connections) and the data processing sub-system (algorithms to Level 1b and 2 (for GHG and RCAQ instruments), processing loads, number of computers). The processing levels are defined in Table 4-4.

TABLE 4-4 DATA PROCESSING LEVELS

Raw Data	Data in their original packet as received from the spacecraft
Level 0	Raw instrument data.
Level 1a	Calibrated instrument data but not geocoded.
Level 1b	Calibrated and geocoded instrument data processed to sensor units.
Level 2	Products derived from Level 1b.
Level 3	Gridded and quality controlled.
Level 4	Model output, derived variables.

Special attention must be paid to the product generation, including data processing and distribution sub-systems such that it can be implemented on a decentralized architecture.

The Contractor must integrate the ground segment architecture in the System Conceptual Design Document (CDRL MM-11).

The high-level constraints imposed on the Ground Segment are:

- The system must be scalable so it can handle a large increase in users, workload or increased processing load without system strain or degraded performance. (expand to support increasing workloads and grow overtime).
- The Contractor must consider that the science center operation and processing could be controlled remotely.
- The GS must have dedicated primary and backup ground stations.
- The Contractor must select the location of the ground station(s), based on the orbit analysis, using existing and/or new Canadian or international infrastructure.
- The GS must be capable of tasking for different types of ABI scanning modes, including, but not limited to full disk (scan of the entire visible disk), conus and mesoscale scanning modes (scan of smaller portions of the visible disk). See [RD-20] for details on the ABI scanning modes.
- The GS must respond to the Payload instruments data's latency requirements, as follows:
    - For the RCAQ, 3 hours is the goal while the maximum time lag between end of image acquisition and providing a Level 1B product must not exceed 6 hours.
    - For the MET, a full disk scan must be downlinked, processed and available to end users before the next full disk scan ends for both L1b and L2 products.
    - For the GHG instrument, the time lag between science data acquisition and L1B and L2 product generation at the GS must not exceed 2 working days.
    - The Space Weather (SpWx) instrument must have a near realtime (NRT) latency similar to that of the MET instrument.

- For the GHG and RCAQ instruments, science data processing and archiving will be in Canada. The Contractor must provide the required interface and services to support archiving the data at NRCan Earth Observation Data Management System (EODMS).
- For the MET and SpWx instruments data, it is to be assumed that downlinked science data can be either transmitted to a Canadian SOC or a SOC managed by our international partner. The Contractor must plan for both options.
- The Contractor must provide the capability, if needed, to CSA to archive the downloaded science data of the MET and SpWx instruments at NRCan EODMS.
- The GS must comply with AOM security profile as stipulated in [RD-17].

4.2.3.9 Concept of Operations

The Contractor must develop an initial version of the ConOps document (CDRL OPS-3) describing how a fully compliant mission would be operated. The Contractor must use the Ground Segment subsystem and the instruments constraints as guidelines for the Concept of Operations. An initial release must be presented at the SCDR.

4.2.3.10 System Conceptual Design Review (SCDR)

The Contractor must hold a SCDR with the CSA Technical Team to present an initial release version of CDRLs MM-11, ENG-3, ENG-130, ENG-132, ENG-156, OPS-3. The documentation must be made available to the CSA Technical Team no later than 15 working days prior to the SCDR.

Following the SCDR, an update of CDRLs MM-11, ENG-3, ENG-130, ENG-132, ENG-156, OPS-3 must be submitted to the CSA TA for approval within 20 working days.

4.2.4 Mission Architecture

The Contractor must regroup the information gathered until the SCDR to arrive at a suggested Mission Architecture to implement a fully compliant mission. The proposed architecture must be documented in the System Conceptual Design Document (CDRL MM-11) and presented at a Mission Concept Review. The items to cover and their level of details is specified in Appendix A.

4.2.4.1 Finalization of Concept of Operations

The Contractor must finalize the ConOps document (CDRL OPS-3) describing how a fully compliant mission would be operated and present the final version at the Mission Concept Review (MCR).

4.2.4.2 Main Interfaces Update

The Contractor must produce an initial version of the following interface documents as per CDRL ENG-59:

- Spacecraft bus to Instrument Interfaces
- Spacecraft to MOC interfaces
- Spacecraft to Ground Segment Communications Interfaces
- Spacecraft to launcher interface

The Contractor must present the initial release of these interface documents at the MCR.

4.2.4.3 MCR

The Contractor must hold a Mission Concept Review (MCR) with the CSA Technical Team to present a final version of CDRLs MM-11, MM-11a, MM-11b, ENG-130, ENG-132 and OPS-3, an update of CDRLs ENG-9a, ENG-9b, ENG-9c, ENG-9d and an initial release version of CDRL ENG-59. The documentation must be made available to the CSA Technical Team no later than 15 working days prior to the MCR.

Following MCR, an update of CDRL ENG-59 must be submitted to the CSA TA for approval within 20 working days.

4.2.5 Cost and Development Plans

The Contractor must produce a Life Cycle Cost Analysis document (CDRL MM-12), for each of the scenarios described in

Table 4-1 and present it at the MRR. The Contractor must use scenario 1 as the baseline.

In establishing cost estimates and development plan, the Contractor must consider the product assurance requirements of a class B mission (AD-11) as applicable to Phase BCD of the project as well as the systems engineering methods and practices (AD-10).

In addition of the technology development plans for the instruments, the Contractor must produce a Mission Development Plan (CDRL MM-7) and present it at the MRR.

4.2.5.1 General Cost, Schedule, and Risks Requirements

The Mission Development Plan Document (including Detailed Lifecycle Cost Estimate) will capture all aspects of the project development lifecycle required to realize the scenarios in order to better understand and validate the costing and scheduling of the scenarios and provide GC central agencies with all the necessary costing and schedule information.

At a minimum the Cost Breakdown Structure (CBS) must be at level 3 in general, at sub-system level when applicable, and follow the NASA Space Flight Program and Project Management Handbook WBS (RD-21) and NASA Cost Estimating Handbook (RD-14) guidelines.

The Contractor must produce cost estimates that will capture all aspects of the project development lifecycle for all the options, for all phases (A to F, as per CSA's phases convention) leading to the development, implementation, operation and disposal as per the attached CDRL Lifecycle Cost Analysis (CDRL MM-12).

The contractor’s Work Breakdown Structure must be consistent with a detailed product tree of the mission, that will be used for cost estimation and scheduling of the mission.

Costing methodology used must be provided and justified for each item of the Cost Breakdown Structure

It must be possible to isolate the complete development cost for the instruments and other main elements of the mission. The Contractor must identify at least the following per main element: the development cost, components cost, level of effort cost, procurement cost, qualification modeling cost and assembly, integration and testing. In case of a ‘Buy’ decision of an instrument, a complete cost breakdown shall be presented. In case of a ‘Build’, a similar costing scenario must be provided

Where possible, quotations should be obtained and referred to. Cost Elements must already include mark-ups and profits, and will take into consideration risks and uncertainty associated with these costs. The assumptions need to be clearly listed.

Cost Drivers must be identified, quantified, and correlated with the cost elements described. CSA must be able to understand the sensitivity of cost elements to the associated drivers, and have a clear picture of what, if modified, could significantly impact costs of the project at a granular level of the work.

The impact of following elements on cost must be identified:

- Data standards and interfaces;

- Cyber security considerations, including documentation and approval;
- Quality and Software assurance requirements, Verification and Validation requirements, Test plan, roll out Plan, Operation Plan and capacity management that might impact the project cost and schedule.

A Schedule based on the Work Breakdown Structure (WBS), showing the main phases/major milestones, key decision points and indicating any dependencies in the project must be done. It must cover phases A through F. The schedule must be included in CDRL PM-12. Schedules for different elements of the mission are requested, but they should be consistent with a unified overall schedule for the entirety of the mission.

The Contractor must manage mission risks per RD-01 and RD-21 recommendations and plan for the early identification, qualitative and quantitative assessment of risks related to phases A to F that may impact cost, schedule, programmatic and technical performance and develop appropriate response plans for all risks. This information must be included in a Risk Management Plan (CDRL PM-8). Risks identified must be logged in a Risk Register, and appropriate metrics such as impact, likelihood, management costs, residual costs values must be assigned to them.

4.2.5.2 Instrument Cost and Development Plans

The Contractor must provide cost estimates for the RCAQ and GHG instruments and include them in the project Life Cycle Cost Analysis (CDRL MM-12).

The Contractor must finalize the RCAQ Instrument Development Plan (CDRL MM-7a) and the GHG Instrument Development Plan (CDRL MM-7b) for the MRR.

4.2.5.3 Space Segment Cost and Development Plans

The Contractor must provide cost estimates for launch services, spacecraft and its sub-systems and include them in the project Life Cycle Cost Analysis (CDRL MM-12). In all cases, a development schedule must be provided. The cost for first and second flight units should be clearly distinguished.

The Contractor must get launch costing information for the orbits described in section 4.2.1.3. Launch costing based on similar orbits, such as a Geo Transfer Orbit is not considered sufficient in the context of this SOW.

The Contractor must provide a Space Segment Development plan as part of the Mission Development Plan (CDRL MM-7).

4.2.5.4 Ground Segment Cost and Development Plans

The Contractor must provide cost estimates for developing the Ground Segment, which includes, but is not limited to:

- The prime Mission Operations Center (MOC) and a potential back-up center including:
    - Mission Planning Subsystem,
    - Spacecraft Control Subsystem, and
    - Payload Control and Calibration Subsystem (for each instrument).
- The Communication Sub-System (for telemetry and data downlink)
- Data Processing for the each instrument.

- Data Storage and Dissemination

In all cases, a development schedule must be provided. They must be included in the project Life Cycle Cost Analysis (CDRL MM-12).

The Contractor must assume that only short-term data will be kept within the data processing sub-system. Long-term archiving will be discussed separately with the users.

The Contractor must provide an estimate of the operation costs per year including, but not limited to, manpower, facilities, communication fees, network costs, archiving costs, maintenance costs, and any other cost associated with the Phase E of the mission. Operation cost elements should be line items in the WBS/CBS that are independent from non-operation costs, and should mainly have an impact on Phase E.

The cost of ground segment must be provided for each scenarios presented in
Table 4-1. To simplify the reporting, the Contractor can produce detailed cost for the compliant mission and only report the detailed cost reduction that each option would entail.

The Contractor must provide a Ground Segment Development plan as part of the Mission Development Plan (CDRL MM-7).

4.2.6 Mission and System Requirements

4.2.6.1 Finalization of Mission Requirements

The Contractor must first review the existing Mission Requirements [RD-03 and RD-11] and flag any inconsistencies or missing information that may require clarification.

The Contractor must produce a final version of the Mission Requirement Document (CDRL MM-10) based on outcomes of the TIMs and the MCR and present it at the MRR.

4.2.6.2 Preliminary System Requirements

The Contractor must produce a preliminary system requirements document per CDRL ENG-1 for the MRR.

4.2.6.3 Mission Requirements Compliance Matrix

The Contractor must present a System Conceptual Design to Mission Requirements Compliance Matrix (CDRL ENG-156) at the MRR to show compliance of the proposed system conceptual design to the mission requirements.

4.2.6.4 MRR

The Contractor must hold a Mission Requirements Review (MRR) with the CSA to present a final release version of CDRLs MM-7a, MM-7b, MM-10 and ENG-156, and initial release version of CDRLs MM-7, MM-12 and ENG-1. The documentation must be made available to the CSA Technical Team no later than 15 working days prior to the MRR.

Final: ENG-9a, ENG-9b, ENG-9c, ENG-9d

Following MRR, an update of CDRLs MM-7, MM-12, ENG-1 must be submitted to the CSA TA for approval within 20 working days.

4.2.7 Task Authorization

During the execution of the work defined in the current SOW, evolution of AOM subsystems and the introduction of new requirements might require the Contractor to execute additional tasks in accordance with the SOW through the task authorization process. The execution of these tasks is subject to the approval of Programmatic and Contractual authorities. The Contractor must evaluate, within15 working days, Task Authorizations for the involvement of other work requirements in this SOW and ensure that all aspects are addressed in the plan to implement the Task. Unless otherwise stated, Task Authorizations must be completed without any delay to the work requirements in this SOW.

4.3 PROJECT MANAGEMENT REQUIREMENTS

The Contractor is responsible for establishing and maintaining a project management control system according to RD-01 and RD-21 necessary to meet the requirements provided in the next sub-sections.

The Contractor is responsible for the technical, cost and schedule performance of the current work.

In performing the Project Management, the Contractor must ensure that:

- The project is managed in accordance with this SOW.
- A project management organization is implemented and maintained, and meets the requirements of the project within the specified timeline.
- A technical team is implemented and maintained that meets the management, technical leadership, subject matter expertise in all applicable disciplines to meet the requirements of the project within the specified timeline.
- A project management and control system is implemented to track progress and schedule.
- The Contractor is responsible for managing their subcontractors and ensuring that requirements are flow-down to their subcontractors.

The Contractor is 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 CSA TA, copies of subcontractor documentation must be delivered to the CSA TA.

4.3.1 Project Team Organization

The Contractor must provide and maintain Project Organizational Chart, showing personnel assignments by name and function.

The Contractor must appoint an experienced Project Manager (PM) and alternate, to act in their absence, who will be responsible for all aspects of the work carried out by the Contractor and will act as the single point of contact within its project organization for communications between the Contractor and the CSA TA.

The Contractor must show Subcontractor reporting relationships.

The Contractor must identify all key personnel who are considered essential to the execution of the contract with supporting rationale.

The Contractor must maintain all key personnel and ensure a succession plan is in place for replacements, in order to avoid disrupting the achievement of SOW objectives on schedule.

4.3.2 Communication and Access

The Contractor must establish and maintain a close management and technical interface with the CSA TA to coordinate program effort and monitor the total program cost, schedule and performance.

The Contractor must provide access to its plant and personnel, at mutually agreeable dates, to representatives of CSA and ECCC 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, photocopying and internet access.

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

4.3.3 Schedule

The Contractor must prepare and maintain a schedule for all the work to be performed under this contract. The schedule must include all the meetings listed in Table 4-7. The schedule must be included in the monthly progress report (CDRL PM-9).

Any changes to the schedule must be presented at the Progress meetings as soon as possible (ASAP).

4.3.4 Risk Management

The Contractor must manage risks per 5RD-01 recommendations and plan for the early identification, qualitative and quantitative assessment of risks that may arise during the execution of the contract and develop appropriate response plans for all risks. This information must be included in the monthly progress report (CDRL PM-9). Risks identified must be logged in a Risk Register, and appropriate metrics such as impact, likelihood, management costs, residual costs values must be assigned to them (refer to RD-01 for risk management best practices).

4.3.5 Project Meetings

The Contractor must hold the meetings described in Table 4-7. Some or all of these meetings may be attended by representatives of the CSA and ECCC, and/or other organizations nominated by the CSA. CSA reserves the right to invite additional knowledgeable people (Public Servants or others under NDA) to these meetings.

All meetings will be held at a mutually agreeable time (between the Contractor and the CSA TA). The Contractor must provide formal notification of the proposed meeting date to the CSA TA no less than 10 working days before the meeting (with the exception of the Kick off Meeting (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 CSA TA of the names of Contractor and Subcontractor attendees no less than 10 working days before each meeting. Foreign participants must provide additional information such as their nationality and passport number 10 working days prior to visiting CSA.

Additional teleconferences or face-to-face review meetings must be held if necessary when mutually agreed to by the Contractor and the CSA TA.

Any meetings held in person must be carried out in accordance with safety guidelines in effect at the time of the meeting in the context of the COVID-19 pandemic response.

When mutually agreed, 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.

The Contractor must use Government of Canada authorized solutions for remote meetings.

4.3.5.1 Agendas, Minutes and Action Item Log

The Contractor must provide a Meeting Agenda (CDRL PM-13) for all reviews and meetings, including teleconferences, and must deliver these to the CSA TA no less than 5 working days before the meeting and must have it approved by the CSA TA. Agenda can be combined with the meeting presentation as long as the information required is provided.

The Contractor must produce the minutes (CDRL PM-14) 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) (CDRL PM-15) 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 must be produced at the meetings. The AIL must be delivered the next business day following the review or meeting (including teleconference). An electronic access to the current AIL must also be provided to the CSA TA for consultation (read access) .

The Contractor must produce and deliver a Phase Closure Report as close out to the Contract, per CDRL PM-22.

4.3.5.2 Programmatic Reviews

The Contractor must implement the project reviews as per Table 4-6.

4.3.5.3 Kick-off Meeting

Within ten (10) working days of the contract award (or at a date mutually agreeable to by the CSA TA and the Contractor) a Kick-Off Meeting (KOM) must be scheduled by the Contractor. The purpose of the meeting is to review the Contractor’s plans, the requirements of the work (SOW), schedule, deliverables, risks and to address issues. A presentation must be prepared and must include, at a minimum, the following content:

- Address any contractual and any other outstanding issues.
- Review of contract deliverables.
- Work requirements.
- Schedule.

- Foreground Intellectual Property (FIP) and Background Intellectual Property (BIP).
- Other items as deemed appropriate.

This meeting will be held at the CSA.

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

4.3.5.4 Progress Meetings

The Contractor must hold Progress teleconference meetings with the CSA TA monthly. Frequent exchanges between the Contractor and CSA throughout the duration of the contract are necessary to ensure CSA's input into the work carried out. The teleconferences are mainly to address technical issues, discuss progress and review the schedule.

4.3.5.5 Ad-hoc Meetings

The Contractor may request Ad-hoc meetings with the CSA whenever required to resolve unforeseen and urgent issues pertaining to work performed as part of this statement of work.

The CSA may also request such Ad-hoc meetings with the Contractor, in which the Contractor must participate.

4.3.5.6 Technical Interchange Meetings

The Contract must implement the Costing Technical Interchange Meetings (TIM) as per Table 4-6.

Decisions, interpretations and agreements made at the TIM which may change and have an impact to the contract technical scope, cost or schedule must be brought forward to the CSA TA for approval/resolution.

The Contractor must plan for 1 ad-hoc TIM to be decided during the course of the contract. This TIM will not require any formal release of documents but only presentation material to support discussions.

4.4 DELIVERABLES

4.4.1 SOW Deliverables

The deliverables associated to the work packages described in Section 4 are provided in Table 4-5.

Approval Category A corresponds to document requiring CSA approval while Approval Category R corresponds to document requiring CSA review.

The term "Approval" as used in this document and in other documents referred to herein, means written approval by CSA TA, of documents submitted by the Contractor. Once approved, the document is authorized for further use. The CSA 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 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 implies 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.

TABLE 4-5 DELIVERABLES

CDRL No.	Title	Section(s)	Milestone	Version	Approval Category	DID No.
ENG-1	System Requirements Document	4.2.6.2	MRR	IR	A	400
ENG-3	Environment Requirements Document	4.2.3.7	SCDR MRR	IR Final	A	404
ENG-9a	RCAQ Instrument Requirements Specification	4.2.1.2.1	ROR MCR MRR	IR Update Final	A	400
ENG-9b	GHG Instrument Requirements Specification	4.2.1.2.2	ROR MCR MRR	IR Update Final	A	400
ENG-9c	MET Instrument Requirements Specification	4.2.1.2.3	ROR MCR MRR	IR Update Final	A	400
ENG-9d	Space Weather Instrument Interface Requirements Specification	4.2.1.2.4	ROR MCR MRR	IR Update Final	A	500
ENG-59	System Interface Requirements	4.2.4.2	MCR MRR	IR Final	A	500
ENG-95a	Technical Notes on Mission Requirements	4.2.1.1	ROR	IR	R	CF
ENG-95b	Technical Notes on GHG Instrument Detector selection	4.2.1.4	ROR	IR	A	CF
ENG-113	Orbit Model, Analysis and Selection	4.2.1.3	ROR MCR MRR	IR Update Final	R	623
ENG-114	Orbit Determination and Control Model Analysis	4.2.1.3 4.2.1.5	ROR MCR MRR	IR Update Final	R	624
ENG-130	Space Segment Design Document	4.2.3.5	SCDR MRR	IR Final	R	701
ENG-132	Ground Segment Design Document	4.2.3.8	SCDR MRR	IR Final	R	701
ENG-156	Mission Requirements Compliance Matrix	4.2.3.4 4.2.6.3	SCDR MRR	IR Final	A	531
MM-7	Technology Development Plan	4.2.5 4.2.5.3 4.2.5.4	MRR	Final	A	006
MM-7a	GHG Instrument Technology Development Plan	4.2.2.3 4.2.5.2	ICDR MRR	IR Final	A	006
MM-7b	RCAQ Instrument Technology Development Plan	4.2.2.3 4.2.5.2	ICDR MRR	IR Final	A	006
MM-10	Mission Requirements Document	4.2.1.1 4.2.6.2	ROR MCR	IR Update	A	008

			MRR	Final		
MM-11	System Conceptual Design	4.2.3 4.2.3.1 4.2.3.2 4.2.3.3 4.2.3.5 4.2.3.6	SCDR MCR	IR Final	A	700
MM-11a	GHG Instrument Concept Design	4.2.2.1	ICDR MCR	IR Final	A	700a
MM-11b	AQ Instrument Conceptual Design	4.2.2.2	ICDR MCR	IR Final	A	700b
MM-12	Life Cycle Cost Analysis	4.2.5 4.2.5.2 4.2.5.3 4.2.5.4	MRR	IR	R	009
OPS-3	Concept of Operations	4.2.3.9 4.2.3.10	SCDR MCR	IR Final	R	825
PM-8	Risk Management Plan	4.3.4	Monthly MRR	Update Final	A	106
PM-9	Progress Report	4.1 4.3.3 4.3.4	Monthly	Update	R	107
PM-12	Project Schedule	4.3.3	KOM Monthly MRR	IR Update Final	R	105
PM-13	Meeting Agenda	4.3.5.1	Every Meeting		R	110
PM-14	Meeting Minutes	4.3.5.1	Every Meeting		R	111
PM-15	Action Item Log	4.3.5.1	Every Meeting		R	112
PM-20	BIP Report	4.5.1	KOM	IR	R	120
PM-21	FIP Report	4.5.1	MRR	Final	R	120
PM-22	Phase Closure Report	4.3.5.1	MRR	Final	R	114

4.4.2 Review Process

The Contractor must prepare and deliver the document or review data packages requested in CDRLs listed in Table 4-5 in accordance with the relevant DIDs.

For items requiring Approval or Review by the CSA TA, the Contractor must provide fifteen (15) working days for review and / or approval of the CDRL item. In the event that the CSA TA does not approve or concur with a document submitted for approval or review, the CSA TA will so notify the Contractor in the form of Review Item Discrepancies (RIDs) which will include the explanation of the reasons for the lack of approval or concurrence and will identify omissions or recommend the additions, deletions or corrections that the CSA TA deems beneficial to the needs of the project**.** The Contractor is obligated to consider implementation of the changes suggested in CSA RIDs insofar as the changes are in accordance with the relevant DID in Appendix B and this SOW.

The Contractor must propose disposition and an implementation schedule for all RIDs. The final disposition and implementation schedule of the RIDs must be agreed with the CSA TA. The Contractor must implement the final (agreed) RID dispositions and propose RIDs for closure to the CSA TA once the related actions are completed. CSA TA has final authority on the closure of RIDs.

Comments may also be provided by CSA TA on any document delivered by the Contractor. Comments do not required to be formally dispositioned or tracked.

The Contractor must maintain a RID database containing as a minimum the RID identification, RID description, disposition, status and closure details.

TABLE 4-6 REVIEW PROCESS FOR FORMAL REVIEWS

Duration	Activity
15 working days prior to review, as per CDRL	Contractor submits documents; document versions must be as per the CDRL.
15 to 0 working days prior to review, and during the review, as per CDRL	The TA reviews documents and submits RIDs as they are generated. Contractor prepares RID responses in parallel. The TA determines whether the review entry criteria have been met and requests actions from the Contractor if necessary.
1 – 3 days during and after the review	Review is held. Contractor conducts the Review, summarizing design status. During the review, the TA may submit additional RIDs. Contractor proposes RIDs dispositions for discussion. As a goal, all RIDs should have dispositions agreed at this meeting. At the end of the meeting, the Review Board convenes to decide on whether the objectives and exit conditions of the review have

Duration	Activity
	been achieved, considering the number and severity of the RIDs and Action items.
	If necessary, additional meetings may be planned for resolution of outstanding RIDs and Review Action Items. In this case the Review Board is delayed until all RID disposition and Action items closures are agreed.
As agreed during the Review on a RID basis	Contractor submits documents implementing RID dispositions and Action items; these revised documents must be released versions of one or more revisions higher and must be submitted to CSA for review or approval.

The Contractor must deliver all documentation listed in the CDRL Table 4-5 as a minimum. Documents may be combined or divided subject to CSA TA approval to optimize production and avoid unnecessary duplication of information. 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.

With the exception of documents that will remain CSA documents, the Contractor may propose documents in a Contractor's format (CF) 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.

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

All documents must be delivered per DID-0000.

Documents must be delivered in the original software application format. One electronic copy of each deliverable document must be transferred to the CSA per DID-0000. No paper copy is to be delivered.

Presentation material should be in Power Point format. Documents provided in Adobe PDF format must not be protected against copy of text and figures.

All simulation scenarios that have been considered (e.g. with STK) must be delivered in their original format.

The delivery schedule for all documentation must be as defined in Table 4-5.

The Contractor must obtain approval from the CSA TA for all CDRL Documents as indicated in Table 4-5.

4.5 SCHEDULE AND REVIEW MEETINGS

TABLE 4-7 MEETINGS

Meeting	Targeted Date	Location
Kick-off Meeting [KOM]	ACA* + 2 weeks	CSA
Requirements and Orbit Review (ROR)	ACA + 2 months	Teleconference
Instruments Conceptual Design Review (ICDR)	ACA + 7 months	Teleconference
System Conceptual Design Review (SCDR)	ACA + 12 months	Teleconference
MCR	ACA + 14 months	Contractor
Costing TIM	ACA + 16 months	Teleconference
MRR	ACA + 18 months	CSA
Ad hoc TIM	TBD	Teleconference
Project Management Progress meetings	Monthly	Teleconference (1 hr)

* After Contract Award

Note: Meetings taking place at the CSA or at the Contractor must accommodate hybrid mode (teleconference).

Review and ad-hoc meetings will be held during the course of the contract. Decisions, interpretations and agreements made at a review or ad-hoc meeting which may change and have an impact to the contract technical scope, cost or schedule must be brought forward to the CSA TA for approval/resolution. Section 4.4 shows the different required deliverables for holding successful review meetings. All review meetings are subject to the review processed discussed 4.4.2. The entry and exit criteria of each and every review meeting will comply to [AD-01]. The CSA TA will be in charge of declaring the success or failure of a review deepening on the entry and exit criteria of each and every meeting being met.

4.5.1 Intellectual property

The contractor must mark or identify the Background Intellectual Property (BIP), the IP that will be generated (FIP), the owners of these BIP and FIP and how it will be managed and coordinated. The milestone to receive the Background and Foreground Intellectual Property Reports (CDRLs PM-20 and PM-21) should be at the KoM and on a continuous basis or as soon as created and at the end of the contract. The Final BIP/FIP Report must be submitted as part of the Final Data Package.

5 GOVERNMENT FURNISHED EQUIPMENT AND INFORMATION

There is no Government Furnished Equipment (GFE) associated with this SOW.

Government Furnished Information (GFI) will be provided to the Contractor per Table 5-1. The Contractor must plan for the receipt of this information and incorporate the information into their final work. To gain access GFI-01 and GFI-02, the Bidder should anticipate the need to sign agreements with international organizations or companies.

TABLE 5-1 GOVERNMENT FURNISHED INFORMATION

GFI number	Information	Dependencies	Date of availability (anticipated)
GFI-01	SpWx instrument(s) selection and information	CDRL-MM11 (SCDR)	ICDR
GFI-02	ABI instrument Information	CDRL-MM11 (SCDR)	ICDR
GFI-03	GHG detector guidelines	CDRL ENG-95b (ROR)	KoM
GFI-04	GHG Context Camera requirements	CDRL ENG-9b (ROR)	KoM

6 ACRONYMS AND ABBREVIATIONS

This list contains the acronyms and abbreviations contained in this document. Those not contained in this list may be categorised as trademark or standard names used in the software industry.

ABI	Advanced Baseline Imager
ACA	After Contract Award
AD	Applicable Document
AI	Action Item
AIL	Action Item Log
AIM-North	Atmospheric Imaging Mission for Northern Regions
AI&T	Assembly, Integration and Testing
AQ	Air Quality
AQ-GHG	Air Quality and Greenhouse Gases
AOCS	Attitude and Orbit Control System
AOM	Arctic Observing Mission
BIP	Background Intellectual Property
CAD	Computer-Aided Design
CBS	Cost Breakdown Structure
CDRL	Contract Data Requirements List
CF	Contractor’s Format
CI	Cloud Imager
CPU	Central Processing Unit
CSA	Canadian Space Agency
CTE	Critical Technology Element
CWBS	Contractor Work Breakdown Structure
DID	Data Item Description
EAR	Export Administration Regulations
ECCC	Environment and Climate Change Canada
EMC	Electromagnetic Compatibility
EODMS	Earth Observation Data Management System
EOL	End Of Life
ERTS	Environmental Requirements and Test Specification
ESA	European Space Agency
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FCAQ	Full Capability Air Quality
FIP	Foreground Intellectual Property

FPA	Focal Plane Array
GC	Government of Canada
GEO	Geosynchronous Orbit
GFE	Government Furnished Equipment
GFI	Government Furnished Information
GHG	Greenhouse Gases
GIDEP	Government/Industries Data Exchange Program
GOES-R	Geostationary Operational Environmental Satellite R
HEO	Highly Elliptical Orbit
ICD	Interface Control Document
ICDR	Instruments Conceptual Design Review
iFTS	imaging Fourier Transform Spectrometer
IP	Intellectual Property
IR	Infrared
IR	Initial Release
IRD	Interface Requirements Documents
IT	Information Technology
ITAR	International Traffic in Arms Regulations
KOM	Kick-Off Meeting
LCCA	Life Cycle Cost Analysis
LV	Launch Vehicle
MCR	Mission Concept Review
MET	Meteorological
MMOD	Micrometeroids and Orbital Debris
MOC	Mission Operation Center
MRD	Mission Requirements Document
MRR	Mission Requirements Review
NASA	National Aeronautics and Space Administration
NDA	Non-Disclosure Agreement
NIR	Near InfraRed
NO_2	Nitrogen Dioxide
NOAA	National Oceanic and Atmospheric Administration
NRCAN	Natural Resources Canada
NRT	Near Real Time
PA	Product Assurance
PCW	Polar Communications and Weather

PM	Project Manager
PSPC	Public Services and Procurement Canada
RAAN	Right Ascension of the Ascending Node
RAM	Random Access Memory
RCAQ	Reduced Capability Air Quality
RFQ	Request for Quotation
RID	Review of Item Discrepencies
RMP	Risk Management Plan
ROR	Requirements and Orbit Review
RSSSA	Remote Sensing Space Systems Act
SCDR	System Conceptual Design Review
SEE	Single Event Upset
SI	International System of Units
S&MA	Safety and Mission Assurance
SNR	Signal-to-Noise Ratio
SOC	Science Operation Center
SOW	Statement of Work
SPI	Schedule Performance Index
SpWx	Space Weather
STDP	Space Technology Development Program
SWIR	Short-Wave InfraRed
TA	Technical Authority
TAA	Technical Assistance Agreement
TBD	To Be Determined
TBR	To be reviewed
TC	Telecommand
TIM	Technical Interchange Meeting
TM	Telemetry
TRL	Technology Readiness Level
TRM	Technology Roadmap
TRRA	Technology Readiness and Risk Assessment
TT&C	Telemetry, Tracking and Commanding
URD	User Requirements Document
UV	Ultraviolet
WBS	Work Breakdown Structure
WP	Work Package

WPD	Work Package Description

APPENDICES

A MISSION ARCHITECTURE PARAMETERS

The different parameters defined below represent the main technical parameters of any missions. The parameters will provide CSA with a harmonized comparative approach that will permit CSA to select one of the proposed options and develop the architecture of the AOM mission accordingly. The list of parameters will enable the Contractor to provide CSA and other government departments such as ECCC with a substantiate mission cost for each and every option being analyzed. Such cost would allow CSA and its governmental partners such as ECCC to seek the necessary governmental funding. Technically the parameters would provide the agency with an engineering baseline to build on it systems and subsystems requirements for the future phases of the mission. The technical dimension and outcome of those parameters would also support the government of Canada departments to discuss and promote the mission and its capabilities with international partners. Details need to be given for scenario 1 in

Table 4-1. The remaining scenarios may be assessed with identification of differences from scenario 1.

Segment	Subsystem	Parameter to be studied	Comment
Space Segment	ABI Instrument	• As per DID 700	
	SpWx Instrument(s)	• As per DID 700	
	GHG Instrument	• As per DID 700a	
	RCAQ Instrument	• As per DID 700b	
	Environment	• Radiation and SEE • Micrometeroids and Orbital debris (MMOD) • Atomic Oxygen • Protection of optical instruments against sun exposure	
	Orbit Control and Maintenance	• Propulsion type • Propulsion system architecture • Nozzle locations • Redundancy • Tank capacity, size and location • Delta V budget (including orbit insertion, orbit maintenance and EOL de-orbiting) • Geo-referencing error budget	
	Attitude Control	• Attitude sensors types, locations, field of view (incl. antennas) • Attitude actuators types and locations • Redundancy • Modes and transitions • Pointing knowledge, accuracy and stability budgets	

	Telemetry and Telecommand	• Types, redundancy, encryption • Passes per day and duration • Data rates, bandwidths • Transmit power, receiver sensitivity • Receiver tolerance to ground based radars • Antennas types and locations • Time tagged commands and telemetry storage capacity • Uplink and Downlink budgets (nominal and tumbling modes) • Power flux density • Protection of astronomy bands	
	Data downlink	• Type, redundancy • Data volume budget • Frequency, bandwidth, data rates • Transmit power • Antenna type and locations • Downlink budget • Power flux density • Protection of astronomy bands	
	Payload accommodation	• Power allocation • Locations of the various instruments • Power interface • Data and control interfaces • Mechanical and thermal interfaces • Fields of view	

	Command and Data Handling	• Type and description • Redundancy, safe mode boot, reprogramming • Modes • Architecture • CPU processing capacity budget • CPU RAM budget • Radiation and SEE budget	
	Power	• Configuration and redundancy • Bus voltage type • Power budgets (peak, orbit average, battery capacity and depth of discharge, solar array capacity, size and pointing) including EOL. • Solar Array type and location • Battery type and location, including thermal management • Load shed approach • Cold launch approach	

	Mechanical and thermal	• Overall architecture and configuration • Structure • Deployables and mechanisms, including redundancy • Shock and vibration • Depressurization • Mass budget • Volume estimates (Stowed and deployed configurations) • Ballistic coefficient • Thermal control approach • Temperature ranges estimates in the various modes • Blankets, heat pipes, heaters, thermostats, radiators locations, sizing and redundancy • Atomic oxygen estimates and measures • Micrometeroids and Orbital debris estimates and measures	
	AI&T	• Identification of high level AI&T process and steps • AI&T facilities • Spacecraft umbilical and test interfaces, including safing plugs • Hoisting interfaces • Description of ground support equipment and specialized test systems.	
Launch	Vehicle	• Performance and served orbits • Reliability • Range of orbits • Frequency and schedule of launches • Export restrictions	

	Services	• Fueling • Testing and integration of SC • Transport • Services to CSA/Contractor Teams	
	Interface	• Mechanical • Electrical • Environment, Launch Configuration/cold launch	
Ground Segment	Overall architecture	• Configuration and interfaces between the various sub-systems of the ground segment	
	Ground Stations	• Identification of Ground stations • Uplink and Downlink data volumetric estimates • Link Budget • Ground stations qualification	
	Mission Planning	• Planning of imaging and data acquisition • Planning of TM& Science Data Downlink. • Planning TC uplinks • Interface with Spacecraft Control Operation Centre and Science Operation Centre.	
	Archiving	• Definition of the application • Science Data Archiving • Interface to mission planning • Latency requirements of product generation defined	Interface to CCEMO EODMS (TBR)
	Product Generation	• Different product generation from the data downloaded from the different instruments.	Location of different processing sites and applications (TBR)

	Satellite Control Operation centre	• Location • TT&C data storage • Planning and Pass reservation. • Upload of commands • Identify number of terminals • Identify number of resources • Spacecraft control planning • Identification of the required infrastructure • Communication with different centres • IT security • Health and safety monitoring of spacecraft	
	Science Operation Centre	• Location • Instrument(s) operations • Science Data storage • Product acquisition planning • Product distribution • Infrastructure, communications and IT security	
Overall system	System interfaces	• Overall architecture • Identification of all interfaces between various sub-subsystems and with external resources	
	Data latency	• MET (ABI): Real Time • RCAQ: 3 hours • GHG: within 2 days • Space Weather: similar to MET	
Operations	Engineering	• Concept of operations • Skill set and number of resources	
	Product generation	• Concept of operations • Skill set and number of resources • Interface to the required different mission subsystems and processing sites	

B DATA ITEMS DESCRIPTIONS (DIDS)

NO TABLE OF CONTENTS ENTRIES FOUND.

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 prepared in the Contractor's format must meet the requirements of this DID.

PREPARATION INSTRUCTIONS:

1. **GENERAL INSTRUCTIONS**

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 CSA PIE-ISEP secure portal or CSA approved secure portal provided by the Contractor. .

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

WXYZ-CDRL-NUM-CIE_ContractNumber_sentYYYY-MM-DD

where:

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

Notification of document availability must be sent to CSA TA via e-mail. 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.

2. **Electronic Documents Format**

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

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.

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**

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. **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
- © HIS MAJESTY THE KING 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.***

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.

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.

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.

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.

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-006 – Technologies Development Plan

DID Issue: IR **Date: 2014-02-17**

PURPOSE:

To define and detail all technologies development activities to be performed in the early phases of the mission in order to maximize the chances of success in achieving the mission objectives within cost and schedule constraints.

PREPARATION INSTRUCTIONS:

The Technologies Development Plan must include functional and performance requirements, and a roadmap (mapping TRL to a timeline coordinated with the mission development schedule) for each Critical Technology.

The Technologies Development Plan must be developed in conjunction with the Technology Readiness Assessment Report and the Technology Trade-off Studies.

The Technologies Development Plan shall include the following data, tailored to the specific needs of each project. The Contractor's format is acceptable.

1. SCOPE

This DID establishes the content, format, maintenance, and submittal requirements for the Technologies Development activities. It is applicable to all technologies used in the system.

2. CONTENTS

This plan shall contain the following information, as a minimum:

a) A description of the Contractor's organisation, methods, and control to implement the technologies development work;

b) A description of the technologies development activities to be performed, detailing benefits, constraints, and objectives;

c) A detailed time-correlated sequence of technologies development milestones from contract-start date through to completion of design certification;

d) A description of support equipment, software, facilities, and tooling necessary for the technologies development activities;

e) A description of technologies development and breadboard tests planned at equipment level;

DID-008 – Mission Requirements Document (MRD)

DID Issue: IR **Date: 2014-02-20**

PURPOSE:

To capture the mission requirements required to proceed with the development of system requirements.

PREPARATION INSTRUCTIONS:

NOTE: the full description of the mission is to be presented in the Mission Concept Document, not in the MRD.

The document must include the following:

1) An introduction including the scope, the purpose, a short description of the mission and a list of assumptions (if any);
2) A list of applicable and reference documents (if any);
3) User requirements, which represent a clear articulation of the data and applications needs as expressed by the user community); these requirements shall be summarized in a table at the end of this section or in an Appendix;
4) Mission requirements that respond to user requirements and break down as follows:
    a) Functional and performance requirements;
    b) Interface requirements:
        i) With higher level system, if applicable;
        ii) With users (e.g. for data transmission);
    c) Mission environmental requirements
        i) Storage and handling environment
        ii) Ground operations environment
        iii) Integration to launch vehicle environment (for flight payload only)
        iv) Launch environment (for flight payload only)
        v) On-orbit environment (for flight payload only)
    d) Operational requirements including (as applicable):
        vi) In-flight requirements:
            - Operational modes,
            - Number of communication opportunities,
            - Upload and download of data requirements,

- Telemetry availability,
- Commanding capabilities;

vii) Telemetry requirements;

viii) Commanding requirements;

ix) Staffing requirements;

The mission requirements shall be summarized in one or more tables at the end of this section or in an Appendix.

DID-009 – Life Cycle Cost Analysis (LCCA)

DID Issue: IR **Date: 2014-02-20**

PURPOSE:

To determine the overall cost of designing, building, testing, operating, maintaining and disposing of a space system.

PREPARATION INSTRUCTIONS:

The LCCA shall be structured on the system WBS and shall analyze all the costs attributed to the system during its life cycle. It shall include the following costs:

1) Initial capital costs, including project planning and management, engineering (design and development), manufacturing, testing, integration, launch and commissioning. Ground segment acquisitions and development shall also be included;
2) Operating costs, including operations personnel, consumables, training, simulations, etc.;
3) Maintenance costs if applicable;
4) Disposal costs;
5) Assumptions on inflation.
6) Profit structure.
7) Documentation to support cost estimate.

The following must be identifiable within the Cost Breakdown Structure and must be reflected through the granularity of the Work Breakdown Structure:

1) Depreciable assets
2) Internal GC manpower
3) Contractor manpower
4) Operating and maintenance costs.

The Cost Breakdown Structure should list the Work Breakdown Structure elements in the rows, the phases in the columns, and should identify whether a Cost Breakdown Structure element is a total cost or a yearly cost. A given CBS element cannot be simultaneously a total cost and a yearly cost.

For each cost element of the Cost Breakdown Structure, the contractor must indicate the costing methodology used, identify 3 point estimates, and must identify at least 2 cost drivers per element that would drive the cost to change. Cost drivers must be quantified (examples of drivers could be power output, TRL level, downlink volume, resources needed, access to facilities, etc.) and linked to the cost estimates.

DID-105 – Project Schedule

DID Issue: IR **Date: 2014-01-06**

PURPOSE:

To provide a schedule planning and control system for the project and to provide visibility to the CSA of the program progress and status.

PREPARATION INSTRUCTIONS:

The project schedule must be based on the WBS, in the form of a Gantt chart. The schedule must be provided in its native tool format (MS project or PS8 are the two accepted formats), and in PDF. The project schedule must be detailed enough to show each WBS task to be performed, and must provide the following information:

1) dependencies,
2) resource requirements,
3) the start and end date of each task (baseline and actual),
4) task duration,
5) completion status in percentage;
6) deadlines and milestones, and
7) critical path.

The schedule must show dependencies between the Contractor and other organizations. For major subcontracts involving significant new development, Subcontractors' master schedules must be provided including the same information as required form the prime Contractor.

The tasks related to deliverables must be limited to three months in the project schedule. When applicable, the Contractor must divide longer tasks into smaller significant tasks.

Tasks that are not related to any specific deliverable, such as Project Management and S&MA activities, must be grouped separately from the deliverables, and must be shown at the top of the chart.

The Contractor must report schedule performance status in tabular form, with the following information provided for each WP:

1) Schedule variance (current and cumulative), and
2) Schedule Performance Index (SPI).

The monthly progress status may be reported as a part of the Monthly Progress Reports. Baseline versions of these schedules will be maintained against which the project will be reported. These baseline schedules must not be revised or changed without prior approval from the CSA.

DID-106 – Risk Management Plan

DID Issue: IR **Date: 2014-01-06**

PURPOSE:

The Risk Management plan (RMP) describes the structured and methodical approach to risk management for the project for the Contractor and for each of the Subcontractors.

PREPARATION INSTRUCTIONS:

The Risk Management Plan (RMP) shall contain the following information, as a minimum:

1) Description of RMP purpose;
2) Project Overview: Shall provide a brief overview of the project and its deliverables while focussing on perceived risk areas;
3) Risk categories or Risk Breakdown Structure to facilitate risk identification to a consistent level of detail. The following main categories shall be used for the first level of the risk breakdown structure:
    a) Cost – Risks associated with system acquisition or development cost exceeding the budget,
    b) Schedule – Risks associated with achieving designated milestones within the designated time frame,
    c) Technical – Risks associated with the engineering process that may keep the system from meeting its technical specifications or may adversely affect overall system quality and performance, and
    d) Programmatic – Risks associated with programmatic factors such as export control, regulations, changes to the project environment, force majeure, etc.;
4) Risk Identification methodology describing the approach to be followed for identifying and documenting risks that might affect the project. The risk statement shall identify the risk cause as well as its consequence using the following wording: *"there is a risk that* _____ (specify cause*) resulting in* _____ (specify consequence)*"*. Risks shall be grouped by category and identified to one or more specific work packages. Lessons learned from previous projects should be considered;
5) Risk Analysis methodology describing the approach for assessing the likelihood and consequence of each risk to be identified; this should take the form of the usual likelihood vs. consequence matrix;
6) Risk Response Plan section describing the strategies that will be considered in responding to each risk, the decision making approach in choosing the right strategy, and the documentation of the resulting actions for each risk; this should include contingency plans, appropriate responses for taking advantage of positive risks (opportunities) and risk closure criteria;

7) Risk Monitoring and Control approach describing the procedures and forums (e.g. risk review meetings, committees, boards) to be implemented for monitoring risk status, for following up on response plan actions, for updating the risk assessment and for evaluating the risk management process. A history of changes made to the baseline risk register shall be maintained (could simply involve keeping track of former risk reports);

8) Reporting formats describing the format of the risk register as well as any other risk reports or tools required. Shall also define how the outcome of the risk management processes will be documented, analyzed and communicated internally and externally;

9) Roles and Responsibilities defining the lead, support, and risk management team membership for each type of activity in the risk management plan including the names of the resources assigned to these roles;

10) Budgeting approach describing the process for assigning resources and estimating costs needed to perform risk management activities (which costs to be included in the project cost baseline); management of risk contingency reserve shall also be addressed including the process for releasing funds to implement a mitigation action or to realize a risk;

11) Timing approach defining when and how often the risk management process will be performed throughout the project. Shall also identify the risk management activities to be included in the project schedule;

12) Risk register, one for each option studied, listing all identified risks, showing at a minimum for each risk its title, description, originator, owner, category, likelihood, consequence, cost impact (in Canadian Dollars), schedule impact (in days), mitigation measure, mitigation cost, residual cost;

13) When it’s the case, a risk should be clearly associated with a given line item of the Work Breakdown Structure.

DID-107 – Progress Report

DID Issue: IR **Date: 2014-01-10**

PURPOSE:

The Progress Report presents the results of the work done to date in the contract, and in particular since the previous report. The Progress Report is used by the Government to assess the Contractor's progress in performance of the work.

PREPARATION INSTRUCTIONS:

NOTE TO CSA PROJECT MANAGERS: The content required below includes all the information required for a large project. For smaller or Phase 0 or A projects, the CSA Project Manager may elect to tailor these requirements down to a suitable level, however, it is necessary to ensure that enough information is obtained to maintain control of the project.

The Monthly Progress Report shall include status data and information summarizing project management, technical and schedule progress and accomplishment for each element of the Contractor's Work Breakdown Structure (CWBS). The report shall address the major activities of the reporting period and shall emphasize major achievements and events of special significance. Difficulties and/or problems that have affected the work progress, proposed corrective actions, project impact expected and concerns for the future, shall also be reported.

Each progress report shall answer the following three questions:

1) Is the project on schedule?
2) Is the project within budget?
3) Is the project free of any areas of concern in which the assistance or guidance of the CSA may be required?

Each negative response must be supported with an explanation.

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

1) Summary outlook, including technical performance, work performed, schedule and cost status (at CWBS level 2), organization and key personnel changes and areas of concerns;
2) Financial status including actual and forecasted expenditures, by month, as compared to the original monthly planned expenditure profile;
3) *For cost reimbursable contracts:* Cost performance status in tabular form, with the following information provided for each Work Package (WP):
   a) Budgeted Cost of Work Scheduled (BCWS), current and cumulative,
   b) Budgeted Cost of Work Performed (BCWP), current and cumulative,
   c) Actual Cost of Work Performed (ACWP), current and cumulative,
   d) Cost variance (current and cumulative),

   e) Budget at completion (BAC),
   f) Estimate at completion (EAC),
   g) Cost variance at completion, and
   h) Cost Performance Index (CPI);

4) *For fixed price contracts:* Updated milestones payment plan;
5) A detailed integrated project schedule status including:
   a) The schedule baseline,
   b) Dependencies between activities,
   c) Percent of completion for all activities,
   d) List of completed milestones,
   e) Critical path,
   f) 1st level Subcontractor's activities having impact on WP delivery date shall be provided, and
   g) All other activities having an impact on WP delivery date shall be provided;
6) Schedule variances from the plan, including deviations from schedule and proposed corrective actions for significant variances;
7) Major meetings schedule update;
8) Status of the work in progress, specifically the work performed in the previous calendar period; sufficient sketches, diagrams, photographs, etc. shall be included, if necessary, to describe the progress accomplished;
9) The work projected for the next period, and estimated date of completion of next milestone;
10) Outline of technical and programmatic issues, with solutions recommended;
11) Contractual issues, including changes to activities and costs;
12) Subcontracts events, status and issues;
13) Equipment ordered, received, made and assembled;
14) Description of trips or conferences connected with the Contract during the period of the report;
15) Risk status report including previous issues resolved, status of on-going risks (changes, likelihoods and impacts), and identification of new risks, their likelihood and impact, and proposed mitigation action;
16) PA reporting:
   a) A narrative section describing: significant accomplishments during the reporting period, audits performed, significant problems, recommended solutions, and corrective action status, significant changes in the PA Organization and Program related organizations,
   b) Summary tables or updates as applicable:

i) Technical review action items, configuration baseline, non-conformances, failure analysis, audits (internal as well as at the Subcontractors and their sub-tiers),

ii) Reliability analysis status,

iii) Inspection and Test Status,

iv) Deviations/Waivers status,

v) List of Class I Non-conformances,

vi) List of Class II Non-conformances,

vii) PA documentation status,

viii) PA Action Item Log,

ix) Contractor problem status, and

x) Status of GIDEP/ESA Alerts,

c) Software assurance highlights:

i) Assurance accomplishments and resulting metrics for activities such as, but not limited to, inspection and test, reviews, Instrument Provider/Subcontractor surveys, and audits,

ii) Trends in metrics data (e.g., total number of software problem reports, including the number of problem reports that were opened and closed in that reporting period),

iii) Significant problems or issues that could affect cost, schedule and/or performance, and

iv) Plans for upcoming software assurance activities; and

17) Status of all action items from previous review(s) and meeting(s).

DID-110 – Meeting Agenda

DID Issue: IR **Date: 2013-12-19**

PURPOSE:

The Meeting Agenda specifies the purpose and content of a meeting.

PREPARATION INSTRUCTIONS:

The meeting agendas shall 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;
   g) Opening Remarks: CSA;
   h) Opening Remarks: Contractor;
   i) Review of previous minutes and all open action items;
   j) Project technical issues;
   k) Project management issues;
   l) Other topics;
   m) Review of newly created/closed action items, decisions, agreements and minutes; and
   n) Set or confirm dates of future meetings.

DID-111 – Minutes of Meetings

DID Issue: IR **Date: 2013-12-19**

PURPOSE:

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

PREPARATION INSTRUCTIONS:

Minutes of meeting shall be prepared for each formal review or meeting in the Contractor's format and shall, as a minimum, include the following information:

1) Title page containing the following:
    a) Title, type of meeting and date
    b) Project title, project number, and contract number
    c) Space for signatures of the designated representatives of the Contractor, the CSA and the Public Services and Procurement Canada (PSPC), and
    d) Name and address of the Contractor.
2) Purpose and objective of the meeting;
3) Location;
4) Agenda;
5) Summary of the discussions, decisions and agreements reached;
6) List of 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 shall 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."

DID-112 – Action Items Log (AIL)

DID Issue: IR **Date: 2013-12-19**

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 Action Item Log (AIL) must be in a tabular form, with the following headings in this order:

1) Item Number;
2) Item Title;
3) Description of the action required;
4) Open Date;
5) Source of AI (e.g. review meeting, RID, etc.);
6) Originator;
7) Office of Prime Interest (OPI);
8) Person responsible (for taking action);
9) Target/Actual Date of Resolution;
10) Progress update;
11) Rationale for closure;
12) Status (Open or Closed); and
13) Remarks.

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

DID-114 – Phase Closure / Final Report

DID Issue: IR **Date: 2014-01-16**

PURPOSE:

The purpose of the Phase Closure/ Final Report is to record formally the history of the Phase (or Project if this is the Final Report), its achievements, financial, material and human resources expenditure, problems encountered and solutions implemented.

PREPARATION INSTRUCTIONS:

The Phase Closure / Final Report will encompass all the work done in the project during the Phase just ended or for the entire project. It should be a comprehensive summary of the phase or project work with the emphasis on the problems encountered, solutions implemented, successes encountered and lessons learned. It must include sufficient drawings, graphs, tables, figures, sketches and photographs as appropriate. The Phase Closure Report shall be a standalone document and shall contain at least the following information:

1) Executive Summary.
2) Comparison of system performance results against system requirements and objectives.
3) Comparison of run-out costs with estimates by major Work Package (if applicable).
4) Comparison of actual versus planned schedules and milestones.
5) Comparison of risks anticipated versus actual experience.
6) Problems encountered and solutions implemented.
7) Final CDRL.
8) Lessons learned.

DID-120 – FIP and BIP Disclosure

DID Issue: IR **Date:**

PURPOSE:

The BIP/FIP Disclosure Report serves to identify FIP produced under the Contract with the CSA, as well as any BIP elements that were used to develop the FIP.

PREPARATION INSTRUCTIONS:

The Contractor must complete Table 1 for the report to be provided with the proposal (BIP). The report to be provided at the end of the contract must include Tables 1, 2 and 3 (BIP/FIP).

Background Intellectual Property (BIP)

Table 1 - Disclosure of Background Intellectual Property (BIP) brought to the project

BIP ID#	Project Element	Title of the BIP	Type of IP	Type of access to the BIP required to use/improve the FIP	Description of the BIP	Reference Documentation	Origin of the BIP	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, patent?*	*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.*

Foreground Intellectual Property (FIP)

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

FIP ID #	Project Element	Title of FIP	Type of FIP	Description of the FIP	Reference documentation	BIP used to generate the FIP	Owner of the FIP	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, patent*	*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.* **If Canada is the owner of the FIP, complete Table 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 3 only for this IP.*

Table 3 - Canada's Owned FIP Additional Information

FIP ID #	**Title of FIP**	**Aspects of FIP that are novel, useful and non-obvious**	**Limitations or drawback of the FIP**	**References in literature or patents pertaining to the FIP**	**Has the FIP been prototyped, tested or demonstrated? (e.g. analytically, simulation, hardware)? Provide results**	**Inventor(s)**	**Was the FIP disclosed to other parties?**
ID# should be same as corresponding FIP element in Table2	*Title of FIP should be same as corresponding FIP element in Table2*	*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.*

DID-400 – Requirements Document

DID Issue: IR **Date: 2014-01-23**

PURPOSE:

To define the functional, performance, environmental and other requirements for a given system, segment, subsystem, unit, module or assembly and to provide the basis on which the Specifications Documents will be developed.

NOTE: Requirements Documents are sometimes called "Requirements Specification". This DID applies to them as well.

PREPARATION INSTRUCTIONS:

1) Requirements documents shall conform to norms of English usage for Systems Engineering:

   "shall" indicates a mandatory requirement

   "should" indicates a preferred but not mandatory alternative,

   "will" indicates statement of intention or fact

   "may" indicates an option.

2) Requirements documents shall define the requirements on the subject item (segment, subsystem, etc.) as a whole and shall not contain specific requirements on sub-items. All requirements shall be verifiable on the item as integrated.
3) All requirements shall be documented in the MBSE model and requirements documents expressed from the model *(Optional)*.
4) Requirements documents shall cite applicable standards and parent requirements, and shall make clear the priority sequence of the applicable documents.
5) There shall be one set of requirements for each node in the System Hierarchical Tree. Note that interface requirements (which are between two or more nodes) are in separate documents.
6) Requirements shall conform to the following standards for quality:
   a) They shall be unambiguously clear to the intended readership;
   b) There shall be one requirement per paragraph;
   c) Each requirement shall have a unique identifier (e.g. an ID number or paragraph number);
   d) They shall not define design solutions;
   e) They shall define their source and/or rationale
   f) They shall be verifiable, preferably by test;
   g) They shall specify the conditions under which they apply; and
   h) Performance requirements shall be quantified.

7) The Requirements Document shall comprise a number of sections, each defining a specific set of requirements. The document shall address all of the following categories of requirements, as applicable to the project:
   b) Functional and performance requirements (see item 8) below);
   a) External interface requirements (unless done in a separate document);
   b) Resource allocation requirements,
   c) Design requirements;
   d) Construction requirements (see item 9) below);
   e) Environmental requirements (see item 10) below),
   f) Qualification and/or verification requirements;
   g) Safety requirements
   h) System environmental requirements associated with:
      i) Storage, packaging and handling environment
      ii) External stowage requirements, if any;
      iii) Ground operations environment
      iv) Integration to launch vehicle environment (for flight payload only)
      v) Launch environment (for flight payload only)
      vi) On-orbit environment (for flight payload only)
   i) Operational requirements, if any;
   j) Ground Support Equipment requirements, if any (unless done in a separate document); and
   k) Other applicable requirements types.
8) Functional and performance requirements shall include, as applicable to the project:
   a) Functional and performance requirements imposed on the system by the scientific needs (flow down from MRD);
   b) Operating modes requirements;
   c) Power requirements including:
      i) Power consumption,
      ii) Power transients,
      iii) Voltage requirements;
   d) Telemetry and Telecommand requirements;
   e) Software requirements;
   f) Other applicable requirements.
9) Construction requirements shall include, as applicable to the project:

a) Requirements associated with materials, parts and processes;
b) Physical requirements including
   i) mass properties,
   ii) envelopes,
   iii) physical attributes (# of samples, etc.);
c) Containment requirements.

10) Environmental requirements shall address the following, as applicable to the project:
a) Environmental test factors;
b) Protoflight and Qualification testing, philosophy and factors;
c) Environmental Design and Test Requirements:
   i) Structural/Mechanical Design Requirements,
   ii) Thermal Design requirements,
   iii) Grounding requirements
   iv) Electrostatic and EMC Design requirements,
   v) Atmospheric Environment,
   vi) Radiation Environment,
   vii) Meteoroid and orbital debris environment, and
   viii) Cleanliness and contamination environment;
d) Subsystem and Component requirements Item c) applied to subsystem and units.

DID-404 – Environmental Requirements and Test Specification (ERTS)

DID Issue: IR **Date: 2014-01-24**

PURPOSE:

To document the environmental design and test requirements for the launch vehicle, launch site, transportation, integration and operational environments together with their associated test environments. These requirements apply to the spacecraft and its subsystems, modules, units and subassemblies.

PREPARATION INSTRUCTIONS:

The ERTS may be prepared in the Contractor's format. The document shall address all of the following requirement areas, as a minimum:

1) General Requirements
    a) Launch vehicle
    b) Orbit
    c) Lifetime
2) Environmental Design Limits
    a) General
    b) Mechanical Environment
    c) Thermal Environment
    d) Electromagnetic Environment
    e) Atmospheric Environment
    f) Space Radiation Environment
    g) Meteoroid and Orbital Debris Environment
3) Generic Environmental Test factors
    a) Unit and Subsystem Test Factors
    b) Spacecraft and Module Test Factors
    c) Pressure Vessel Load Factors
    d) Test Tolerances
    e) Spacecraft Design Loads and Test Factors
    f) Unit and Subsystem Design Loads and Test Factors
4) Protoflight Testing
    a) General

   b) Protoflight Test Levels

5) Test Requirements
   a) Tests To Be Performed
   b) Test Levels and Durations
   c) Test Tolerances
6) Test Description
   a) Subsystem / Unit Level Tests
   b) Module Level Tests
   c) Spacecraft Level Tests
7) Spacecraft/module level Environmental and Test Requirements
   a) Structural/Mechanical Environmental Design Requirements
   b) Thermal Design Requirements
   c) Electrostatic and EMC Environmental Design Requirements
   d) Atmospheric Model
   e) Radiation Environment
   f) Meteoroid and Orbital Debris Environment
   g) Contamination
   h) Transportation and Ground Environments
   i) Spacecraft Structural Tests
   j) Payload Electrical Development Model Test
   k) Protoflight Tests
8) Subsystem and Component Level Requirements

   Similar to above. At subsystem and component level. Internally and externally mounted units to be addressed accordingly (different environments). Qualification testing to be addressed in terms of durations, cycles, tolerances, margins, etc. Acceptance testing to be addressed similarly.

DID-500 – Interface Requirements Documents (IRD)

DID Issue: IR **Date: 2014-01-28**

PURPOSE:

Interface Requirements Documents (IRD) define requirements on each of the two or more nodes sharing an interface to ensure that when connected physically or virtually they are compatible and together achieve their combined functions. The IRD serves as the parent for the Interface Control Document.

PREPARATION INSTRUCTIONS:

Interface requirements typically cover the following interface characteristics:

1) Electrical: power supply levels and consumption, digital and analogue signals, EMC;
2) Mechanical: loads, attachment locations, attachment methods, volume constraints;
3) Thermal transmission: heat loads and lifts, radiative properties, especially for enclosures;
4) Data: data to be passed and standards;
5) Synchronization: timing and delay requirements;
6) Optics: properties of optical rays transmitted between subsystems, e.g. focal length, focal point, aberrations of a telescopically focused image.

Some environmental requirements (e.g. transmitted mechanical vibration levels) can logically be placed into a Requirements Document or an IRD, it being the author's choice.

The following requirements apply to all interface requirements documents.

All requirements applicable at the interface between the subject items shall be documented. This should cover the standard items listed above.

Requirements documents shall define the requirements on the subject item (segment, subsystem, etc.) as a whole and shall not contain specific requirements on sub-items. All requirements shall be testable on the item as integrated.

Requirements shall conform to the following standards for quality:

1) They shall be unambiguously clear to the intended readership;
2) There shall be one requirement per paragraph;
3) Each requirement shall have a unique identifier (e.g. An ID number or paragraph number);
4) They shall not define design solutions;
5) They shall define their source and/or rationale;
6) They shall be verifiable, preferably via a direct measurement;
7) They shall specify the conditions under which they apply; and

8) Performance requirements shall be quantified.

Requirements documents shall cite applicable standards and parent requirements, and shall make clear the priority sequence of the applicable documents.

Following are examples of IRDs that may be required, depending on the nature of the project:

1) Spacecraft-to-Launch Vehicle IRD
2) Spacecraft-to-Ground Segment IRD
3) Spacecraft Internal IRD (e.g. between Bus and Payloads)
4) Ground Segment Internal IRD

DID-531 – Verification and Compliance Matrix

DID Issue: IR **Date: 2014-02-05**

PURPOSE:

To show the details of the compliance of a system, subsystem or payload and the verification thereof through the life of the project with respect to each requirement. It is a living document that is updated at each review with new data. The matrix is tightly coupled with the Verification Plan because it provides the detailed linkage of verification activities to the specific requirements they address.

PREPARATION INSTRUCTIONS:

The Verification and Compliance Matrix shall contain, for each requirement, as a minimum:

1) The requirement document number and requirement identifier;
2) The requirement description;
3) Other relevant requirement references;
4) Verification method for each requirement, indicating level-of-assembly;
5) Requirement compliance based on verification data presented at the current phase;
6) Link to the verification data that justifies the compliance and the quantitative value;
7) Comments as required; and
8) Verification Status.

The Verification and Compliance Matrix may be contained within the Verification Plan document, or delivered under a separate cover, since the two are closely linked.

Software Verification and Compliance Matrices shall be developed within the Unified Modeling Language (UML) model and the deliverable document expressed therefrom.

DID-623 – Orbit Model, Analysis & Selection

DID Issue: IR **Date: 2014-01-29**

PURPOSE:

To determine the orbital parameters and lifetime orbital behaviour and support the determination of LV requirements.

PREPARATION INSTRUCTIONS:

GENERIC FORMAT AND CONTENT FOR ALL ANALYSES

All CAD models developed shall be delivered. All CAD models developed in accordance with the requirements stipulated in the DID for Computer-Aided Design (CAD) Models.

Analysis documents shall contain all analysis work that is performed in support of the design. The analysis material shall be sufficiently detailed that, in combination with the delivered models, CSA or an external reviewer can reproduce the results. The analysis shall establish feasibility and verification of the design to meet the requirements.

The data shall include references to sources such as equations, material values, parameters and properties.

Each report shall contain, as a minimum, the following information:

1) Objectives of the analysis;
2) Reference to the relevant requirements;
3) Description of the analysis tools used;
4) Description of the model developed to aid the model user;
5) Identification of the assumption(s) made;
6) Description of the main analysis steps and intermediate results;
7) Results of the analysis and compatibility with the requirements;
8) Identification of potential problem areas and presentation of alternative design solutions;
9) Conclusion.

Delivered models shall contain at least example outputs so that the user can check their function, and should contain the main outputs used in the analysis documents.

SPECIFIC CONTENTS

The analysis shall determine the orbital parameters and lifetime orbital behaviour of the satellite and support the determination of LV requirements, eclipse requirements on the power system, communication requirements on the space-ground link (frequency and length of passes, and requirements on ground station location), and other orbit-related requirements.

It shall take into account all orbital effects (solar radiation and atmospheric drag, non-spherical Earth gravity field, perturbations due to sun and moon gravity fields, etc.)

A model of the orbit shall be developed. The orbit model shall be delivered in System ToolKit (STK) format. The model shall include determination of uplink and downlink opportunities.

DID-624 – Orbit Determination and Control Model and Analysis

DID Issue: IR **Date: 2014-01-29**

PURPOSE:

To simulate the spacecraft orbit and plan and verify orbit acquisition manoeuvres, orbit maintenance manoeuvres, satellite de-orbiting, and total fuel reserves including margin.

PREPARATION INSTRUCTIONS:

GENERIC FORMAT AND CONTENT FOR ALL ANALYSES

All CAD models developed shall be delivered. All CAD models developed in accordance with the requirements stipulated in the DID for Computer-Aided Design (CAD) Models.

Analysis documents shall contain all analysis work that is performed in support of the design. The analysis material shall be sufficiently detailed that, in combination with the delivered models, CSA or an external reviewer can reproduce the results. The analysis shall establish feasibility and verification of the design to meet the requirements.

The data shall include references to sources such as equations, material values, parameters and properties.

Each report shall contain, as a minimum, the following information:

1) Objectives of the analysis;
2) Reference to the relevant requirements;
3) Description of the analysis tools used;
4) Description of the model developed to aid the model user;
5) Identification of the assumption(s) made;
6) Description of the main analysis steps and intermediate results;
7) Results of the analysis and compatibility with the requirements;
8) Identification of potential problem areas and presentation of alternative design solutions;
9) Conclusion.

Delivered models shall contain at least example outputs so that the user can check their function, and should contain the main outputs used in the analysis documents.

SPECIFIC CONTENTS

A detailed model of the orbit shall be developed and delivered in System ToolKit (STK) format. The model shall include determination of uplink and downlink opportunities and shall take into account all orbital effects (solar radiation and atmospheric drag, non-spherical Earth gravity field, perturbations due to sun and moon gravity fields, etc.)

Analysis by simulation shall verify all orbit acquisition manoeuvres including launch dispersion correction, collision avoidance during orbit insertion, and constellation re-phasing if applicable. Analysis by simulation shall also verify all orbit maintenance manoeuvres and satellite de-orbiting. These analyses shall also verify that total fuel reserves, including margin, are sufficient.

DID-700 – System Conceptual Design Document

DID Issue: IR **Date: 2014-02-20**

PURPOSE:

In its preliminary form, to describe the preliminary system conceptual design proposed to meet the mission requirements.

In its final form, to describe the conceptual design of the system, to assist in finalizing the design of the system and allocating the requirements to subsystems, to demonstrate its feasibility and to support programmatic estimates.

PREPARATION INSTRUCTIONS:

NOTE: This DID comprises two sets of requirements: the first for the preliminary form of the document and the second for its final form.

Preliminary form

The preliminary document must include the following:

1) An introduction including the scope, the purpose and a list of assumptions (if any);
2) A description of the overall system conceptual design;
3) A description of any payload detailed analysis, breadboard design and performance (field) testing, if applicable; and
4) A description of any trade-off studies performed.

Final form

The final document must include the following:

1) Introduction: recalling the major objectives and guidelines for the project;
2) Architecture, design and interfaces: giving a high level description of the architecture and design of the system and its subsystems, including internal and external interfaces, as per Appendix A;
3) Trade-offs: criteria definition, analysis, criteria results, decisions;
4) Design decisions: rationales for design choices;
5) Budgets: a summary of the engineering budgets and TPMs, and margins, their allocation to subsystems;
6) Drawings and schematics: architectural diagrams for the main aspects of the system (structure, electronics, power, communications, software, etc.) describing and referencing important design drawings such as functional interconnect diagrams, activity flow diagrams, ICDs;

7) Analyses: summarizing the analyses performed, main results and problems encountered; this is a summary of each full analysis report presented separately;
8) Tests: summarizing the tests to be performed to verify the performance and environmental requirements;
9) Operations concepts: summarizing the operations of the system in both nominal and contingency conditions;
10) Maintenance approach: describing the maintenance approach especially for maintainable items such as the spares for manned systems, flight software and ground systems;
11) Matrix: To demonstrate design compliance to requirements by providing clear link between design and requirements. Indication of design compliance, non-compliance and partial compliance.

DID-700a – GHG Instrument Concept Report

PURPOSE:

To assess the impact of the greenhouse gas (GHG) instrument design on AOM. Information about the conceptual design of the instrument will assist in finalizing the design of the system and allocating the requirements to sub-systems, demonstrate feasibility and support programmatic estimates.

PREPARATION INSTRUCTIONS:

The document must include as a minimum:

1. Introduction
    a. Scope
    b. Purpose
    c. List of Assumptions
        i. orbit,
        ii. bus accommodation,
        iii. etc.
2. Preliminary Applicable System/Mission Requirements (eg. SNR)
    a. Traceability to Mission Objectives and/or User Requirements
3. Conceptual design of the iFTS GHG instrument
    a. Overall principle of observation
    b. Detailed product tree
    c. Interfaces and environment
4. Instrument Description
    a. Functional Block Diagram
    b. Main Layouts
        i. Mechanical Layout
        ii. Optical Layout
        iii. Data Processing
    c. Optical Sub-system Description
        i. Input aperture and fore optics
        ii. Interferometer, beamsplitter, cube corners
        iii. Focal Plane Arrays and aft optics
        iv. Spectral bands, spectral sampling and resolution throughout the FPA
    d. Thermal Sub-System and Cooling
    e. Calibration Sub-System
    f. Structure
5. Concept of operations
    a. Imaging strategy, integration time, repointing time, total acquisition time
    b. Intelligent Pointing analysis and trade studies
        i. on-board processing requirements
        ii. uplink/downlink

c. Image Navigation and Registration
    i. Context camera integration for geolocation correction
d. iFTS pixel movement
    i. consequences
        1. spectral mixing in inhomogeneous scene
        2. spatial resolution
    ii. imaging constraints
    iii. correction technique
e. Calibration and validation strategy

6. Error budgets
    a. Spectral Accuracy
    b. Radiometric Accuracy
    c. SNR and retrieval precision
    d. Retrieval Accuracy and sources of bias
    e. Spatial Resolution
    f. Pointing Accuracy
    g. Calibrated geolocation accuracy
7. Key Engineering Budgets
    a. Mass
    b. Power
    c. Volume
    d. Thermal
    e. Data Rate Budget

8. Impact on space segment / bus
    a. on-board storage
    b. on-board processing
    c. antennae
    d. down link
    e. solar arrays
    f. etc.
9. Impact on ground segment
    a. data volume
    b. storage
    c. data processing
10. Compliance Assessment,
    a. Compliance matrix to preliminary mission requirements
    b. Current Best Estimates (CBE) of performance

11. Recommendations
    a. Detailed comparison and Trade study
    b. Identification of Key Technologies
    c. Identification of Long-Lead Items
    d. Recommendations

DID-700b – Air Quality Instrument Concept Report

PURPOSE:

To assess the impact of the reduced capability air quality (RCAQ) instrument design on AOM. Information about the conceptual design of the instrument will assist in finalizing the design of the system and allocating the requirements to sub-systems, demonstrate feasibility and support programmatic estimates.

PREPARATION INSTRUCTIONS:

The document must include as a minimum:

1. Introduction
    a. Scope
    b. Purpose
    c. List of Assumptions
        i. orbit,
        ii. bus accommodation,
        iii. etc.
2. Preliminary Applicable System/Mission Requirements (eg. SNR)
    a. Traceability to Mission Objectives and/or User Requirements
3. Conceptual design of the RCAQ instrument
    a. Overall principle of observation
    b. Detailed product tree
    c. Interfaces and environment
4. Instrument Description
    a. Functional Block Diagram
    b. Main Layouts
        i. Mechanical Layout
        ii. Optical Layout
        iii. Data Processing
    c. Optical Sub-system Description
        i. Focal Plane Arrays and optics
        ii. Spectral bands, spectral sampling and resolution
    d. Thermal Sub-System and Cooling
    e. Calibration Sub-System
    f. Structure
5. Concept of operations
    a. Imaging strategy, integration time, repointing time, total acquisition time
    b. Image Navigation and Registration
    c. Calibration and validation strategy
6. Error budgets

    a. Spectral Accuracy
    b. Radiometric Accuracy
    c. SNR and retrieval precision
    d. Retrieval Accuracy and sources of bias
    e. Spatial Resolution
    f. Pointing Accuracy
    g. Calibrated geolocation accuracy
7. Key Engineering Budgets
    a. Mass
    b. Power
    c. Volume
    d. Thermal
    e. Data Rate Budget
8. Impact on space segment / bus
    a. on-board storage
    b. on-board processing
    c. antennae
    d. down link
    e. solar arrays
    f. etc.
9. Impact on ground segment
    a. data volume
    b. storage
    c. data processing
10. Compliance Assessment,
    a. Compliance matrix to preliminary mission requirements
    b. Current Best Estimates (CBE) of performance
11. Recommendations
    a. Detailed comparison and Trade study
    b. Identification of Key Technologies
    c. Identification of Long-Lead Items
    d. Recommendations

DID-701 – Design Document

DID Issue: IR **Date: 2014-01-31**

PURPOSE:

To document the design of a system or major subsystem (e.g. payload) and the supporting analyses and trade-offs, and to provide an integration of the individual analyses and tests presented in supporting documents, showing how they affected the design.

PREPARATION INSTRUCTIONS:

The Design Document shall be first presented at the SCDR and the final version shall be presented at the MRR. Its content shall be adapted to the phase of the project for which it is reporting.

The Design Document acts as an "answer" to the Requirements Document for the system or subsystem. The requirements state what is needed and the Design Document describes what is provided to meet these needs. The Design Document serves as the main reference text for users after delivery of the system, describing the full range of performance and functional capabilities of the item, as verified during the test/verification program.

The Design Document comprehensively presents the technical results of a design or test phase. It describes all technical analyses and trade-offs performed in support of the design and operational concept. It is not intended that other documents' material be repeated, rather referenced and summarized.

The Design Document shall contain as a minimum:

1. **Introduction**

   This section shall present a system overview, recall the major objectives and guidelines for the project and summarize the main results of the phase.

2. **Architecture, design and interfaces**

   This section shall give a detailed description of the architecture and design of the system and its subsystems, including internal and external interfaces.

3. **Drawings and schematics**

   This section shall include architectural diagrams for the main aspects of the system (software, communication, electronics, power, structure, etc.); it shall describe and reference important design drawings such as functional block diagrams, activity flow diagrams, ICDs.

4. System Analysis and Trade-offs

This section shall present the evaluation of the design approaches, including the accomplishment of trade-off studies supporting design decisions. Trade-off studies shall include criteria definition, criteria results and decisions. System analysis is accomplished through the appropriate use of various operations research methods to assist in problem resolution (simulation, queuing theory, linear and dynamic programming, optimization, mathematical models etc.). The system analysis must include rationales for design decisions.

5. Analyses

This section shall summarize the analyses performed, main results and problems encountered; this is a summary of each full analysis report presented separately.

6. Budgets:

This section shall present a summary of the TPM budgets including discussion of significant decisions regarding allocations, challenges in achieving budgeted values, and important changes in the budgets through the life of the project.

7. Tests

This section shall summarize tests performed and main results and problem areas; this is a summary of each full test report presented separately.

8. Operations

This section shall describe the operational and support environments and the operational modes, and shall summarize the operations of the system in both nominal and contingency conditions.

9. Maintenance approach

This section shall describe the maintenance approach and the proposed spares, especially for maintainable items such as flight software and ground systems.

DID-825 – System Concept of Operations

DID Issue: IR **Date: 2014-02-06**

PURPOSE:

To define the overall end-to-end System Concept of Operations.

PREPARATION INSTRUCTIONS:

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

The System Concept of Operations must contain the following information:

1) Introduction including the scope, the purpose and a list of assumptions (if any);
2) Description of the overall concept of operations that proves the feasibility of command and control, housekeeping and payload data acquisition, downlinking, turnaround time, processing, analysis and distribution and payload calibration;
3) System operations requirements and constraints:
    a) System description,
    b) End-users description and requirements,
    c) System Health and Safety requirements,
    d) Programmatic and operational constraints,
    e) Relationship with other missions / programs,
    f) External dependencies or interfaces with other organisations;
4) Space segment characteristics including spacecraft monitoring and control, and spacecraft modes;
5) Ground segment characteristics including Command & Control and Data Reception for the LEOP, commissioning phase and routine operations phase;
6) System operations concepts:
    a) Planning processes,
    b) Operations execution processes,
    c) Evaluation processes,
    d) Data Reception,
    e) Data Transfer,
    f) Data processing,
    g) Data turnaround time,

   h) Instrument calibration,
   i) Support processes,
   j) Operations team,
   k) Orbit determination and maintenance;

7) Operational Scenarios.