Agence spatiale canadienne | Canadian Space Agency

CSA-GERI-SOW-0001

Canadian Space Agency

ANNEX "A"

GATEWAY EXTERNAL ROBOTICS INTERFACES: EXPLORATION LARGE ARM INTERFACES

STATEMENT OF WORK
PHASE A

REVISION A
April 17, 2019

Livelink #: 37703697

This Page Intentionally Left Blank

REVISION HISTORY

Revision	Description	Issue Date	Initials
I.R.	Initial Release	25-JAN-2019	AI
A	Per CSA CR 1746A	17-APR-2019	AI

TABLE OF CONTENTS

LIST OF TABLES

TABLE PAGE

LIST OF FIGURES

FIGURE PAGE

This Page Intentionally Left Blank

1 INTRODUCTION

Canada, as a partner in the International Space Station (ISS)[1], program has undertaken important discussions with the partnership to determine the next step for human exploration. A common long term goal is the human exploration of Mars, for which a vision of the evolutionary approach to that goal is contained within the Global Exploration Roadmap[2] (GER, see Figure 1-1). One step towards this long term goal is demonstrating and proving technologies beyond the ISS. The partnership is discussing a lunar orbiting space platform, the Deep Space Gateway (DSG), which will extend human presence and further demonstrate and prove technologies and operations at a larger distance from Earth.

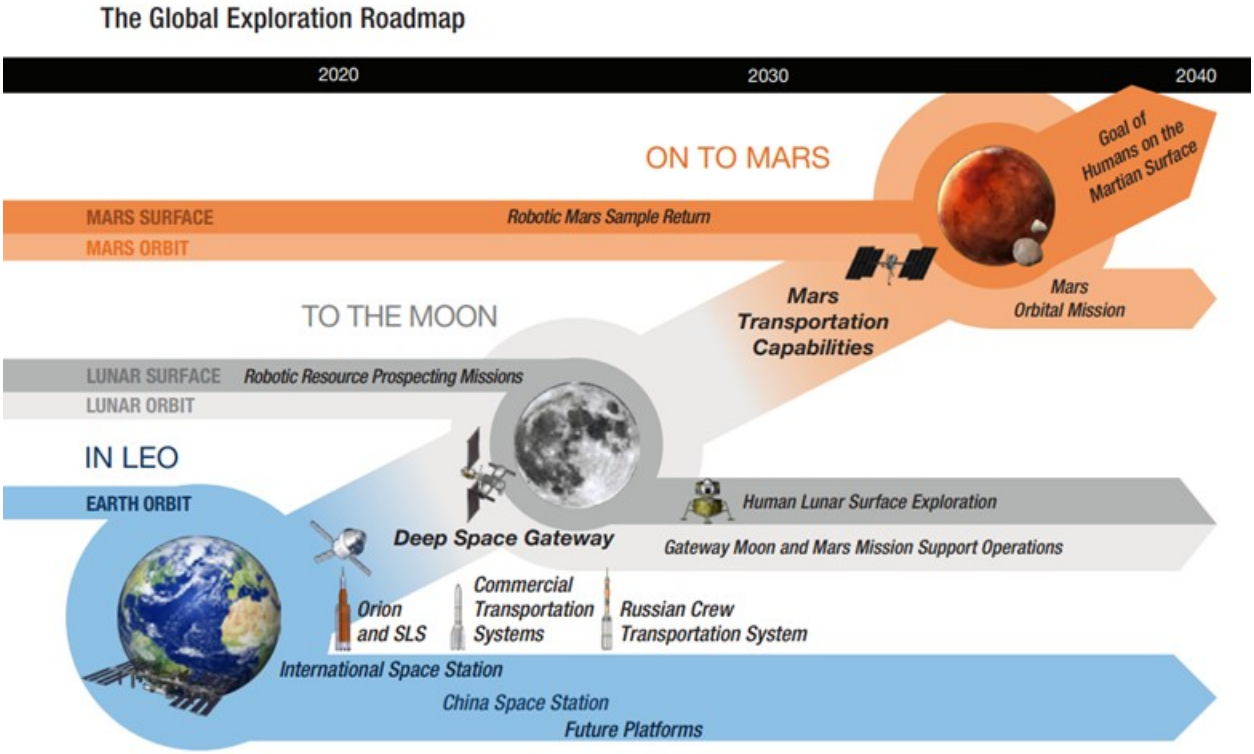

FIGURE 1-1: THE GLOBAL EXPLORATION ROADMAP

[1] Refer to NASA's website for an overview of the ISS
[2] Refer to International Space Exploration Coordination Group's (ISECG) 2018 update to the GER

As with Canadarm2 and Dextre[1], which are major external elements of Canada's Mobile Servicing System (MSS) on the International Space Station, a Deep Space eXploration Robotics system (DSXR, see Figure 1-2) is being proposed to provide similar Extra-Vehicular Robotics (EVR) services to the Gateway including external logistics, maintenance, inspection, assembly and reconfiguration, and support to external science payloads. For the current planning concept, the DSXR system consists of the following (refer also to Figure 1-3):

1. A large robotic manipulator system and tools that will provide functions such as remote inspection, free-flying vehicle capture, payload and Orbital Replaceable Unit (ORU) handling, and external station maintenance.
2. A dexterous robotic manipulator system and tools that will perform detailed external servicing of the DSG and the DSXR.
3. Robotic interfaces, platforms and receptacles that will be needed by the habitat vehicles, ORU providers, payloads, and DSXR itself.

This phase A SOW captures the work required to develop the concept of the robotics interfaces of the DSXR's large robotics manipulator system and its end effector. The phase will be completed with a review of detailed system and interface requirements for those items.

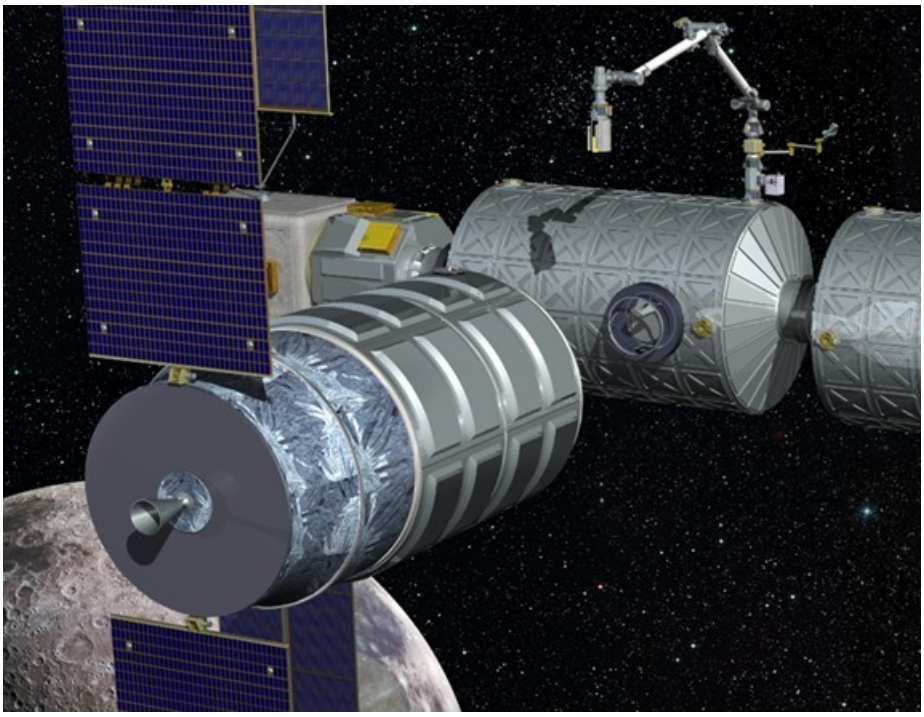

FIGURE 1-2: CONCEPT OF DSXR ON DEEP SPACE GATEWAY

[1] Refer to the Canadian Space Agency's website for information on Canada's involvement in supporting the ISS

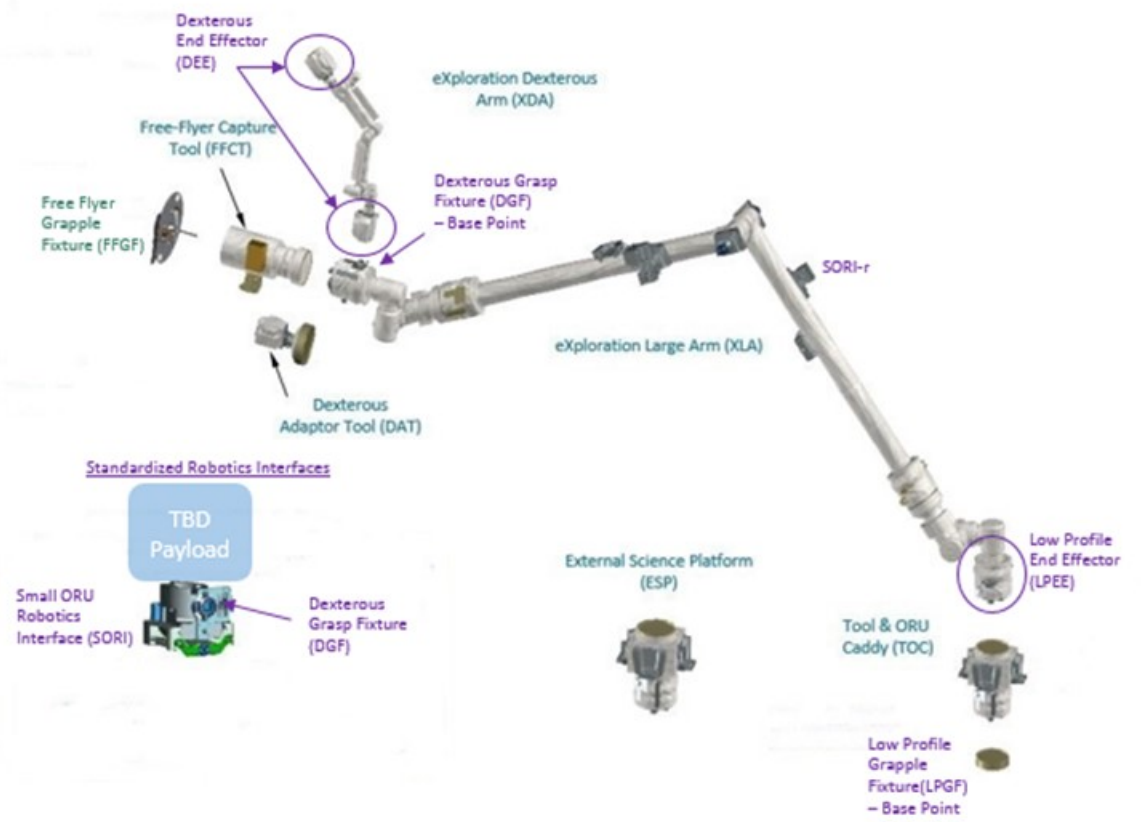

FIGURE 1-3: PRELIMINARY CONCEPT OF DSXR ELEMENTS WITH INTERFACES

1.1 SUMMARY

In support of the Deep Space Gateway (DSG)[1] program currently under development, the Canadian space Agency (CSA) is engaging with its International Partners (IPs), including the National Aeronautics and Space Administration (NASA), to provide Extra-Vehicular Robotics (EVR) services to the lunar orbiting platform. While the entire DSXR segment on the DSG is not planned for the first few Gateway Missions (GM, see AD-10 for the notional order of Gateway missions), the connection points to the DSG are required for integration to DSG modules and elements starting with the first mission (GM-1). To support the advanced schedule of that aspect of the overall DSXR system, CSA has defined the Gateway External Robotics Interfaces (GERI) project to define, build, deliver and integrate the standardized connection points to the DSG that the DSXR will be based off of and operate from.

The GERI group of interfaces are to provide the critical components that interface with the eXploration Large Arm (XLA) and the eXploration Dexterous Arm (XDA) that are the major robotic manipulator elements of the broader DSXR concept. This document addresses the XLA interfaces.

The XLA interfaces for the external manipulator include both active and passive sides and consist of an active End Effector (EE) along with its mechanically and electrically passive Grapple/Grasp Fixture (GF).

While the entire DSXR group of manipulator systems and their tools has been undergoing iterative conceptual development, under the GERI project only the LPGF is planned to be developed to full flight certified maturity, then built, tested, and integrated to the DSG (see Figure 1-4 for an overview of the project final deliverables related to the XLA interfaces). In support of this goal, the concepts for the XLA and its EEs need further maturation. For the purposes of this SOW, the concepts for both the active and passive aspects of the XLA interfaces will be developed and validated to the same level of maturity, in order to provide the necessary products for other DSG stakeholders to proceed with the designs of their modules and elements that will incorporate the GERI.

[1] Refer to NASA's proposed Lunar Gateway program for an overview

1.2 SCOPE

This Statement of Work (SOW) defines activities for Phase A, including feasibility assessments, the development of interface and system requirements, and the maturation of the required interface designs necessary to provide the DSG module and element developers with design information to support the integration of the XLA and its interfaces.

These activities will also include a review of CSA's Gateway External Robotics Concept Definition Document (CDD, see AD-01) to confirm the approach, feedback, and maturation of the GERI Mission Requirements Document (MRD, see AD-04). These documents form the CSA provided parentage for the system and interface requirements of the robotics interfaces:

The XLA interfaces include both the active and passive sides for the external manipulator:

- Active interface: the **Low Profile End Effector (LPEE)**;
- Passive interface: the **Low Profile Grapple Fixture (LPGF)**.

Key results expected from Phase A are to finalize the GERI concepts initially presented in the contractor's proposal and updated at the Concept Design Review (ConDR). Following a successful Systems Requirements Review (SRR), these concepts will be validated and implemented into documentation to formalize the GERI XLA interfaces at the Interface Design Review (IDR). The interface requirements and control drawings delivered at IDR, once approved by CSA, will be used to generate multi-lateral IRDs that will be used by DSG IPs for the design of their modules and payloads.

These activities will also include an assessment of the Gateway Extra Vehicular Robotics Product Assurance Requirements (PAR, see AD-03) and their applicability to GERI.

This information will be used to plan, in detail, the follow on project development associated with these interfaces.

Additionally it is expected that the plan for the overall project will be provided, which will include a detailed schedule, costs, and risks associated with subsequent phases. The costing provided will have sufficient granularity to allow cost estimation of the GERI project across the life cycle (i.e. Phase B to D) of the project to enable CSA to plan for the follow-on phases leading to the delivery of ten (10) LPGFs in 2023.

1.2.1 GERI End Item Deliverables

While all GERI interface (I/F) components need to be designed, the actual end item deliverables to the DSG for the GERI group consist only of the electrically passive components, specifically the LPGF.

Figure 1-4 provides an overview of the GERI XLA interface end item deliverables and their interaction with the supporting XLA active interface (i.e. the LPEE) and with the DSG/payload structure relevant to the GERI project. While the DSXR end effectors (LPEE and DEE) designs and prototyping are required to define and build the passive GERI components, the actual flight model builds of the DSXR end effectors are not in scope for the GERI project.

Figure 1-4 includes a functional block inside the LPEE labelled “FMS” attached to the “Grapple Mechanisms” block. This block represents a notional Force Moment Sensor integrated into the LPEE to support active compliance of the XLA manipulator during grappling and potentially module berthing operations.

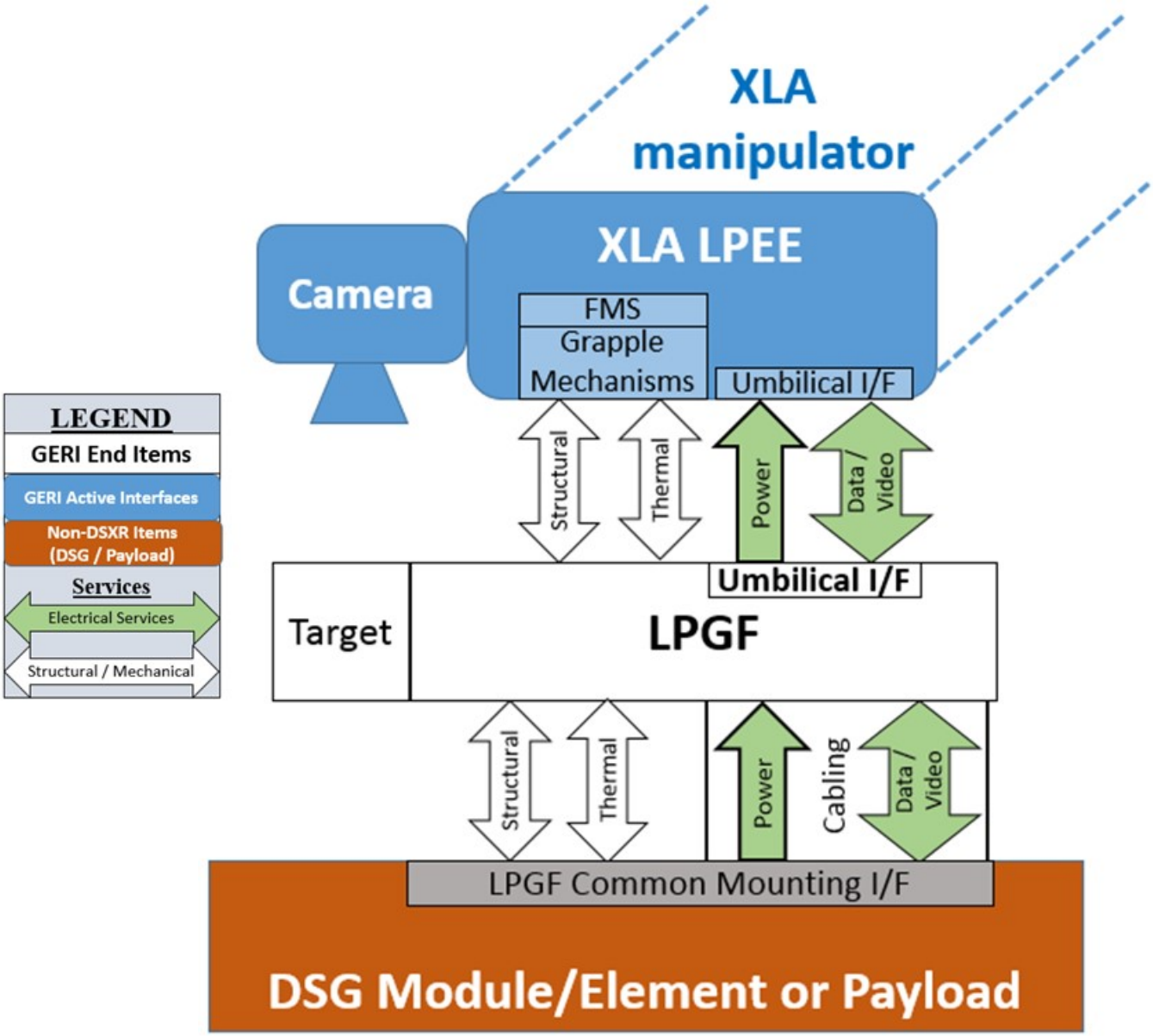

FIGURE 1-4: GERI LPGF END ITEM FUNCTIONAL DIAGRAM

1.3 OBJECTIVE

The primary objectives of Phase A are to define systems and interface requirements, including the flow down of mission level requirements to the system level, validate the concept definition and design, and identify critical technologies and associated risks. The addition of an IDR adds the objectives to mature the interface requirements and to prepare development plans for follow on phases of the XLA interfaces. At the end of Phase A, CSA should have all the necessary technical products needed by the DSG partners to advance their element and module designs. In support of future project phases, CSA should also have all technical and programmatic information necessary to make an informed decision about the XLA interfaces for subsequent programmatic steps.

1.4 DOCUMENT CONVENTIONS

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

1. “Must” indicates a mandatory requirement;
2. “Should” indicates a goal or preferred alternative. Such goals or alternatives must be treated as requirements on a best efforts basis, and verified as for other requirements.
3. “May” indicates an option;
4. “Will” indicates a statement of intention or fact, as does the use of present indicative active verbs.

1.4.1 Language and Units

As English is the standard oral and written language used by the DSG partnership for design, development, operation, and utilization, the Contractor must use English for this Work, along with System International (SI) units in all communications, deliverables, and all other exchanges with CSA and the DSG IPs.

1.5 ROLES AND RESPONSIBILITIES

Table 1-1 provides the Roles and Responsibilities for CSA and the Contractor in the execution of the work described in this document. The Contractor will be responsible for the overall execution of the work described in this SOW while CSA’s role is to ensure technical and programmatic integration with the DSG and the DSXR, including managing needed changes.

The role of the CSA is to verify that the work is done correctly and accept the work and the deliverables. CSA will also act as programmatic integrator with the DSG IPs and manage the integration of requirements between the contractor for the GERI XLA interfaces and the DGS IPs.

TABLE 1-1: GERI ROLES AND RESPONSIBILITIES

Organization/Position	Role	Responsibility
CSA Project Manager (PM)	• GERI contract management; • Programmatic liaison with the CSA Program Management; • Programmatic liaison with NASA and other DSG IPs.	• Management of the GERI project. • Ensuring deliverables meet CSA's mission and programmatic needs for GERI within cost and schedule.
CSA Technical Manager (TM)	• GERI mission requirements management; • Provide technical oversight on the GERI technical related deliverables; • Technical liaison with NASA and other DSG IPs; • Technical liaison with the CSA DSXR project.	• Management of the technical work for the GERI project. • Ensuring deliverables meet mission and technical needs for GERI.
CSA Safety and Mission Assurance (S&MA)	• Product assurance requirements development and management; • Provide S&MA oversight on the GERI related S&MA deliverables and guidance related to GERI S&MA. • Liaison with NASA and other DSG IPs on safety related matters.	• Management of the product assurance requirements for the GERI project; • Ensuring deliverables meet safety and quality needs of the GERI project.
Public Services and Procurement Canada (PSPC)	• Contracting authority for the GERI project.	• Management of the GERIs contract
GERI XLA I/F Contractor (referred herein as 'Contractor')	• Designer of the GERI XLA interfaces.	• Under contract to CSA to develop GERI XLA system concept, requirements and interface design. • Execution of the work described in this SOW.

1.5.1 Normal Working Hours

Key contractual personnel must be available during normal CSA operating hours of 09:00 to 17:00, offset by five (5) hours behind Coordinated Universal Time (UTC-5). These Key personnel are to include project and technical managers.

1.6 GOVERNMENT FURNISHED INFORMATION

Table 1-2 identifies the documents relevant to the execution of the work described in this document that require a Non-Disclosure Agreement (NDA) with the Government of Canada through PSPC.

TABLE 1-2: DOCUMENTS REQUIRING NDA

GFI Number	Document Number	Title	Internal Reference
1	MDA-MIPS-OCD-13956	MIPS Operations Concept Document	RD-06
2	MDA-MIPS-PLN-14036	MIPS Verification and Test Plan	RD-07
3	MDA-MIPS-R-14091	MIPS Operations and Sensing Assessment	RD-08
4	MIPS-PR-016-MDA	MIPS Technology Readiness and Risk Assessment	RD-09
5	MIPS-TN-012-MDA	MIPS Final Technical Report (Phase 1 & 2)	RD-10
6	MDA 4001005	DSXR Preliminary Interface Control Document	RD-03
7	MDA 4001007	DSXR Preliminary System Requirements Document	RD-04
8	MDA-DSXR-SG-14344	DSXR Mission Requirements Document	RD-05
9	DSG-ADD-001	Gateway Architecture Design Document	AD-10
10	DSG-CONOP-001	Gateway Concept of Operations	AD-11
11	DSG-RQMT-001	Deep Space Gateway System Requirements	AD-12
12	SSP 41167	MSS Segment Specification for the ISS Program	RD-28
13	SSP 42004 Part 1	MSS to User Interface Control Document (Generic)	RD-29
14	SSP 42003 Part 1	United States On-orbit Segment (USOS) to MSS Interface Control Document	RD-30
15	SSP 57003	External Payload Interface Requirements Document	RD-31

GFI Number	Document Number	Title	Internal Reference
16	DSG-RPT-001	System Safety Analysis Report for the Gateway	RD-17
17	DSG-RQMT-010	Gateway Program Safety and Mission Assurance Requirements	RD-32
18	DSG-RQMT-011	Gateway Hazard Analysis (HA) Requirements	AD-13
19	DSG-RQMT-012	Gateway Program Failure Modes and Effects Analysis/Critical Items List (FMEA/CIL) Requirements	RD-33
20	DSG-RQMT-013	Gateway Non-conformance Processing and Corrective Action Requirements	RD-34
21	ESD 30000	Space Launch System (SLS) Mission Planner's Guide	RD-01
22	DSG-ADD-005	Gateway Integrated Performance Assessment	RD-11
23	DSG-CONOPS-XXX	Utilization Concept of Operations (ConOps)	RD-12
24	DSG-IRD-EVA-008	Gateway Program EVA Compatibility Interface Requirements Document (IRD)	RD-13
25	DSG-PLAN-007	Gateway System Engineering Management Plan (SEMP)	RD-14
26	DSG-PLAN-009	Gateway Verification and Validation Plan	RD-15
27	DSG-PLAN-014	Gateway Interface Management Plan	RD-16
28	DSG-RPT-002	Summary of Gateway Preliminary Probabilistic Risk Assessment (PRA)	RD-18
29	DSG-RQMT-002	Gateway Human-System Requirements	RD-19
30	DSG-RQMT-002, Vol. 2	Gateway Human-Systems Interface Requirements for Subsystems Specs	RD-20
31	DSG-RQMT-004	Gateway Electromagnetic Environmental Effects (E3) Requirements	RD-21
32	DSG-SPEC-AV-004	Gateway Program Subsystem Specification for Avionics	RD-22

GFI Number	Document Number	Title	Internal Reference
33	DSG-SPEC-IMG-016	Gateway Program Subsystem Specification for Imagery	RD-23
34	DSG-SPEC-PWR-011	Gateway Program Subsystem Specification for Power	RD-24
35	DSG-SPEC TCS-0015	Gateway Program Subsystem Specification for Thermal Control Systems	RD-25
36	DSG-SPEC-FSW-014	Gateway Program Subsystem Specification for Flight Software	RD-26
37	SLS-SPEC-159	Cross Program Design Specification for Natural Environments	RD-27
38	HEOMD-003-08	International Software System Interoperability Standards (ISwSIS)	RD-35

2 DOCUMENTS

2.1 APPLICABLE DOCUMENTS

This section lists the documents that are required for the bidder to develop the proposal. The following documents are applicable and form an integral part of this document to the extent specified herein. The majority of the applicable documentation can be obtained from the following File Transfer Protocol (FTP) site:

ftp://ftp.asc-csa.gc.ca/users/geri/pub/

The Technology Readiness and Risk Assessment (TRRA) related items (AD-05, AD-06 and AD-07) can be obtained from the following FTP site:

ftp://ftp.asc-csa.gc.ca/users/TRP/pub/TRRA/

TABLE 2-1: APPLICABLE DOCUMENTS

AD #	Document Number	Title	Revision
AD-01	CSA-GWY-CD-0001	Gateway External Robotics Concept Design Document	I.R.
AD-02	CSA-GWY-CO-0001	Gateway Extra Vehicular Robotics Concept of Operations	I.R.
AD-03	CSA-GWY-RD-0002	Gateway Extra Vehicular Robotics Product Assurance Requirements	I.R.
AD-04	CSA-GERI-RD-0001	GERI Mission Requirements Document	B
AD-05	CSA-ST-GDL-0001	Technology Readiness and Risk Assessment Guidelines	D
AD-06	CSA-ST-FORM-0003	Critical Technologies Elements Identification Criteria Workbook	B
AD-07	CSA-ST-RPT-0003	Technology Roadmap Worksheet	A
AD-08	CSA-SE-STD-0001	CSA Technical Reviews Standard	A
AD-09	CSA-SE-PR-0001	Systems Engineering Methods and Practices	B
AD-10*	DSG-ADD-001	Gateway Architecture Design Document	DRAFT dated 06-SEP-2018
AD-11*	DSG-CONOP-001	Gateway Concept of Operations	DRAFT dated 31-AUG-2018
AD-12*	DSG-RQMT-001	Deep Space Gateway System Requirements	DRAFT dated 04-APR-2019
AD-13*	DSG-RQMT-011	Gateway Hazard Analysis (HA) Requirements	I.R.

AD #	Document Number	Title	Revision
AD-14	HEOMD-003-07	International External Robotic Interface Interoperability Standard (IERIIS)	Baseline
AD-15	Guidelines on Costing (Treasury Board)	English	

* Only available after signing Non-Disclosure Agreement (NDA)

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, but are not required to develop the proposal.

TABLE 2-2: REFERENCE DOCUMENTS

RD #	Document Number	Title	Revision
RD-01*	ESD 30000	Space Launch System (SLS) Mission Planner's Guide	A
RD-02	PMBOK Guide	Project Management Body of Knowledge	Latest
RD-03*	MDA 4001005	DSXR Preliminary Interface Control Document	I.R.
RD-04*	MDA 4001007	DSXR Preliminary System Requirements Document	I.R.
RD-05*	MDA-DSXR-SG-14344	DSXR Mission Requirements Document	C
RD-06*	MDA-MIPS-OCD-13956	MIPS Operations Concept Document	C
RD-07*	MDA-MIPS-PLN-14036	MIPS Verification and Test Plan	B
RD-08*	MDA-MIPS-R-14091	MIPS Operations and Sensing Assessment	A
RD-09*	MIPS-PR-016-MDA	MIPS Technology Readiness and Risk Assessment	A
RD-10*	MIPS-TN-012-MDA	MIPS Final Technical Report (Phase 1 & 2)	A
RD-11*	DSG-ADD-005	Gateway Integrated Performance Assessment	DRAFT dated 31-AUG-2018
RD-12*	DSG-CONOPS-XXX	Utilization Concept of Operations (ConOps)	DRAFT dated 27-NOV-0218
RD-13*	DSG-IRD-EVA-008	Gateway Program EVA Compatibility Interface Requirements Document (IRD)	DRAFT dated 28-MAR-2019
RD-14*	DSG-PLAN-007	Gateway System Engineering Management Plan (SEMP)	DRAFT dated 04-SEP-2018
RD-15*	DSG-PLAN-009	Gateway Verification and Validation Plan	DRAFT dated 31-AUG-2018

RD #	Document Number	Title	Revision
RD-16*	DSG-PLAN-014	Gateway Interface Management Plan	DRAFT dated 07-SEP-2018
RD-17*	DSG-RPT-001	System Safety Analysis Report for the Gateway	BASIC dated 26-JUL-2018
RD-18	DSG-RPT-002	Summary of Gateway Preliminary Probabilistic Risk Assessment (PRA)	Baseline
RD-19*	DSG-RQMT-002	Gateway Human-System Requirements	DRAFT dated 12-APR-2019
RD-20*	DSG-RQMT-002, Vol. 2	Gateway Human-Systems Interface Requirements for Subsystems Specs	I.R.
RD-21*	DSG-RQMT-004	Gateway Electromagnetic Environmental Effects (E3) Requirements	DRAFT
RD-22*	DSG-SPEC-AV-004	Gateway Program Subsystem Specification for Avionics	DRAFT
RD-23*	DSG-SPEC-IMG-016	Gateway Program Subsystem Specification for Imagery	DRAFT
RD-24*	DSG-SPEC-PWR-011	Gateway Program Subsystem Specification for Power	DRAFT
RD-25*	DSG-SPEC TCS-0015	Gateway Program Subsystem Specification for Thermal Control Systems	DRAFT dated 28-MAR-2019
RD-26*	DSG-SPEC-FSW-014	Gateway Program Subsystem Specification for Flight Software	DRAFT
RD-27*	SLS-SPEC-159	Cross Program Design Specification for Natural Environments	E
RD-28*	SSP 41167	MSS Segment Specification for the ISS Program	J
RD-29*	SSP 42004 Part 1	MSS to User Interface Control Document (Generic)	L
RD-30*	SSP 42003 Part 1	United States On-orbit Segment (USOS) to MSS Interface Control Document	J
RD-31*	SSP 57003	External Payload Interface Requirements Document	L
RD-32*	DSG-RQMT-010	Gateway Program Safety and Mission Assurance Requirements	DRAFT Rev A dated FEB-2019
RD-33*	DSG-RQMT-012	Gateway Program Failure Modes and Effects Analysis/Critical Items List (FMEA/CIL) Requirements	Baseline
RD-34*	DSG-RQMT-013	Gateway Non-conformance Processing and Corrective Action Requirements	DRAFT dated 20-SEP-2018
RD-35*	HEOMD-003-08	International Software System Interoperability Standards (ISwSIS)	DRAFT dated FEB-2018

* Only available after signing Non-Disclosure Agreement (NDA)

3 WORK REQUIREMENTS

The Contractor must provide the management, technical leadership, technical subject matter experts in all applicable disciplines, and the support necessary to ensure effective and efficient performance of all project efforts and activities.

The Work requirements that must be accomplished by the Contractor are detailed in this section and subsequent sections. The Deliverables and Contract Data Requirements List (CDRL) as well as their Data Item Description (DID) can be found in the Appendices B and C.

4 PROJECT MANAGEMENT

The work defined in this Section must be performed throughout the project. The Contractor must manage the project to effectively achieve project performance, scope, quality, cost and schedule requirements detailed throughout 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 dedicate experienced personnel to the project in all the disciplines required to carry out the work.

The Contractor personnel must establish and maintain a close management and technical interface with the CSA Technical Manager (TM) and/or the CSA Project Manager (PM) to assure a coordinated program effort and monitoring of the project cost, schedule, technical performance and risks to meet the project objectives.

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

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

4.1 PROJECT MANAGEMENT CONTROL

The Contractor must provide and implement the Project Management Plan (PMP, CDRL PM1).

The PMP is used to guide both project execution and project control. The PMP is used by the Government to assess the adequacy of the Contractor's plan for management of the work and to provide a basis on which to monitor and assess the progress of the work.

The Contractor must establish and maintain a project management control system to effectively integrate the approved scope of work with the schedule, budget, quality and potential risk issues in order to allow proactive problem identification and resolution in concert with the CSA.

The Contractor must maintain all project status data, and provide visibility and assurance to the CSA TM and CSA PM that the project is on schedule and that it is meeting contract and performance requirements.

The Contractor's project management control system must provide for cost effective and timely re-planning of activities in progress to support workarounds. The project schedule must be maintained in order to produce valid and viable critical path analysis, provide critical summary data, and serve as a useful tool for controlling and reporting the status of the work. The schedule must show the baseline, the current plan and the progress of each activity.

The management control system must track, control and report project schedule and deviation to the schedule, as well as technical performance and risk issue through the Monthly Progress Report as per CDRL PM9.

The management control system must track and control total project costs on a monthly basis. The estimate at completion must be evaluated on a monthly basis.

4.2 PROJECT TEAM ORGANIZATION

The Contractor must set up and maintain a project organization as described in the proposal. The Contractor must provide and maintain a current Project Organizational Chart, showing personnel assignments by name and function and showing subcontractor reporting relationships.

The Contractor must nominate a Project Manager, who will be responsible for all aspects of the work carried out by the Contractor. The Project Manager must possess all the qualifications and experience needed to lead the Contractor's work throughout the duration of the contract. The Contractor's Project Manager must have full access to the Contractor's senior management for timely resolution of all issues affecting the project.

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

The Contractor must maintain and update on a monthly basis the project team organization submitted in its proposal. The Contractor must provide in the Monthly Progress Report (CDRL PM9) any variation in personnel assignments identified in the proposal by name and function.

4.3 CONTRACTOR WORK BREAKDOWN STRUCTURE AND WBS DICTIONARY

The work must be planned, controlled and directed using a Work Breakdown Structure (WBS) that organises and defines the total work scope of the project. The Contractor must update and maintain, the Contract Work Breakdown Structure (CWBS, CDRL PM3) provided with the proposal. The CWBS must be based on the GERI project WBS shown in Figure 4-1, without any grouping of the CSA WBS elements. The Contractor may add elements, as required.

The Contractor must establish and maintain a CWBS Dictionary defining the work to be done against each WBS element identified in the CWBS, by means of a Work Package Description (WPD) for each such element. Updates of the CWBS Dictionary must be provided along with the CWBS updates.

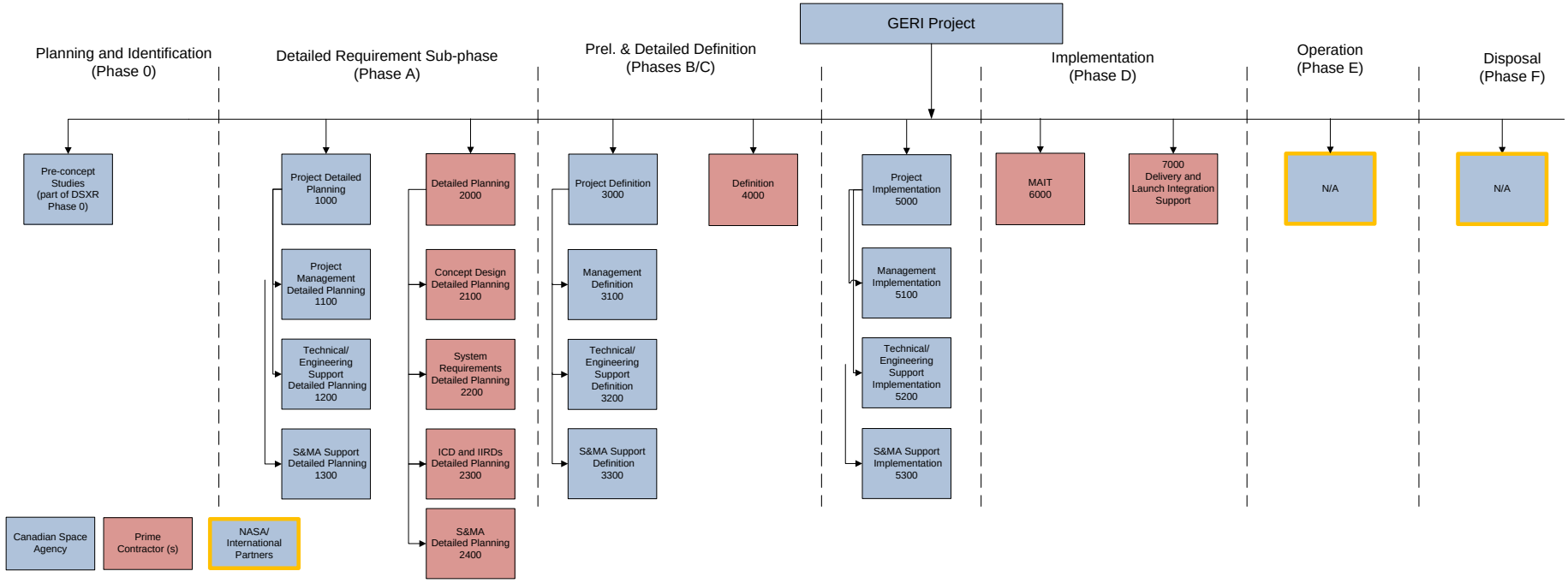

FIGURE 4-1: WBS OF THE ENTIRE GERI PROJECT

4.4 DETAILED SCHEDULE AND CRITICAL PATH

The Contractor must prepare and maintain a detailed schedule (CDRL PM5) based on the CWBS for all the work to be performed under the Phase A contract. The schedule must include all the milestones listed in Table 4-1. The schedule must include the duration, % complete, show dependencies between the activities to identify the critical path,

The Contractor must maintain and deliver the Project Schedule each month to reflect Phase A activity progress and must be updated during progress reviews, and at each formal milestones (i.e. formal technical reviews).

4.5 RISK MANAGEMENT

The Contractor must establish and implement a risk management system for the early identification and assessment of risks that may impact cost, schedule, programmatic and technical performance, and the development of appropriate risk response plans. The risk management process must consist of risk management planning, risk identification and assessment, risk response planning and risk tracking, monitoring and control. The risk management system must be described in the PMP (CDRL PM1); see item 9) in the associated DID.

The Contractor must continuously identify and monitor areas of cost, schedule, programmatic and technical risk and must identify and implement risk reduction and resolution activities. The Contractor must assess and report the status of each risk element in the Monthly Progress Report (CDRL PM9), during progress reviews, and each formal milestones (i.e. formal technical reviews).

4.6 COMMUNICATIONS AND ACCESS

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

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

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

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

All documentation and data generated by the Contractor for the project must be accessible to the CSA TM and/or the CSA PM for review.

4.7 PROJECT MEETINGS AND REVIEWS

The Contractor must hold the meetings described in Table 4-1. Some or all of these meetings may be attended by representatives of the CSA, and/or other organizations nominated by the CSA.

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

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

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

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.

All technical reviews will be chaired by the CSA TM and/or CSA PM.

The Contractor must provide agendas (CDRL PM10) and minutes of the meetings and Formal Technical Reviews. Minutes will primarily report decisions and the summary of discussions, and action items. Minutes must be produced and delivered to the CSA not later than 5 days after a milestone meeting; in the case of teleconferences they must be delivered the next business day.

In order to pass the reviews included in Table 4-1 all criteria related to the review included in the CSA reviews standard (AD-08) must be demonstrated and that all Review Item Discrepancies (RIDs) and action items raised during the review must be dispositioned to CSA’s satisfaction or forward plan agreed by CSA.

4.8 PHASE A MILESTONE REVIEW MEETINGS

This section summarizes the schedule for the Phase A activities. For the sake of planning purposes, the date of Contract Award (CA) can be assumed to be August 1, 2019. The contractor must adhere to the Milestone dates which are a maximum limit. This phase must be completed within a 12-month period.

Each Review requires a Review Data Package be delivered to CSA as per CDRL PM18.

TABLE 4-1: PLANNED REVIEW MEETINGS

ID	Meeting and Reviews	Month After Contract Award	Venue
R1	Kick-Off Meeting (KoM)	≤ 1 month	CSA
R2	Concept Design Review (ConDR)	≤ 5 month	CSA
R3	Phase 0 Safety Review Meeting (SRM)	≤ 8 month	Contractor
R4	Systems Requirements Review (SRR)	≤ 8 month	Contractor
R5	Interface Design Review (IDR)	≤ 12 month	Contractor
	Monthly Meetings	As required	Telecom
	Provision to support two (2) international meetings	TBD	TBD, could be USA or Europe

4.8.1 Kick Off Meeting (KOM)

The Contractor must support a KOM at CSA in the first month after Contract award. The Work must start at contract award. The purpose of the KOM is to introduce the Contractor and CSA teams, review the scope of work, the schedule, the basis of payment, update the concept provided with the proposal, and discuss any other topics as required. All key participants under the contract, including representatives from each major subcontractor, must attend. Attendance of some team members by teleconference is acceptable if agreed with the CSA prior to the meeting.

The Contractor must produce a presentation and other necessary material in support of the KOM (CDRL PM13). Also, all other CDRLs relevant to the KOM as per Table B-2 need to be delivered, accepted and/or reviewed.

4.8.2 Conceptual Design Review (ConDR)

The Contractor must prepare and conduct a Concept Design Review (ConDR) meeting. The purpose of the ConDR is to describe the system conceptual design proposed to meet the mission requirements. The format of the meeting will be to review the preliminary System Conceptual Design (see Section 5.6).

The concept design, analyses and related information must be summarized in a Review Presentation (CDRL PM14) and must include at a minimum the CDRLs as per the due date and version in the CDRL table (Table B-2) to meet the entry criteria of the ConDR. To pass this review, the contractor must demonstrate that mission requirements have been flowed down to the concept under design and that the project is ready to proceed with the design of the system level requirements and the baselining of the concept.

The objectives of the ConDR are summarized as follows:

1) The GERI System Conceptual Design document (SCD, CDRL SE2, see section 5.6) is tailored to meet the mission requirements and is feasible within appropriate margins (mass, power, load, etc.). Consideration must be given to the eventual manufacturing of the design;
2) The CSA provided Gateway Extra Vehicular Robotics Concept of Operations (AD-02) and the contractor provided concept design are clearly compatible, by demonstrating that there are no discrepancies between them;
3) The CSA provided Gateway Extra Vehicular Robotics Product Assurance Requirements (AD-03) and the contractor provided concept design are clearly compatible, by demonstrating that there are no discrepancies between them;
4) External and internal interfaces have been identified and have been characterized to a preliminary level;
5) The Interface Requirements Document (IRD, CDRL SE11) has been produced and contains preliminary requirements for both internal and external interfaces;
6) The Technical Performance Measures have been produced and a report released that is coherent with the system conceptual design document;
7) The technical, cost, schedule and programmatic risks have been identified with preliminary analysis performed, and viable mitigation plans have been produced;
8) The execution of the contract can be reasonably expected to result in the successful completion within imposed constraints, financial, schedule and human resources.

4.8.2.1 Entry Criteria for the ConDR

1) The Review Plan and agenda have been agreed by the CSA and distributed to all attendees.
2) Action Items from KoM are completed or closure plan has been approved.
3) All the work required for this review has been completed, except for the Review itself.
4) All documents and analyses identified as required for ConDR have been placed under Configuration Control, have been delivered within the period stipulated per the relevant CDRL in Table B-2, and in accordance with the respective DID.
5) The presentation package addresses all the review objectives.
6) Any regulations that might affect the preparation and execution of the ConDR, such as the International Traffic in Arms Regulations (ITAR) and Controlled Goods Registration Program (CGRP) have been identified and complied to such that the review can be held.

4.8.2.2 Exit Criteria for the ConDR

1) All objectives of the review have been achieved.
2) All RIDs have a disposition agreed with CSA and its project partners.
3) Actions (if any) have clear description, actionees, and due dates;
4) All GERI mission requirements have been properly accounted for in the concept design;
    a. Any recommended updates to the GERI Mission Requirements have been addressed and the system concept adjusted to align with updated mission requirements;
5) Trade-off analyses demonstrate that the system conceptual design is the optimum choice for the mission;
6) Design analyses show that the system conceptual design has been tailored to meet mission requirements in a cost effective manner;
7) Modeling and analysis results show that the system conceptual design is feasible within appropriate margins (mass, power, data rate, etc.);
8) The estimated design margins for critical resources (mass, power, data rate, etc.) are realistic and are they sufficient to accommodate variations due technological maturity;
9) The margins used for the design are based on the appropriate standard;
10) The CSA provided Gateway Extra Vehicular Robotics Concept of Operations (AD-02) and the contractor provided systems concept design are compatible, including command and control, data throughput, loading scenarios, and other analysis required to meet the mission requirements;
11) Launch and orbital scenarios been conceptually defined;
12) Interface requirements with external systems produced and provide coverage for expected functionality and performance;
13) Are all internal interface requirements identified and assessed;

14) All the interface requirements are distributed and common to all parties to ensure compatibility between subsystems and the various external interfaces;

15) CSA's Gateway Extra Vehicular Robotics Product Assurance Requirements (AD-03) have been assessed to be compatible with type and cost of the project or otherwise updates have been proposed and accepted;

16) An approach has been defined to control the technical activities during the contract.

4.8.3 Conceptual Phase (Phase 0) Safety Review Meeting (SRM)

The Contractor must prepare and conduct a Safety Review Meeting to support the Gateway Safety and Engineering Review Panel (SERP) process defined in DSG-RQMT-011 – Gateway Program Hazard Analysis Requirements (AD-13). The Safety Phases are defined as Phase 0, I, II and III. The Safety Review Meeting (SRM) can be held at the same time as the System Requirements Review (SRR). DSG-RQMT-011, Section 4.1.1 – Concept Development outlines the requirements for the preliminary System Safety Analysis Report and Appendix C. Section C-1 – Preliminary Hazard Analysis outlines the requirements for analysis and resulting Preliminary Hazard Listing (PHL).

DSG-RQMT-011, Appendix G outlines the Safety Review and Data Submittal Requirements and process that will be followed on Gateway. Section G2.2.1 references a typical Safety Review Meeting and data items expected to be presented during the review. When combined with the SRR, some of these items may be in the SRR presentation or Phase 0 Safety Review Meeting (CDRL PM15), and the safety portion of the review will focus on the PHL.

4.8.4 System Requirements Review (SRR)

The Contractor must prepare and conduct an System Requirements Review (SRR) meeting. The purpose of the SRR is to demonstrate the validity of the system requirements (CDRL SE8, see section 5.7) and the project readiness to proceed to the interface design leading to the Interface Design Review (IDR).

The SRR must meet the objectives, entry and exit criteria detailed in the CSA's Technical Reviews Standard (CSA-SE-STD-0001, see AD-08). This information must be summarized in a Review Presentation (CDRL PM16) and must include as a minimum the CDRLs as per the due date and version in the CDRL (Table B-2) to meet the criteria of the SRR.

The objectives of the SRR are summarized as follows:

1) The mission requirements have been logically and fully flowed down to the system requirements. Each system requirement traces to a parent mission requirement and any orphan requirements (those without a trace to a mission requirement) clearly identified.

2) The system, human factors, environmental, design, operational, and interface requirements have been defined, and are verifiable. Each requirement identifies it's criticality (see AD-09, Section 5.3.3.4)

3) The system conceptual design is tailored to meet the system requirements and is feasible within appropriate margins (mass, power, load, etc.). Consideration must be given to the eventual manufacturing of the design.

4) The CSA provided Gateway Extra Vehicular Robotics Concept of Operations (AD-02) and the contractor provided system requirements and concept are clearly compatible, by demonstrating that there are no discrepancies between them.
5) External interface requirements have been defined.
6) Internal interface requirements have been characterized.
7) All requirements and performance parameters are identified and supported by analysis; all constraints and limitations are identified and quantified
8) The preliminary verification approaches, test planning and model philosophy are defined.
9) The technical, cost, schedule and programmatic risks have been analyzed, quantified and viable mitigation plans have been identified;
10) Substantiated and validated life-cycle costs and project schedule have been established for the whole project;
11) The execution of the Project can be reasonably expected to result in the successful completion of the project within imposed constraints, financial, schedule and human resources.

4.8.5 Interface Design Review (IDR)

The Contractor must prepare and conduct an Interface Design Review (IDR) meeting. The purpose of the IDR is demonstrate the external interface definitions and related drawings of the XLA interfaces comply with CSA and DSG User needs, expanding on the maturity of the deliverables from the SRR and to demonstrate the validity of the external and key internal interfaces. As a minimum the external and key internal interfaces consist of all mating parts of both sides of the interface, including but not limited to alignment, mechanical, electrical, and data interfaces consistent with all aspects of the intended environment.

This information must be summarized in a Review Presentation (CDRL PM17) and must include as a minimum the CDRLs as per the due date and version in the CDRL (Table B-2) to meet the criteria of the IDR.

The objectives of the IDR are summarized as follows:

1) The XLA Interfaces SCD (CDRL SE2, see section 5.6) has been logically and fully flowed down to the Interface Design Document (IDD, CDRL SE10, see section 5.7.2) and the IDD is compliant to the Interface Requirement Document (IRD, CDRL SE11, see section 5.6.2);
2) The system requirements have been logically and fully flowed down to the IRD and the Interface Control Drawings (ICD, CDRL SE26);
3) The ICDs define physical and functional interfaces and address all aspects of the IRD and the IDD;
4) The external ICDs are complete and available for distribution to the DSG partners;
5) The defined interfaces are supported by analysis, are appropriate, manufacturable and verifiable;

6) All relevant TPMs have been met, if exceptions are identified these are documented along with the required work to address the exceptions;
7) The interfaces are compatible with the IERIIS (AD-14);
8) The technical, cost, schedule and programmatic risks have been analyzed, quantified and viable mitigation plans have been identified;
9) Substantiated and validated life-cycle costs and project schedule have been established for the whole project;
10) All previous documentation has been updated as relevant based on the IRD, the IDD and the ICDs;
11) System development and verification plans have been reviewed and accepted;
12) Interface validation has been performed and successfully validates the interface designs and ICDs;

    Note: CSA could provide access and support for the operation of the Next Generation Small Canadarm testbed (NGSC). The NGSC testbed is detailed in Appendix E.
13) Demonstration of the interface validation has been witnessed and accepted by CSA;
14) For CSA, all relevant formal Joint Implementation Plan (or similar) with the DSG partner(s) have been agreed to, signed and in place.

4.8.5.1 Entry Criteria for the IDR

1) The Review Plan and agenda have been agreed by the CSA and distributed to all attendees.
2) Action Items from previous reviews are completed and RIDs from the SRR are closed.
3) All of the work required by this document has been completed, except for the Review itself.
4) All documents identified as required for IDR have been placed under Configuration Control, have been delivered within the period stipulated per the relevant CDRL in Table B-2, and in accordance with the respective DID.
5) The presentation package addresses all the review objectives.
6) Any regulations that might affect the preparation and execution of the IDR, such as the International Traffic in Arms Regulations (ITAR) and Controlled Goods Registration Program (CGRP) have been complied to such that the review can be held.
7) Documentation, especially design and analysis, meets acceptable levels of stability and details; the external ICDs are complete and contain no TBCs and TBDs. The SRD, IRD, IDD and the internal ICDs contain no significant TBD/TBCs and no significant issues;
8) All risk reduction activities for Phase A have been completed and results are available.
9) Validation of the external interfaces is complete including demonstration to CSA;

10) Up to date project progress reports, including technical status, cost and schedule actual data, and projections to the end of the project, are available for the review.

4.8.5.2 Exit Criteria for the IDR

1) All objectives of the review have been achieved.
2) All RIDs have a disposition agreed with CSA and its project partners.
3) Actions (if any) have clear description, actionees, and due dates;
4) Requirements:
    a. All the system, operational and interface requirements have been allocated down to the configuration item level;
    b. All interface specifications are complete, traceable to higher-level requirements and ready for formal approval and release;
5) Design:
    a. Design analyses demonstrate, with a high degree of confidence, that the proposed interfaces can be expected to meet all the requirements (system, operational, environmental, design, safety and product assurance) within the planned cost and schedule;
    b. Technical issues of the design have a defined plan for resolution and correction;
    c. For exceptional cases where the design may not meet the requirements, deviations/waivers have been discussed and agreed on. The work necessary to achieve the requirements has been well defined, with priorities and an estimated schedule provided;
    d. The human factors considerations of the proposed design support the intended end users' ability to integrate the GERI interfaces and perform the mission effectively;
        i. OPTION: EVA is to be considered an operator of an EVA-installable variant of the LPGF and applicable human factors need to be considered;
    e. Any proof of heritage (elements or design) has been assessed and is appropriate for the intended mission;
    f. The concept and interface designs are compatible with the Gateway Extra Vehicular Robotics Concept of Operations (AD-02);
6) Total System Performance:
    a. Preliminary system performance estimates have been completed;
    b. Design margins been allocated reflecting the maturity of the design;
    c. Engineering budgets and margins for system performance (payload mass handling, power to payloads, etc.) have been defined;
    d. Estimates of critical resource margins (e.g. mass, power, Central Processor Unit (CPU) throughput and memory, etc.) been determined based on design the maturity of the design;

7) Interfaces:
    a. The IRD, IDD and the internal and external ICDs are complete;
    b. Any “TBDs” and “TBCs” are clearly identified along with plans and schedules provided that define their resolution;
8) Verification / Testing / Qualification
    a. The approach to Qualification/Proto-flight/Acceptance testing been defined through a preliminary Qualification Plan;
    b. The verification matrices provide tracing (forward and backward) to all requirements;
    c. Breadboards, prototyping and simulations been produced and have they successfully validated the XLA Interface SCD, IDD, and external ICDs;
    d. The System Design and Development Plan (CDRL SE25) has been provided and covers predicted testing to be performed during Phases B and C, such as on an Engineering Model;
9) Risk Management:
    a. A risk management process meeting the CSA Risk Management policy, procedures and practices has been defined and utilized;
    b. All significant risks, problems, and open items have been identified and tracked (including programmatic, development and flight performance related items);
    c. All assigned risks have mitigation plans appropriate to the scope of GERI and the maturity of the design;
    d. The Technology Readiness Level (TRL) is minimum Level 5 for the passive interfaces and the components of the active interface that interacts directly with the passive interface;
    e. All relevant lessons learned been appropriately researched and adapted;
    f. Risks are at an acceptable level to proceed with the completion of the preliminary design;
10) Safety:
    a. A preliminary safety plan is provided that identifies all requirements as well as any planned tailoring approaches or intended non-compliances;
    b. Preliminary hazards, controls, and verification methods have been identified and documented;
11) Product Assurance (PA):
    a. The Product Assurance Implementation Plan (PAIP) is complete and submitted for information, including the problem reporting system;
    b. Initial reliability, availability and maintainability analyses are completed and results been factored into the design;
    c. Special materials considerations have been identified;
    d. Any contamination requirements have been identified and preliminary control plans defined;
    e. Preliminary non-standard parts have been identified;

12) Implementation / Production:

a. The proposed design is deemed producible;
b. Relevant make/buy decisions and contracting decisions are reasonable and acceptable;
c. Any long lead items have been identified;

13) Cost and Schedule:

a. The cost estimates provide sufficient granularity to allow cost estimation of the GERI project across the life cycle (i.e. Phase B to D) of the project to enable CSA to plan for the follow-on phases leading to the delivery of ten (10) LPGFs in 2023.
    i. The cost estimate is detailed to WBS levels 4 as a minimum such that a single work package does not exceed 10 per cent of the cost or duration of the project.
b. Appropriately detailed schedule shows realistic event times;
c. Schedule is compatible with need dates (i.e. delivery of ten (10) LPGFs in 2023);
d. Sufficient schedule margin is available to proceed further.

4.9 AGENDAS, MINUTES AND ACTION ITEM LOG

The Contractor must provide a Meeting Agenda (CDRL PM10) for all reviews and meetings including and must deliver these to the CSA TM and/or CSA PM no less than 5 working days before the meeting and must have it approved by the CSA TM and/or CSA PM.

The Contractor must produce the minutes for all reviews and meetings (CDRL PM11). including teleconferences and must deliver these to CSA (CDRL PM10). In the case of teleconferences, they must be delivered the next business day.

The Contractor must maintain a detailed Action Item Log (AIL, CDRL PM12) 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 for the monthly progress report and at the meetings. The AIL (CDRL PM12) must be delivered with the Monthly Progress Report (CDRL PM9).

4.10 BI-WEEKLY TELECONFERENCE MEETINGS

The Contractor must conduct bi-weekly project status meetings with the CSA to review the project status and to resolve unforeseen and urgent issues. The selection of participants will depend on the nature of the issue. These meetings will be held by teleconference.

4.11 PROJECT REPORTING

4.11.1 Monthly Progress Reports

The Contractor must establish and maintain a project management control system to effectively integrate the approved scope of work with the schedule, budget, quality and potential risk issues, maintain all project status data, and provide visibility and assurance to the CSA TM and/or CSA PM that the project is on schedule and that it is meeting contract and performance requirements.

The management control system must track, control and report on project costs and schedule, programmatic and technical risk on a monthly basis through the Monthly Progress Report (CDRL PM9).

The Contractor must submit Monthly Progress Reports to the CSA and to the Contracting Authority, no later than 5 working days after the end of the month covered by the report. As all deliverables, it must be submitted via CSA's Configuration Management Library for the GERI project, and a copy must also be sent by email to (PSPC) Contracting Officer.

4.12 DOCUMENT DELIVERABLES

The Contractor must deliver all documentation listed in the CDRL tables (Appendix B, Table B-2) as a minimum and as per the instructions provided in Appendix A. The format and content of the deliverables must be in accordance with the requirements specified in the Data Item Descriptions (DIDs) (Appendix C), both the specific DID identified in the CDRL and the DID-100 – General Preparation Instructions.

4.12.1 Documents Delivered for Approval

The term "Approval" as used in this document and in other documents referred to herein, means written approval by CSA TM and/or CSA PM, of documents submitted by the Contractor. Once approved, the document is authorized for further use by CSA. The CSA does not take responsibility for the validity of the data, or statements, and the Contractor is fully responsible for the content and secondary effects derived there from.

The document may not be changed without the CSA TM and/or CSA PM approval. No request or document for which approval is required must be acted upon or implemented by the Contractor until such approval is provided. Such requests and documents will be reviewed promptly by the CSA TM and/or CSA PM. The CSA TM and/or CSA PM will provide approval or disapproval fifteen (15) working days after the formal review meeting.

Note: All CDLRs submitted for review or approval must be delivered prior to the meeting as defined in Table B-2.

In the event that a request or document is disapproved, the CSA TM and/or CSA PM will advise the Contractor in writing as to the reasons for such disapproval and will define the additions, deletions or corrections that the CSA TM and/or CSA PM deems necessary to render the request or document acceptable. Disapproved requests or documents that are subsequently amended by the Contractor and resubmitted for approval will be either approved or disapproved by the CSA. Approval or disapproval of resubmitted requests or documents will be based solely on those points that were not previously deemed to be acceptable.

4.12.1.1 Documents Delivered for Review

The term “Review” as used in this document and in all other documents referred to herein, means, unless specifically stated otherwise, a CSA review of the documents submitted for that purpose by the Contractor. The acceptance by the CSA TM and/or CSA PM of a document for review must imply that the document has been reviewed, commented on, revised as necessary, and has been determined to meet the requirements.

The CSA does not take responsibility for the validity of the data, or statements, and the Contractor is fully responsible for the content and secondary effects derived there from.

In the event that the CSA TM and/or CSA PM does not concur with a document submitted for review, the CSA TM and/or CSA PM will so notify the Contractor. Such notification will include a full explanation of the reasons for the lack of concurrence and will recommend the additions, deletions and/or corrections that the CSA TM and/or CSA PM deems beneficial to the needs of the project.

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

4.12.1.2 Technical Notes

The contractor must prepare engineering reports or documents in the form of informal Technical Notes (TNs) that are required to address and resolve individual technical problems that occur during the contract. The purpose of the TNs is to document and exchange technical information on the progress of the work. Copies of all TNs must be delivered to the CSA. TNs dealing with significant technical or quality issues must be delivered to the CSA TM and/or CSA PM for review, in accordance with CDRL SE21.

4.13 SUBCONTRACT MANAGEMENT

The Contractor must be fully responsible for implementation and execution of all tasks, including those subcontracted to others. Whenever this is the case, the Contractor must prepare and maintain subcontract Statements of Work, technical requirements documents, etc., necessary to effectively manage the subcontractors’ work. Subcontractors status must be provided in the Monthly Progress Report (CDRL PM9).

At the request of the CSA TM and/or CSA PM, copies of subcontractor documentation must be delivered to the CSA TM and/or CSA PM via CSA CM.

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

4.14 OVERALL PROJECT DEVELOPMENT PLAN

The contractor must breakdown the system into sub-systems (i.e. Product Breakdown Structure, see Section 5.4.1) at a level sufficient to estimate required developments, schedule cost, risk and performance. The system breakdown must be the basis of the TRRA and System Design and Development Plan (CDRL SE25) for the project

The Project Development Plan (CDRL PM2) must include all the project Life Cycle Cost (LCC) phases leading to the delivery of 10 LPGFs as shown in Figure 4-1, in 2023.

The information requested in sections 4.14.1 through section 4.14.8 must be presented in the Project Development Plan (CDRL PM2).

4.14.1 Cost Estimate

The Contractor must provide an indicative Cost Estimate (CDRL PM7) for the XLA interfaces Phase B,C,D work in accordance with Treasury Board (TB) guidelines (AD-15).

Template for Cost Breakdown, broken down per Work Breakdown Structure (WBS, CDRL PM4), for phase B, C and D to enable CSA to plan for the follow-on phases leading to the delivery of ten (10) LPGFs in 2023. Along with the cost estimate, a detailed justification for those costs must be included. The justification must describe the type of cost estimate (analogous, bottom-up, etc.). All assumptions used to create the estimate must be listed.

Cost estimates must provide sufficient granularity to allow cost estimation of the GERI project across the life cycle (i.e. Phase B to D) of the project to enable CSA to plan for the follow-on phases leading to the delivery of ten (10) LPGFs in 2023.

Therefore the cost estimate must be detailed to WBS levels 4 as a minimum such that a single work package does not exceed 10 per cent of the cost or duration of the project. Any options or de-scope options that are included must be clearly described.

TABLE 4-2: TEMPLATE FOR COST BREAKDOWN (EXAMPLE)

Category (per WBS)		**Phase A**	**Phase B**	**Phase C**	**Phase D**
Labour	Management				
	Technology Development				
	Design				
	Documentation				
	Reviews				
	Manufacturing				
	Assembly				
	Testing				
	Product Assurance				
	Integration Team Support				
	Total Labour				
Non-Labour	Hardware / Software Procurement				
	Integration Team Support				
	Tools, Equipment and Facilities				
	Travel and Living				
	Other Direct Charges				
	Total Non-Labour				
Risk	Risk Contingency				
Taxes	GST				
Total By Phase					
Total All Phases					

4.14.2 Schedule

The Contractor must provide a Schedule (CDRL PM6) relative to the overall life cycle of the project including the impact of hardware qualification and integration milestones. The timeline must include key activities and milestones from Phase B to D completion, such as design, prototyping, Preliminary Design Review, engineering model development, Critical Design Review, qualification unit development, flight model development and integration support. Delivery dates must be provided for Prototype(s), Engineering Model(s), Ground Support Equipment, Qualification Unit(s) and the Flight Model sequence.

Refer to CSA Systems Engineering Technical Review Standard (AD-08) for a full description of all the possible reviews.

4.14.3 Risk Assessment

The Contractor must provide a preliminary technical, schedule, cost and programmatic risk assessment for the entire Project lifecycle, starting with Phase B to D. For each risk identified, the Contractor must identify the phase of the mission to which the risk applies, the likelihood of occurrence, the impact should the risk occur and any possible mitigation actions that may be taken to decrease either the likelihood or the impact. Specific mitigation actions must be identified for medium and high risks. Contingency plans (i.e. identifying alternative strategies) must also be developed for medium and high risks, or when it is uncertain that mitigation plans will be effective.

The Contractor must integrate all risks when producing risk-related information and document it in a Risk Assessment document (CDRL PM8) which must include a Risk Matrix.

4.14.4 Contractor Work Breakdown Structure and WBS Dictionary

The work must be planned, controlled and directed using a Contractor Work Breakdown Structure (CWBS, CDRL PM4) that organises and defines the total work scope of the Project lifecycle, starting with Phase B to D. The CWBS must be based on the CSA WBS for the entire GERI project as depicted in in Figure 4-1, without any grouping of the CSA WBS elements. The Contractor may add elements, as required.

The contractor must update and deliver the WBS as per CDRL PM4.

The Contractor must establish and maintain a CWBS Dictionary (per CDRL PM4) defining the work to be done against each CSA WBS element identified in Figure 4-1, by means of a Work Package Description (WPD) for each such element. Updates of the CWBS Dictionary must be provided along with the CWBS updates by the contractor as per CDRL PM2.

4.14.5 Development and Manufacturing Approach

The Contractor must provide an overview of the development and manufacturing approach, specifying the major tasks required in the development and manufacturing cycles and the general strategy best suited for this approach. The Contractor must also identify the potential long-lead parts required, the timeframe and rationale supporting the statements.

4.14.6 Collaboration

The Contractor must identify potential partners/stakeholders (for example, Universities, sub-system providers, terrestrial commercial partners, etc.), state the benefits of their participation in such project and provide a preliminary assessment of roles and responsibilities. The basis and process of stakeholder analysis is described in the Project Management Book of Knowledge (PMBoK) (RD-02).

4.14.7 Canadian Capabilities Development

This report must provide an estimate of the anticipated percentage of Canadian content relative to the overall cost presented in Table 4-2, what options could be undertaken to maximize the Canadian content and their corresponding impacts and benefits. The Contractor must describe the Canadian supply chain involved in this current Phase A, and expected to be involved in subsequent phases.

The report must also provide an overview of the Contractor's strategy to develop and maintain Canadian capabilities. If the overall approach of the Contractor implies technology transfer and partnership with foreign entities to develop the Canadian capabilities, the Contractor must specify teaming arrangements, Intellectual Property (IP) ownership issues, licensing, royalties and opportunities that this partnership would open.

4.14.8 Commercialization Plan

The Contractor must provide information on the minimum business in the field required to maintain the necessary expertise in the long run.

The Contractor must provide a commercialization plan to explain the potential economic benefits of an investment in such a mission. This plan must include a description of potential products and spin-offs (space and non-space) that can be commercialized, a stakeholder analysis, and analysis of the competitors (national and international) for the potential products. The Contractor must include an estimate of the potential market for their products as well as specify companies/market segments/export markets that would purchase their products. The Contractor must describe and explain their overall/general business model for any potential new business.

If applicable the plan should include a description of how commercial products can be spun-in, leveraged and further advanced by this work.

4.15 BENEFITS ANALYSIS

The Contractor must provide benefits analysis inputs as per CDRL PM20. This information will be used to provide management with a strong case that links investments with program results and, ultimately, with the strategic outcomes of the organization. The Contractor must address, at a minimum, the following topics:

1) Socio-Economic Benefits for Canadians
2) Supports Canadian Key Industrial Capabilities
3) Commercialization Potential
4) Positions Canada for future space exploration
5) Potential to inspire Canadians
6) Demonstrates multiple use and application of knowledge acquired from past space exploration missions
7) Supports multiple destinations
8) Canadian Capability – Canadian content target
9) Partnerships – government, industry, academia, domestic or international
10) Produces new products, processes and/or technologies
11) Know-how acquired through space exploration endeavours
12) Potential to transfer know-how and technology to other applications (including terrestrial)

4.16 INTELLECTUAL PROPERTY

The Contractor must explicitly define the Foreground Intellectual Property (FIP) generated during the execution of the contract and report this in the IP Disclosure Report (Appendix D). This document must also identify the Background Intellectual Property (BIP) that is required to use the FIP. The BIP/FIP Disclosure Report (CDRL PM19) provided with the proposal as per Appendix D must be updated as required.

5 ENGINEERING

For the engineering work, the GERI Mission Requirements Document (MRD, AD-04) contains the governing technical requirements for the contract with CSA's Gateway External Robotics Concept Design Document (CDD, see AD-01) and Gateway Extra Vehicular Robotics Concept of Operations (AD-02) providing context and clarifications on the Use Cases (see AD-04, Section 1.3) driving the GERI designs. Supporting parent, applicable and reference documents and information influential to the development of the GERI concepts and designs are comprised in the design of the GERI MRD (AD-04) and the Gateway Extra Vehicular Robotics Concept of Operations (AD-02).

The GERI MRD contains the mission level requirements for the complete GERI group of DSXR interfaces. The Contractor deliverables must respond to the requirements listed in Appendix B of AD-04.

The GERI group of interfaces can be viewed as a subset of the broader DSXR system. In order to bound the GERI technical work to that necessary to further mature and build the critical end item deliverables, a proposed Functional Breakdown Structure (FBS) for the XLA interfaces is provided in Figure 5-1. While the entire LPEE needs to be conceptualized and designed to some extent, only critical aspects of the active side of the XLA interface are required to be designed and validated to the same levels as the passive side at the completion of the contract. This is in support to the final end item deliverables of the GERI project will consist of only the passive aspects (i.e. LPGFs – see discussion in Section 1.2).

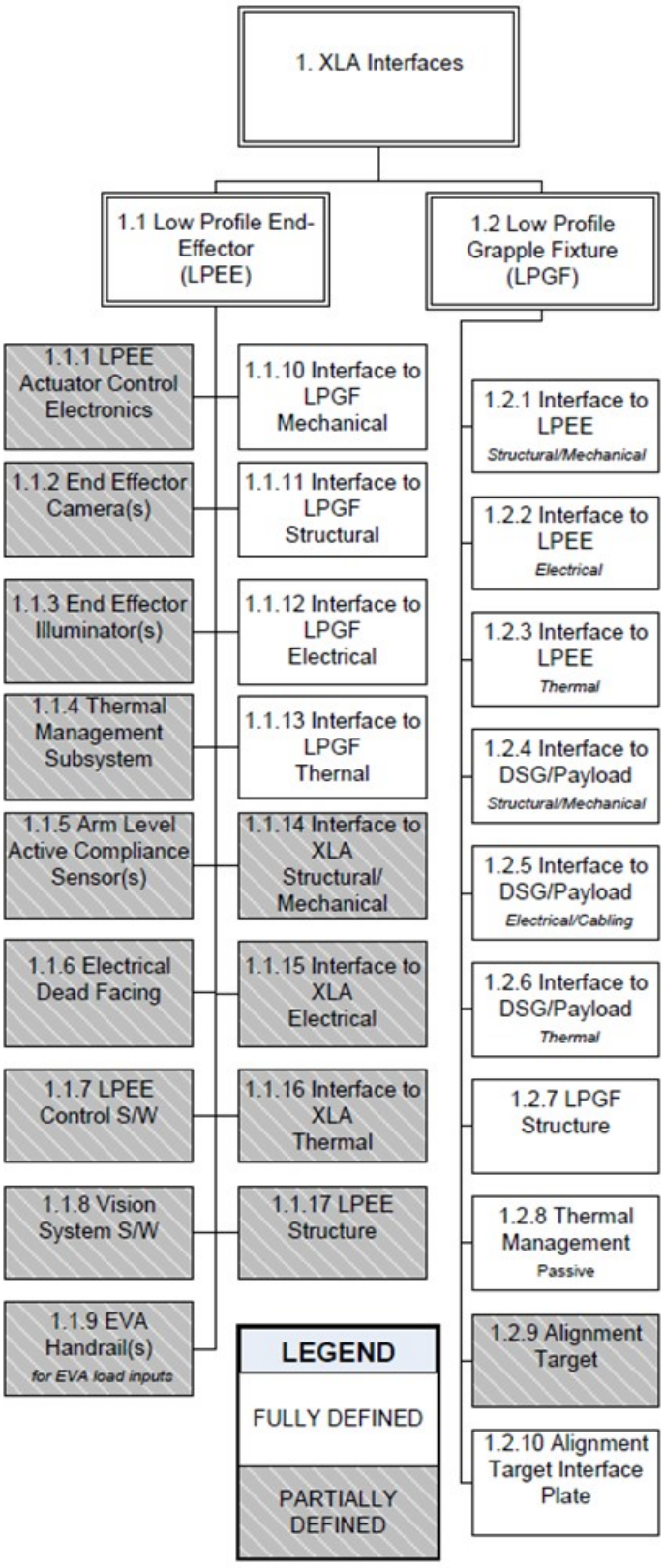

FIGURE 5-1: XLA INTERFACES FBS FOR PHASE A

5.1.1 XLA Interface Deliverables

As described in Section 1.2 and in the MRD (AD-04), the GERI manipulator interfaces are classified into active and passive sides. For the XLA, that reflects the LPEE as being the active end and the LPGF as being passive. Both sides need to be developed by the work described in this document to the same levels of maturity in order to provide valid end products.

For the XLA interfaces, Figure 5-2 provides an overview of the expected deliverables related to the XLA interfaces, the CSA products that drive those deliverables, and their interaction with the DSXR and with the broader DSG via the items identified as deliverables to NASA. While Figure 5-2 reflects a sequence, the exact timeline dependencies and expected maturity for each deliverable are defined in the CDRL listing provided in Appendix B.

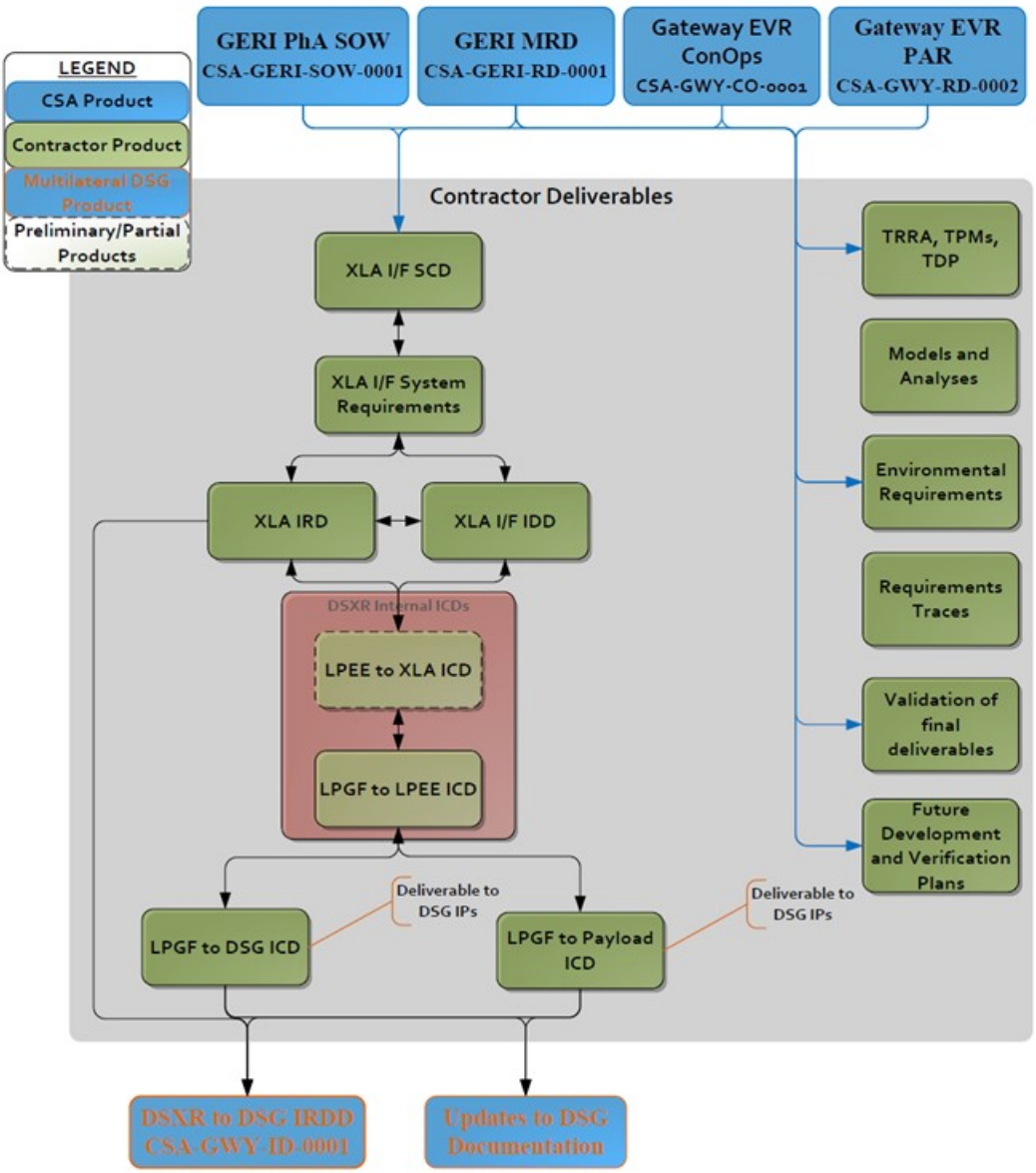

FIGURE 5-2: XLA INTERFACE DOCUMENTS AND DELIVERABLES

5.1.2 Technical Integration Meeting with DSG IPs

Coordination meetings between CSA and international space agencies are ongoing regarding the development of overarching mission objectives and requirements with regards to the DSG. These meetings offer "up to the minute" information that is beneficial to the work performed in this Contract. As such, subject to CSA approval, the Contractor must plan to support these meetings. Furthermore, the Contractor must include allowances to adjust any of the deliverables based on information from these meetings, as applicable and at the appropriate Contract milestones. Two international, week-long meetings must be accounted for, supported onsite by a maximum of two members of the Contractor team. These meetings typically also require the review of material and may require presentation material from the contractor.

5.1.3 Technical Integration Support

The Contractor must support CSA GERI project members at Deep Space Gateway level meetings. This support will be focused on integration of GERI interfaces to the DSG elements, modules and payloads. The support will likely cover the following topics (non-exhaustive):

1) Ground integration and testing;
2) Considerations for the launch and transit phases while integrated to the DSG element;
3) Considerations for the operations phase as base points for the DSXR robotic manipulator and as interfaces to manipulated payloads.
4) Gateway Safety and Engineering Review Panel (SERP) process when GERI inputs are required for the identified hazards and control of those hazards.

Level of support is estimated at two (2) equivalent personnel at five (5) hours a week for the duration of the contract.

5.1.4 On-request Level of Effort Support

The contractor must allocate 5% of the full contract value to support a Level of Effort (LoE) task order that provides engineering services per CSA requests to perform tasks related to the GERI project but not currently specified, such as:

1) Analysis;
2) Document review;
3) Meeting support;
4) Travel;
5) Technical Note.

5.2 GERI MRD SUPPORT AND RELATED DOCUMENT REVIEWS

The GERI MRD (AD-04) contains the top level technical requirements for the GERI project. The GERI feasibility studies were performed as part of the broader Deep Space eXploration Robotics (DSXR) concept studies, for which the relevant portions have been re-conceptualized into the GERI MRD.

The other major influence on the GERI MRD is the recent development of NASA's high level DSG requirements with the following being particularly relevant:

1) DSG Architecture Design Document (AD-10);
2) DSG Concept of Operations (AD-11), and;
3) DSG System Requirements (AD-12).

The three DSG documents listed above along with CSA's external robotics CDD (AD-01) form the parentage to the GERI MRD with the majority of the GERI Mission Requirements being traced to the DSG System Requirements (AD-12).

As both the DSG and the DSXR are still at conceptual phases, it is expected that the GERI MRD will be updated during the course of the execution of the contract. To support the evolving concept, the contractor must perform the following tasks:

1) Review any updates to CSA's GERI MRD and external robotics CDD (AD-01) and provide feedback on compliance of the contractors concept and derived requirements and other impacts;
2) Review any updates to the relevant DSG requirements (e.g. AD-12) and provide feedback on compliance to the contractors concept and requirements and other impacts;
3) Review any updates to the relevant DSG requirements (e.g. AD-12) and other relevant sources and provide recommended changes to the GERI MRD (AD-04) and CSA's external robotics CDD (AD-01). These documents include, but are not limited to, all Parent and Applicable Documents listed in the GERI MRD , Section 2.0;
4) Review the SLS Mission Planner's Guide (ESD 30000, see RD-01)[1] and any other document providing launch vehicle environments, assess for impacts to GERI, and provide recommended changes to the GERI MRD (AD-04) and CSA's external robotics CDD (AD-01), if any;
5) Review the DSXR Preliminary Interface Control Document (MDA 4001005, see RD-03) and assess for applicability to the GERI design;
6) Review the DSXR Preliminary System Requirements Document (MDA 4001007, see RD-04) and assess for applicability to the GERI design;
7) Review the Gateway Extra Vehicular Robotics Concept of Operations (AD-02**)** and provide recommended updates to the GERI MRD (AD-04) and contractor products;

[1] ESD 30000 is viewed as a coarse reference for launch environment. It is expected that throughout the course of the GERI Phase A contract execution that other source will be made available, including those related to non-SLS launch systems.

8) Review the Gateway Extra Vehicular Robotics Product Assurance Requirements (AD-03**)** and provide recommended updates to the GERI MRD (AD-04) and contractor products.

5.2.1 Review of MIPS Material

CSA has advanced the Technology Readiness Level (TRL) of the LPGF and the LPEE functionality under the Manipulator Interface Plate System (MIPS) contract. The deliverable material from that work will be made available to the Contractor for their review. In support of that, the Contractor *should* review the following documents:

1) MIPS Operations Concept Document,RD-06;
2) MIPS Verification and Test Plan, RD-07;
3) MIPS Operations and Sensing Assessment, RD-08;
4) MIPS Technology Readiness and Risk Assessment, RD-09;
5) MIPS Final Technical Report (Phase 1 & 2), RD-10.

5.3 TECHNOLOGY READINESS AND RISK ASSESSMENT (TRRA) AND ROADMAP

The TRRA is used to assess the project technological maturity and risks, and to guide the definition of risk reduction work in the current and follow-on phases. The Contractor must perform a Technology Readiness and Risk Assessment (TRRA) three times:

The first assessment is performed on the Bidder's proposed concept, and submitted with the proposal as per the Evaluation Criteria included in the Request for Proposal and this document. The objective is to assess the technological maturity of the proposed concept, to propose Phase A risk mitigation activities arising from this assessment, and to prioritize these activities. The proposed risk mitigation activities must be shown to be feasible, while maximizing the amount of development work that can be performed during Phase A within the schedule and budget limitations provided in this RFP (see 5.3.1 for more information on expected risk mitigation activities). For this assessment the Bidder *should* use the CSA Technology Readiness and Risk Assessment Guidelines (AD-05) for guidance in performing the TRRA. The TRRA results, including the plans for risk mitigation must be documented in a TRRA report (Contractor Format as per CDRL SE1).

The requirement for Phase A is for the Technology Readiness Level (TRL, see AD-05 for definitions used by CSA) to reach TRL 5 for the XLA passive interface and the components of the active interface that interact directly with the passive interface. Refer to Figure 5-1 for the clarification of expected levels of completeness (fully defined or Partially defined) for the respective functional components of the active and passive interfaces.

The second assessment is performed on the updated concept following the Conceptual Design Review (ConDR). The objective is to update Phase A risk mitigation development activities arising from this assessment. The third (final) assessment must be performed on the Phase A final concept following the System Requirements Review (SRR). The objective of this assessment is to propose risk mitigation development needs for future phases based on the concept developed.

The second and third assessments must be performed in accordance with the requirements of AD-05 to formally document the system technology status. For each assessment, the results of the TRRAs must be provided in the Stand Alone Report format of CDRL SE1, or in Contractor Format if it meets or exceeds the intent of CDRL SE1, and include the Critical Technology Elements (CTEs) Identification Criteria Workbook (AD-06).

For the third assessment, the Contractor must also provide a Technology Development Plan (CDRL SE13) that specifies the required technology developments required to meet mission needs and includes a plan and timeline to reach TRLs 6 and 8[6]. In support of this, the contractor must fill out the Technology Roadmap Worksheet (CSA-ST-RPT-0003, see AD-07) applicable to the GERI project.

5.3.1 Phase A Risk Mitigation Activities

The Contractor must conduct Phase A risk mitigation activities which are a result of the TRRA report (CDRL SE1) submitted by the Contractor in the proposal. The activities target the CTE's that were identified in the TRRA conducted on the proposed concept in the Bid. The work plan associated with these activities is described in the proposal submitted by the Contractor, and the Contractor must continue to track and update the work packages as per CDRL PM3 and the schedule as per CDRL PM5. This work is critical to project success, as it mitigates the technical risk for the subsequent phases.

5.4 PRODUCT BREAKDOWN STRUCTURES AND TREES

5.4.1 Product Breakdown Structure

The Contractor must establish a Product Breakdown Structure (PBS, CDRL SE15) to define the functional decomposition of the robotics interfaces into subsystems. As a PBS is produced for the TRRA, it may be identical. The PBS must use a unique identification name for each structure node. This identification name must be used to identify documents and work packages related to the corresponding node.

The Contractor must provide a PBS for the future development of the XLA interfaces (CDRL SE16) along with a listing of long lead items (CDRL SE19) that impact the schedule for Phases B, C and D provided in CDRL PM6.

5.4.2 Documentation Tree

The Contractor must establish a documentation tree (CDRL SE18) that captures all documentation generated in the execution of the contract.

5.4.3 Drawing Tree

The Contractor must establish a drawing tree (CDRL SE17) that captures all documentation generated in the execution of the contract.

[6] Aspects of the GERI project will not mature further than TRL-6. This includes the active side of the DSXR interfaces such as the robotic End Effectors (see AD-04). As the project ends with the delivery, integration and testing of the passive interfaces, the highest TRL level to be achieved is TRL-8.

5.5 SYSTEM TRADE STUDIES AND BUDGETS

5.5.1 Trade-off Studies

The trade-off analyses demonstrate that the system conceptual design is the optimum choice for the mission. The Contractor must perform analyses and studies to optimize the system design, select between alternative design choices and determine the best allocation of requirements and resources between subsystems (CDRL SE12). As a minimum, the following must be considered for each trade-off:

1) Purpose of the study;
2) Cases considered;
3) Analysis description (alternatively, pros and cons);
4) Analysis results;
5) Decisions/recommendations.

5.5.2 Engineering Budgets and Margins

Budgets play a central role from a systems engineering standpoint. CDRL SE2 (the System Conceptual Design) requires that all engineering budgets must be presented on a per-subsystem basis.

The budgets must include a summary of the engineering budgets and Technical Performance Measurements (TPMs, CDRL SE 20), margins, and their allocation to subsystems.

The budget must include, as a minimum:

1) Physical resources
    a. Mass: this section must indicate the current allocated system mass, the current estimated mass, and the current mass margin; mass estimates should be broken down to the unit level.
    b. Power (steady-state and transient peaks): this section must provide estimates of power consumption (maximum, minimum) and available load power (maximum, minimum) against the Requirements Document.
    c. Volume: this section must indicate the current allocated instrument volume, the current estimate volume, and the current volume margin; volume estimates should be broken down to the unit level.
2) Thermal margins;
3) Mechanism performance, reliability, duty cycle, etc.;
4) Reliability (probability of success): present an estimate of reliability, and a calculation of the reliability margin against the applicable GERI System Requirements Document.

5.6 SYSTEM CONCEPT DESIGN

The Contractor must develop a system concept design of the XLA interfaces. This conceptual design must be presented in the GERI System Conceptual Design document (SCD, CDRL SE2), and will be reviewed at the Concept Design Review (ConDR) and finalized at the Systems Requirements Review (SRR).

The conceptual design is tailored to meet the mission requirements and is feasible within appropriate margins (mass, power, data rate, etc.). It assists in the derivation of the system requirements and in finalizing the design of the system and allocating the requirements to subsystems, to demonstrate its feasibility, and to support programmatic estimates.

Although the deliverable is defined by CDRL SE2, it is generic in nature.

5.6.1 Verification Compliance Matrices

The Contractor must provide a Verification Compliance Matrix to the applicable GERI Mission Requirements (AD-04) as per CDRL SE22:

1) Establish the traceability from the Contractor's system design and requirements to the GERI Mission Requirements as per AD-04, Appendix B;
2) Show the verification method(s) for each requirement (CDRL SE23) as per CSA's Systems Engineering Methods and Practices (AD-09), Section 5.5.2.

5.6.2 Interface Requirements Document

The Contractor must provide an Interface Requirement Document (IRD) for the XLA as detailed in CDRL SE11. The IRD to be developed must account for all external and internal interfaces.

This deliverable must be compliant to the International External Robotic Interface Interoperability Standard (IERIIS, see AD-14) and will be used to generate and update multi-lateral DSG level interface requirements.

The Contractor *should* reference the ISS Interface Requirements Document for payloads (RD-31) in the development of the IRD.

The system requirements and the trace to/from the GERI mission requirements (AD-04) must also be provided in a Dynamic Object Oriented Requirements System (DOORS) compliant format for integration to CSA's requirements tracking tool.

Note that, once approved by CSA, CSA may provide the final release of this deliverable, or portions thereof, to CSA's International Partners on the DSG program.

5.6.3 Analyses and Models

Analyses are required in order to support the understanding of different design choices, budgets and to predict the performance of the different instruments.

The System Concept Design (CDRL SE2) must present a summary of the analyses performed, main results and problems encountered. Each fully detailed analysis report, in Contractor format, must also be provided as per the appropriate CDRL as captured in the following sub-sections.

Analyses may be provided as Technical Notes (CDRL SE21) or integrated into other formalized documentation, such as the System Concept Design, etc.

5.6.3.1 Mechanical Models and Analysis

All mechanisms that form part of the designs of the interfaces must be supported with the appropriate analysis. These analyses (CDRL SE3) must cover items such as performance, reliability, life, hazards, etc.

The Contractor must provide mechanical three dimensional (3D) models of the interfaces per CAD model CDRL SE7 that is supported by the mechanical analyses and design of the interfaces. These models must be provided in a format that support:

1) Standard CAD model viewing application (e.g. STEP – see CDRL SE7);
2) Standard 3D printing (e.g. STL format).

5.6.3.2 Structural Analysis

The Contractor must perform structural analysis on the designs of the interfaces (CDRL SE4).

5.6.3.3 Mass Model and Analysis

The Contractor must provide a mass model of the interfaces and perform the relevant analyses (CDRL SE5) that supports the model.

5.6.3.4 Thermal Models and Analyses

The contractor must provide a thermal model of the interfaces being designed in Phase A (CDRL SE6). The Contractor must perform a preliminary thermal analysis (CDRL SE6) based on the thermal model provided for the Gateway environment as captured in RD-27.

5.7 SYSTEM REQUIREMENTS

The Contractor must define and develop the XLA Interface Systems Requirements Document (SRD, CDRL SE8) according to the directions, content and properties described in the GERI Mission Requirements Document (MRD) as per CDRL SE8. The system requirements must account for any and all operational requirements (CDRL SE30).

The system requirements and the trace to/from the GERI mission requirements (AD-04) must also be provided in a Dynamic Object Oriented Requirements System (DOORS) compatible format for integration to CSA's requirements tracking tool.

The Contractor *should* reference the MSS Segment Specification (RD-28) for this work.

5.7.1 System concept to Requirements Trace

The Contractor must provide a traceability matrix (CDRL SE24) from the System Design Concept document (see Section 5.6) to the XLA Interface SRD (see Section 5.7).

5.7.2 Interface Design Document

The Contractor must provide an XLA Interface Design Document (IDD) as detailed in CDRL, SE10 and designed compliant to the XLA Interface (SRD, CDRL SE8)and the XLA IRD (CDRL, SE11, see Section 5.6.2), which accounts for internal interfaces:

1) LPEE to XLA ICD;
2) LPEE to LPGF ICD;

and external interfaces:

1) LPGF to DSG ICD;
2) LPGF to Payload ICD.

The Contractor *should* reference the MSS to ISS ICD (RD-30) and MSS to User ICD (RD-29) for this work.

Note that portions of the IDD will be used to update the DSXR Interface Requirements and Design Document (IRDD) and other documents (see Figure 5-2).

5.7.3 Interface Control Drawing

The Contractor must provide Interface Control Drawings (ICDs) per CDRL SE26 and designed compliant to the IRD (see Section 5.6.2) and ICD (see Section 5.7.2). There are multiple ICDs required, including internal ICDs:

1) LPEE to DSXR ICD;
2) LPEE to LPGF ICD;

and external:

1) LPGF to DSG ICD;
2) LPGF to Payload ICD;

Note that, once approved by CSA, CSA will provide the external ICDs to CSA's International Partners on the DSG program.

5.7.4 System Design and Development Plan

The Contractor must produce a system design and development plan (CDRL SE25) that represented the future activities required to deliver and integrate the end items as described in Section 1.2.1. This plan must support the development of the Project Development Plan (CDRL PM2) and must be in accordance with CSA's Systems Engineering Methods and Practices (AD-09, Section 5.2.6).

5.7.5 System Verification Plan

The Contractor must produce a verification approach, high level test planning, and model philosophy (CDRL SE9). This approach must meet the requirements detailed in both the Contractor's IRD (see Section 5.6.2) and XLA Interface SRD (see Section 5.7). This plan must be in accordance with CSA's Systems Engineering Methods and Practices (AD-09, in particular see Section 5.5). This deliverable must reflect the goal of the GERI project to deliver the validated flight passive interfaces as defined in Section 1.2.1, accounting for the continued but lower maturity development on the active interfaces.

A significant part of the verification strategy is the space environmental qualification program. This must addresses the process through which the System will be qualified for operation in the space environment. The space environmental qualification program comprises two major components:

1) Verification Philosophy
2) Model Philosophy

The recommended approach for the Verification Philosophy and Model Philosophy will be reviewed at IDR.

The verification plan must address GERI interface integration to third party equipment (e.g. DSG modules) and the related testing activities.

5.8 INTERFACE VALIDATION

The contractor must provide validation of the interface designs demonstrating the validity of the delivered requirements, IRD, IDD and ICDs. This validation must be supported through physical breadboarding/prototyping (CDRLs SE27, SE28, and SE29) of the interfaces demonstrating the ability of a robotic manipulator to align and capture the passive interface, followed by successful releasing of the interface.

This validation work must include a demonstration to CSA personnel of the capture/release operations using an early emulation of the interfaces comprising the system. Preference is for a demonstration that includes closed-loop-control using a machine vision system to autonomously execute capture and release functions.

The Contractor must take still photographs and video throughout the testing and demonstrations of the capture/release operations of all key hardware (CDRL SE31).

These photographs must be taken with a digital camera with a minimum 8-mega-pixel resolution, and saved to a DVD or contractor repository, accessible by CSA with the lowest Joint Photographic Experts Group (JPEG) compression setting of the camera. Each DVD or contractor repository, accessible by CSA must include a text file providing the following information: image number, date of the photograph, description of the photograph, and any additional keywords.

These videos must be taken with a High Definition digital camera and saved to a DVD or contractor repository, accessible by CSA. Each DVD or contractor repository, accessible by CSA must include a text file providing the following information: video number, date of the video, description of the video, and any additional keywords.

Note: The rights for the videos and still photographs will be owned by CSA and the Contractor must provide all the source files of the videos and still photographs to CSA once completed.

6 SAFETY & MISSION ASSURANCE

6.1 REVIEW OF SAFETY AND MISSION ASSURANCE REQUIREMENTS AND APPLICABILITY

The Contractor must review the CSA Gateway Extra Vehicular Robotics Product Assurance Requirements (AD-03).

The Contractor must produce an Applicability and Compliance matrix per (CDRL PA2). A statement of applicability and compliance to the requirements must be included with the matrix.

This assessment will include:

1. Identification of requirements that the contractor recommends for modification, removal, or not applicable with accompanying justification;
2. Identification of requirements that are significant cost and/or schedule drivers and proposed alternatives. An estimate of the cost and/or schedule impact must be provided for these cases, with assumptions stated;
3. An assessment of mission risks associated with any recommended changes or removals;
4. A rationale as a comment for the requirements the contractor is non-compliant to.

These inputs will be for consideration in tailoring the CSA Product Assurance Requirements for future phases.

Post the SRR, the PAR will be re-issued by CSA. The Contractor must produce, maintain and update a Product Assurance and Implementation Plan (PAIP) per CDRL PA1 which responds to the PAR for Phases B, C and D. The purpose of the PAIP is for the contractor to demonstrate and plan how the Product Assurance Requirements will be addressed, and plan for any product assurance requirements that may be applicable to the design or documentation required for the IDR. During Phase A, CSA requests the PAIP for information only. There may be additional updates and modifications to the PAR during the Phase A contract and the assumption at this time is that the final PAR will be provided as part of the Request for Proposal and SOW for the next phases of the GERI project.

The CSA PA requirements are derived from the NASA Gateway Safety and Mission Assurance documentation which are invoked as required in the CSA PAR:

- DSG-RQMT-010 (RD-32) – Gateway Program Safety and Mission Assurance Requirements

This document establishes the programmatic Safety and Mission Assurance (S&MA) requirements for the Gateway Program.

- DSG-RQMT-011 (AD-13) – Gateway Program Hazard Analysis Requirements

The Hazard Analysis Requirements Document outlines the specific terminology to be used cross-program for the Gateway. A subsection of this document is applicable to the conceptual design phase and these deliverables are covered in more detail in section 4.8.2.

- DSG-RQMT-012 (RD-33) – Gateway Program Failure Modes and Effects Analysis/Critical Items List (FMEA/CIL) Requirements

The FMEA/CIL Requirements Document outlines the specific terminology to be used cross-program for Gateway. These requirements will apply to the Design and Mission Phases for GERI. In the preliminary design phase, a Critical Item List will be documented for any critical hazards identified in the Preliminary Hazard List. Controls may be required cross-program, and these controls will need to be identified on the Interface Control Document for each system.

- DSG-RQMT-013 (RD-34) – Gateway Nonconformance Processing and Corrective Action Requirements

This document outlines the proposed Gateway Problem Reporting, Analysis, and Corrective Action (PRACA) process. It describes a cross-program approach to problem resolution, tracking and documentation. The document describes the use of contractor nonconformance database usage, and levies the requirement for the transfer of information from a contractor format to the Gateway format. Review of this document and the contractor process may identify differences in approach and documentation.

6.1.1 Hazard Analysis Requirements

The Contractor must perform a Preliminary Hazard Analysis in accordance with DSG-RQMT-011 (AD-13) – Gateway Program Hazard Analysis Requirements.

1) A Preliminary Hazard Analysis (PHA) for the Concept Development Phase must be produced. (CDRL PA3);
2) A Preliminary Hazard List (PHL) for the Concept Development Phase must be produced. (CDRL PA4);
3) The NASA Gateway Program has completed a Preliminary System Safety Analysis Report for the Gateway DSG-RPT-001 (RD-17). A review of the report and hazards assigned to the Robotic Arm must be completed. Any identified hazards that are applicable to the interfaces will need to be identified and incorporated into the Preliminary Hazard List;
4) The contractor must prepare for the Phase 0 Safety Review Meeting to present the hazard analysis. (This meeting may be held at the same time as the SRR). This meeting is described in Section 4.8.3.

6.1.2 Reliability and Maintainability Requirements

The Contractor must perform a preliminary GERI Reliability and Maintainability analysis to support the requirement definition, based on the Concept of Operations (CDRL PA5).

7 OPTIONAL SCOPE – EVA INSTALLABLE LPGF

On the direction of CSA to execute this option, the Contractor must provide additional system and interface requirements in support of an Extra-Vehicular Activity (EVA) installable LPGF. Whereas the baseline design supports ground installation by dedicated specialist technical staff, this option would generate the requirements for a version of the LPGF that would be installed on-orbit by a crewmember.

The execution of this option will likely be determined at or prior to the Systems Requirements (SRR) milestone – (see Table 4-1) pending programmatic review of updated schedules and other considerations. Mission requirement GERI-MRQ-0290 in the GERI MRD (AD-04) is the high level driver for this aspect of the GERI concept.

The Contractor is directed towards the design of the MSS grapple fixtures as an important reference, in particular the EVA replaceable Power Data Grapple Fixture (PDGF, see RD-29 and RD-30). The development of the concept based on the MSS heritage, along with the related system and interface requirements, will be required to be completed at the Interface Design Review (IDR) and the relevant updates to the other deliverables (e.g. SRD, ICDs, etc.) provided at that time.

The costing for this option must be accounted for in the proposal as planned work and will be limited to 5% of the awarded contract value.

If CSA elects not to implement this option, the applicable costing will be merged with other, prioritized tasking.

APPENDICES

A CONTRACTOR DELIVERABLES

A.1 HARDWARE DELIVERABLES

The Contractor must deliver all hardware listed Table A-1. All items are delivered to CSA but may be shipped according to the instructions below.

TABLE A-1 – HARDWARE DELIVERABLES

Description	Quantity	Delivery Date	Shipped to
3D print of LPGF Model[1]	2	IDR	CSA
3D print of LPEE Model[1]	2	IDR	CSA
Software (source codes and executables)	N/A	Post-IDR	CSA
Breadboards and Prototypes	As built	Post-IDR	CSA

A.2 DOCUMENTATION DELIVERABLES

The Contractor must ensure that documents delivered comply with the general preparation instructions and applicable Data Item Description (DID). In cases where Contractor Format (CF) is specified as an "or", the Contractor Format must include the substantive content of the DID.

The contractor must provide redlines version for all updated documentation in order to expedite the review and approval by CSA.

The contractor is encouraged to merge CDRLs where reasonable. The contractor, in this case, must identify which CDRL's are merged. In general, the intent of CDRL and DID are to indicate the type of material and depth of work expected.

Alternatives to the Data Items Descriptions (DIDs) document format, content and submission methods are acceptable to the CSA in principle. Merged CDRL and Contractor format must be approved by the CSA and must meet the intent of the stated CDRL and DID within the context of this project.

Documents must be delivered in the original software application format, plus in Portable Document Format (PDF). One electronic copy of each deliverable document must be delivered via CSA's Configuration Management Library for the GERI project. No paper copy is to be delivered, except when requested by CSA TM and/or CSA PM.

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

The delivery schedule for all documentation must be as defined in the CDRL table.

The Contractor must obtain approval from the CSA for all CDRL Documents so indicated in the CDRL table.

[1] Minimum desired scale is 1/5.

B CONTRACT DATA REQUIREMENTS LIST (CDRL)

This Appendix defines the documentation, computer models, and analyses to be delivered by the Contractor.

B.1 ABBREVIATIONS USED

TABLE B-1: ABREVIATIONS IN CDRL LISTING

ABBREVIATION	DEFINITION
A	Approval
R	Review
I	Information
CF	Contractor Format
IR	Initial Release
Prelim	Preliminary release
ConDR	Concept Design Review
IDR	Interface Design Review
SRM	Gateway Safety Review Meeting
SRR	System Requirements Review

B.2 DISTRIBUTION AND COPIES

All documents must be provided in the format specified in the relevant DID, ten (10) working days prior to the specified Review/Meeting unless otherwise indicated. Paper copies are not required.

TABLE B-2: CONTRACT DATA REQUIREMENTS LIST

CDRL No.	Deliverable	Due Date	Version	Approval Category	Format/DID
B.3 PROJECT MANAGEMENT					
PM1	Project Management Plan – Phase A	KOM - 10 working days As required IDR-10 working days	IR Update Final	A A A	101 101 101
PM2	Project Development Plan – Phase B,C,D	SRR-10 working days IDR-10 working days Project Closeout	IR Update Final	R R R	109 109 109
PM3	WBS and Work Package Description – Phase A	KOM - 10 working days As required IDR-10 working days	IR Update Final	A A A	102 102 102
PM4	WBS and Work Package Description – Phase B, C, D	SRR-10 working days IDR-10 working days Project Closeout	IR Update Final	R R R	102 102 102
PM5	Project Schedule – Phase A	KOM -10 working days Monthly	IR Update	A A	105 105
PM6	Overall Project Schedule – Phase B, C, D	SRR-10 working days IDR-10 working days Project Closeout	IR Update Final	R R R	104 104 104
PM7	Overall Cost Estimates – Phase B,C,D	SRR-10 working days IDR-10 working days Project Closeout	IR Update Final	R R R	103 103 103
PM8	Overall Risk Assessment – Phase B,C,D	SRR-10 working days IDR-10 working days Project Closeout	IR Update Final	R R R	CF CF CF
PM9	Monthly Progress Reports	Monthly	Final	R	107
PM10	Meeting Agendas	Meeting – 5 working days	Final	R	110
PM11	Meeting Minutes	Meeting + 5 working days	Final	R	111
PM12	Action Items Log (AIL)	Meeting + 5 working days	Final	R	112

CDRL No.	Deliverable	Due Date	Version	Approval Category	Format/DID
PM13	Kick-Off Meeting Presentation	KOM-10 working days	Final	R	108
PM14	Concept Design Review Presentation	ConDR-10 working days	Final	R	CF
PM15	Phase 0 Safety Review Meeting Presentation	SRR-10 working days	Final	R	CF
PM16	System Requirements Review Presentation	SRR-10 working days	Final	R	CF
PM17	Interface Design Review Presentation	IDR-10 working days	Final	R	CF
PM18	Review Data Package	KOM-10 working days ConDR-10 working days SRR-10 working days IDR-10 working days	Final Final Final Final	R R R R	113 113 113 113
PM19	BIP/FIP Disclosure Report	KOM-10 working days End of Contract (BIP/FIP)	IR Final	R R	Appendix C Appendix C
PM20	Benefits Analysis	SRR-10 working days IDR-10 working days Project Closeout	IR Update Final	R R R	CF CF CF
B.4 SYSTEMS ENGINEERING					
SE1	Technology Readiness and Risk Assessment Report	With proposal SRR-10 working days IDR-10 working days	Draft Baseline Final	R A A	CF 013 013
SE2	System Conceptual Design (SCD) Document	ConDR-10 working days SRR-10 working days	Baseline Final	A A	700 700

CDRL No.	Deliverable	Due Date	Version	Approval Category	Format/DID
SE3	Mechanical Analysis	ConDR-10 working days SRR-10 working day IDR-10 working days Project Closeout	IR Update Updated Final	R R R R	604 604 604 604
SE4	Structural Analysis	ConDR-10 working days SRR-10 working day IDR-10 working days Project Closeout	IR Update Updated Final	R R R R	605 605 605 605
SE5	Mass Model and Analysis	SRR-10 working day IDR-10 working days Project Closeout	IR Baseline Final	R R R	606 606 606
SE6	Thermal Model and Analysis	SRR-10 working day IDR-10 working days Project Closeout	IR Baseline Final	R R R	607 607 607
SE7	CAD Models	ConDR-10 working days SRR-10 working days IDR-10 working days	IR Baseline Final	R R R	600 600 600
SE8	System Requirements Document (SRD)	SRR-10 working days IDR-10 working days	Baseline Final	A A	400 400
SE9	System Verification Plan	SRR-10 working days IDR-10 working days	IR Final	R A	461 461
SE10	Interface Design Document (IDD)	SRR-10 working days IDR-10 working days	Baseline Final	A A	700 700
SE11	Interface Requirement Document (IRD)	ConDR-10 working days SRR-10 working days IDR-10 working days	IR Baseline Final	R A A	500 500 500
SE12	Technology Trade-off Studies	ConDR-10 working days	Baseline	R	629
SE13	Technology Development Plan	SRR-10 working days IDR-10 working days	Baseline Update	R R	CF CF

CDRL No.	Deliverable	Due Date	Version	Approval Category	Format/DID
SE14	Environmental Requirements and Test Specification (ERTS)	SRR-10 working days IDR-10 working days	Baseline Update	A A	404 404
SE15	Product Breakdown Structure (PBS) – Phase A	ConDR-10 working days SRR-10 working days IDR-10 working days	Baseline Update Final	R R R	CF CF CF
SE16	PBS – Phases B, C, D	SRR-10 working days IDR-10 working days Project Closeout	IR Update Final	R R R	CF CF CF
SE17	Drawing Tree	SRR-10 working days IDR-10 working days	IR Final	R R	527 527
SE18	Documentation Tree	ConDR-10 working days SRR-10 working days IDR-10 working days	IR Update Final	R R R	526 526 526
SE19	Long Lead Item List	SRR-10 working days IDR-10 working days Project Closeout	IR Update Final	R R R	529 529 529
SE20	Technical Performance Measures Report	ConDR-10 working days SRR-10 working days IDR-10 working days Project Closeout	Prelim Update Update Final	R R R R	530 530 530 530
SE21	Technical Notes	As required	As required	R	CF
SE22	System-to-Mission Requirements Traceability Matrix	ConDR-10 working days SRR-10 working days	IR Baseline	R R	531 531
SE23	System Requirements Verification Matrix	SRR-10 working days IDR-10 working days	Baseline Final	A A	531 531
SE24	System Conceptual Design-to-System Requirements Compliance Matrix	SRR-10 working days IDR-10 working days	Baseline Final	R R	532 532
SE25	System Design and Development Plan (SDDP)	IDR-10 working days Project Closeout	IR Final	R R	451 451

CDRL No.	Deliverable	Due Date	Version	Approval Category	Format/DID
SE26	Interface Control Drawing (ICD)	SRR-10 working days IDR-10 working days	IR Baseline	R A	704 704
SE27	Prototyping Test Plan	SRR-10 working days	IR	A	455
SE28	Prototyping Test Procedures	SRR-10 working days IDR-10 working days Project Closeout	IR Update Final	A R	754 754 754
SE29	Prototyping Test Report	IDR-10 working days Project Closeout	IR Final	A	759 759
SE30	Operational Requirements	SRR-10 working days IDR-10 working days	Baseline Final	A A	800 800
SE31	Digital Imagery and Videos	As required IDR-10 working days	N/A Final	I I	N/A N/A
B.5 PRODUCT ASSURANCE					
PA1	Product Assurance Implementation Plan	SRR+20 working days	Final	I	320
PA2	PAR Applicability and Compliance Matrix	SRR-10 working days IDR-10 working days	Baseline Final	A A	319 319
PA3	Preliminary Hazard List (PHL)	SRR-10 working days IDR-10 working days Project Closeout	Baseline Update Final	R R R	318 318 318
PA4	Preliminary Hazard Analysis (PHA)	SRR-10 working days IDR-10 working days Project Closeout	Baseline Update Final	R R R	317 317 317
PA5	Reliability Analysis	SRR-10 working days IDR-10 working days Project Closeout	IR Update Final	R R R	344 344 344

C DATA ITEMS DESCRIPTIONS (DIDS)

DID-013 – Technology Readiness and Risk Assessment with Stand Alone Report

DID Issue: IR **Date: 2015-04-28**

PURPOSE:

The Technology Readiness and Risk Assessment (TRRA) Report, whether as a stand-alone document or incorporated into the project Technical report, is used to describe in a systematic and objective fashion, at a specific point in time (milestone) in the development process, the technological readiness of a system for a particular spaceflight mission, the criticality of the constituent technologies, and the expected risk and program impact of achieving the remaining technology development steps.

The TRRA Report will document, for each of the Critical Technology Elements (CTEs) of the proposed concept, a high-level summary of the maturity of the technologies, the technology development risks and program impacts, and a recommended path forward to achieve the desired target technology maturity.

The TRRA Report is used to assess project status and technical risks, and to guide the definition of risk reduction work in following phases. It is a recommended deliverable at the end of Concept studies, and Phases 0, A, B, and optionally C.

When written as a stand-alone report, the TRRA report must include the information shown in the Preparation Instructions, below.

PREPARATION INSTRUCTIONS:

The TRRA Stand Alone Report must contain the following information, as a minimum:

1. Introduction

   This section should include:

   1.1. Brief Project Description;

   1.2. Purpose of Document (must include target TRL to be achieved);

   1.3. Scope.

   1.4. Applicable Documents, which must include the following:

   a) TRRA Guidelines (CSA-ST-GDL-0001 and the revision used for the TRRA

   b) Reference or links to the relevant CTE Identification Workbook (CSA-ST-FORM-0003) and TRRA Summary Template (CSA-ST FORM-0004).

   1.5. Reference Documents (which must include the following):

   a) All evidence documents referred to in the body of report.

   1.6. List of Acronyms

2. Mission Description and Objectives

   Provide an overview of the mission, describing the key mission requirements and any assumptions.

3. Mission Environment

   Describe in detail the mission environment and any assumptions.

   This section should include a summary comparison table(s) between heritage and current mission environments with references to source documents.

4. Product Breakdown Structure

   Provide a PBS diagram showing the element hierarchy and element numbers.

   This section may include a PBS diagram annotated to show the Current TRL of each element and those identified as CTEs.

5. Technology Maturity Assessment

   Provide the results of the TMA. This may accomplished either by referencing a completed CTE Identification Workbook, or by presenting a table showing each PBS element and its assessed Previous and Current TRLs, with brief rationales for the choices.

6. Critical Technology Elements (CTEs)

   Each CTE should be discussed in detail, including information such as:

   a) Description of each CTE;

   b) Rationales for selecting the CTEs. Reference may also be made to a completed CTE Identification Workbook; however, the TRRA report should contain more detail.

   c) Rationales for selecting the Risk and Program Impact factors.

   d) A discussion, for each CTE, of the path forward to increasing the TRL to the desired value (e.g., Target and or beyond). This should address the Technology R&D Options, and the risks, cost, and feasibility of advancing the technology.

7. TRRA Summary and Recommendations

   This section must include a Summary table of results with columns covering:

   - PBS # ;
   - Element Name;
   - Assessed TRL values (Target, Previous, Current):
   - and for CTEs, the Risk and Program Impact factors.

   This section must also summarize the recommended technology development activities (Path Forward) with timelines and expected costs. It can refer to a separate Technology Roadmap Worksheet and a Technology Development Plan report, if appropriate.

8. Conclusions

   This section should include a statement regarding the current overall state of the TRRA assessment and identify any open work.

9. Appendix

This section must include, or refer to an attachment, includes the CTE Identification Workbook (CSA-ST-FORM-0003, see AD-06), and (if used) the TRRA Summary Template (CSA-ST-FORM-0004). Templates for these documents can be obtained from the FTP site:

ftp://ftp.asc-csa.gc.ca/users/TRP/pub/TRRA/.

DID-100 – General Preparation Instructions

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

PURPOSE:

This DID specifies:

a) format requirements for the preparation and formatting of deliverable project documentation;

b) document and data delivery methods, notifications and identification requirements;

c) document and data structure requirements;

d) metadata requirements for all document and data submissions.

When documentation is prepared in the Contractor's format, it must still meet the requirements of this DID.

PREPARATION INSTRUCTIONS:

1. GENERAL INSTRUCTIONS

1.1. PREPARATION

All documentation must be written in English and must be delivered in electronic format. Documents must be prepared using the most appropriate software (Microsoft Word, Excel, etc.). Schedules must be submitted in Microsoft Project format. Documents whose native format is not a common office program must be delivered in PDF in addition to the native format.

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

CDRLNUM-CIE-WXYZ-(ABCD)-Document title-Rev no- sentYYYY-MM-DD

where:

- CDRLNUM: The CDRL Identifier
- CIE: Name of the Company (no space, no hyphen)
- WXYZ: A 4-8 letter acronym of the project
- (ABCD): Contractor's document number, in brackets
- Document Title: Short descriptive Text (max. 24 characters)
- Rev.no.: 1st release can be revIR, rev0, or revNC (no spaces)
- sentYEAR-MONTH-DAY: Date Tracking Number

For example:

- PMP 0001 CSA GERI (CSA-GERI-PMP-0001) Gateway External Robotics Interface Project Management Plan – revIR-sent2019-07-14

Note: Failure to observe the file naming convention will be cause for rejection of the deliverable and incur delays in the payment of the claim.

1.2. ELECTRONIC DOCUMENTS FORMAT

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

1.2.1. Page Numbering

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

1.2.2. Document Numbers

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

1.3. DELIVERY, NOTIFICATIONS AND IDENTIFICATION REQUIREMENTS

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

Documents may be delivered via e-mail or direct transfer (FTP) or on DVD or CD-ROM disk.

1.3.1. E-mailed documents

E-mailed documents must be sent to:

mailto:asc.bibliothequegc-cmlibrary.csa@canada.ca

Covering e-mails must contain the project/program acronym or equivalent identifier in the "Subject" line and include the CDRL identifier under which deliverable documents are being submitted.

1.3.2. Direct Transferred Documents

For direct transfer, a notification of the document's availability and location on a contractor repository must be sent to:

mailto:asc.bibliothequegc-cmlibrary.csa@canada.ca

If deliverables contain ITAR content, notifications of their availability on contractor repositories must be sent to: the CSA CM ITAR Receipt Desk:

The notification must include the project/program acronym or equivalent identifier and the CDRL identifier under which deliverable documents are being submitted.

mailto:asc.bibliothequegc-cmlibrary.csa@canada.ca

1.3.3. Secure Web Transfer of Documents

For the transfer of either sensitive, large, or material not suitable for e-mail exchange, the contractor must use the Information Sharing with External Partners (ISEP) portal. Notifications of their availability must be sent to:

mailto:asc.bibliothequegc-cmlibrary.csa@canada.ca

The notification must include the project/program acronym or equivalent identifier and the CDRL identifier under which deliverable documents are being submitted.

For information for the ISEP portal contact: asc.pieadmin-isepadmin.csa@canada.ca

1.3.4. Documents Delivered on DVD or CD-ROM disk

Hard copy and media deliverables are to be addressed to:

CM Library, 6A-100

Attention: CSA XXXX Project

Canadian Space Agency

6767, Route de l'Aéroport

Longueuil, QC, J3Y 8Y9

CANADA

The DVD or CD-ROM label must show the following information:

a) Company Name

b) Document Title

c) Document Number and Revision Status

d) CSA SOW Number

e) CDRL Number and Title

f) Contract Number

2. DOCUMENT STRUCTURE AND CONTENTOVERALL

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

a) Cover/Title Page;

b) Table of Contents;

c) Introduction;

d) Applicable and Reference Documents;

e) Body of Document; and

f) Appendices

2.2. COVER/TITLE PAGE

The title page must contain the following information:

a) Document Number and date: Volume x of y (if multivolume)

b) Rev. indicator / date of Rev.

c) Document Title

d) Project Name

e) Contract No.

f) CDRL Item No. or Nos., if one document responds to more than one CDRL, subject to prior approval from the PA.

g) Prepared for: Canadian Space Agency

h) Prepared by: Contractor name, CAGE Code, address, and phone number

i) Product tree identifier, if applicable

j) © HER MAJESTY THE QUEEN IN RIGHT OF CANADA [YEAR].

2.3. TABLE OF CONTENTS

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

2.4. INTRODUCTION

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

a) Project description and background;

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

c) Purpose of the document;

d) Scope of the document (what it includes and what it does not include);

e) Document conventions; and

f) Roles and responsibilities of the participants and stakeholders.

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

2.5. APPLICABLE AND REFERENCE DOCUMENTS

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

2.6. BODY OF DOCUMENT

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

2.7. APPENDICES

Appendices may be used to provide information published separately for convenience of document maintenance. Acronyms must be in the last appendix.

3. METADATA ON DELIVERABLES

This section is optional at the discretion of the CSA Project Manager.

In order for CSA to be able to properly manage deliverables and the system configuration as well as to process contractor’s deliverables in an efficient manner, the contractor must, for each deliverable, provide metadata as described in the following table.

Provided by Supplier	Metadata Description	Comments
Yes	CSA Project Identifier	Project Acronym
Yes	Contract Identifier	PWGSC identifier
Yes	Contract Revision Identifier	PWGSC identifier
Optional	Contract Revision Date	
Yes	SOW Identifier	CSA Doc ID
Yes	SOW Revision Identifier	CSA Doc Revision ID
Yes	Document Type	Dwg, Doc, RFD, RFW, ECR, ECN, IP CR, IP CN/CD, QN, etc.
Yes	CDRL Identifier	Per CSA SOW (e.g. EN-006)
Yes	CDRL Sub-category Identifier	If multiple, separate subject documents per CDRL item (e.g. EN-006.03) (can be contractor defined)
Optional	Project WBS identifier	
Optional	SOW paragraph identifier.	
Optional	DID/ DRD Identifier	
Yes	Deliverable submission format	Electronic, Hard copy, On media (CD-ROM, etc.)
Yes	Deliverable Transmittal Identifier	e.g. CADM09-0123. Can also be a notification of delivery identifier
Yes	Deliverable Transmittal Date	
Yes	Originator's Organization Identifier	CAGE code, company name, short name, etc.
Optional	Document Author	
Yes	Deliverable Type	Dwg, Doc, RFD, RFW, ECR, ECN, NCR, Problem Report, IP CR, IP CN/CD, QN, etc.
Yes	Document Type	Specification, Design, Plan, Tech Note, Report, etc.
Yes	Originator's Document Identifier	
When applicable	Originator's Document Volume Identifier	
When applicable	Originator's Document Part Identifier	
When applicable	Originator's Document Issue Identifier	When both Issue and Revision are used concurrently to identify released documents
Yes	Originator's Document Revision Identifier	
Yes	Originator's Document Title	
Yes	Document Release Date	
Yes	Document Effective Date	Applicable to document changes, deviations, waivers,
Yes	Document Expiry Date	If applicable
When applicable	Originator's Authorizing ECN Identifier	Class 2 ECN approving document release and submission to customer
Yes	Document Maturity	Draft, Preliminary, Initial Release, Updated Revision, etc.
When applicable	Class	If deliverable is a change, deviation, waiver, etc. to a released item. (Class I, Class II)
Yes	Security Classification of Deliverable	Per Government of Canada definitions for Classified and Protected data (C,S,TS,PA,PB,PC)
Yes	Sensitivity of Document contents	Company Proprietary, Trade Secret, etc.
Yes	ITAR Content Indicator	Yes or No
Yes	Export Controlled Content Indicator	Yes or No

Provided by Supplier	Metadata Description	Comments
Yes	Affected Document Identifier	If deliverable is a change, deviation, waiver, etc. to a released document/drawing/model. Enables change-to-document, waiver-to-document relationships, etc.
Yes	Affected Document Revision Identifier	As above
Yes	Affected Document Title	As above
Yes	Product Breakdown Structure / Item Hierarchy Identifier	Critical for Item-to-Document Relationship
Yes	Associated Project/System Milestone Review	PDR, CDR, etc. When Reviews are at sub-system level, identify accordingly. e.g. Bus PDR
When applicable	Associated System Baseline	If different from Project Milestone
Yes	Filename of Deliverable	Filename and file type (for all representations submitted - .doc, .pdf, etc.). Original, revisable format to be delivered before contract completion.
Yes	Format of Deliverable / Application used to produce	MS WORD 2007, Project Scheduler 9, etc.
When applicable	Filename of Parent Deliverable Bundle	If part of a document Bill of Material
When applicable	Identification of Delivery Media	If physically delivered
When applicable	Originator's Repository Address of deliverable	To identify source location of document

DID-101 – Project Management Plan

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

PURPOSE:

The Project Management Plan (PMP) is used to guide both project execution and project control.

The PMP is used by the Government to assess the adequacy of the Contractor's plan for management of the work and to provide a basis on which to monitor and assess the progress of the work.

PREPARATION INSTRUCTIONS:

The PMP is used to:

a) Guide the project execution;

b) Document project planning assumptions;

c) Document project planning decisions regarding alternatives chosen;

d) Facilitate communications amongst stakeholders;

e) Define key management reviews as to content, extent and timing; and

f) Provide a baseline for progress measurement and project control.

When the Contract has specified delivery of another document that contains aspects of the required information, the PMP should summarize these aspects and refer to the other document.

The PMP must contain the following information, as a minimum:

1. INTRODUCTION

a) Project Objectives;

b) Scope of the Plan; and

c) Applicable and Reference Documents.

2. PROJECT INTEGRATION MANAGEMENT

This section must describe the processes planned to be used to ensure that the various elements of the project are properly coordinated. It must describe:

a) The overall project management strategy;

b) How the plan will be executed; and

c) Overall change control mechanisms.

3. PROJECT SCOPE MANAGEMENT

This section must describe the processes planned to be used to ensure that the project includes all the work required, and only the work required, to complete the project successfully. It must address:

a) Initiation;

b) Scope Planning;

c) Scope Definition;

d) Scope Verification; and

e) Scope Change Control.

4. PROJECT TIME MANAGEMENT

This section must describe the processes planned to be used to ensure timely completion of the project. It must address:

a) Activity Definition;

b) Activity Sequencing;

c) Activity Duration Estimating

d) Schedule Development; and

e) Schedule Control.

This section must include the detailed project baseline schedule down to the activity level. The baseline schedule must include all elements of the CWBS and must depict all linkages and dependencies.

5. PROJECT COST MANAGEMENT

This section must describe the processes planned to be used to ensure that the project is completed within the approved budget. It must address:

a) Resource Planning;

b) Cost Estimating;

c) Cost Budgeting; and

d) Cost Control.

This section must include the detailed project cost baseline down to the activity level. The cost baseline must include all elements of the CWBS.

6. PROJECT QUALITY MANAGEMENT

This section must describe the processes planned to be used to ensure that the project will satisfy the needs for which it was undertaken. It must address:

a) Quality Planning;

b) Quality Assurance; and

c) Quality Control.

7. PROJECT HUMAN RESOURCES MANAGEMENT

This section must describe the processes planned to be used to make the most effective use of the people involved with the project. It must address:

a) Organisational Planning;

b) Staff Acquisition;

c) Team Development;

d) Project organizational chart; and

e) Key personnel.

8. PROJECT COMMUNICATIONS MANAGEMENT

This section must describe the processes planned to be used to ensure timely and appropriate generation, collection, dissemination, storage, and ultimate disposition of project information. It must address:

a) Communications Planning;

b) Information Distribution;

c) Performance Reporting; and

d) Administrative Closure.

9. PROJECT RISK MANAGEMENT

This section must describe the processes planned to be used to identify, analyze and respond to projects risks. It must address:

a) Risk Identification;

b) Risk Quantification;

c) Risk Response Development; and

d) Risk Response Control.

This section must also refer to the detailed project risk assessment and plan to manage project risks.

10. PROJECT PROCUREMENT MANAGEMENT

This section must describe the processes planned to be used to acquire goods and services ("products") from outside the Contractor's organisation. It must address:

a) Procurement Planning;

b) Solicitation Planning;

c) Solicitation;

d) Source Selection;

e) Contract Administration; and

f) Contract Closeout.

11. PROJECT STAKEHOLDERS MANAGEMENT

NOTE: this section of the PMP is required if the PMP is being developed by the CSA, but may not be needed or possible if the PMP is being developed by the Contractor.

This section must describe the processes required to identify the people, groups or organisations that could impact or be impacted by the project, to analyze all the stakeholders' expectations and impact on the project, and to develop appropriate management strategies for effectively engaging stakeholders in projects decisions and execution. Stakeholder management also focuses on continuous communication with stakeholders to understand their needs and expectations, addressing issues as they occur, managing conflicting interests and fostering appropriate stakeholder engagement in project decisions and activities.

It must address:

a) Stakeholders identification and analysis;

b) Stakeholder management planning;

c) Stakeholder engagement management; and

d) Stakeholder engagement control.

DID-102 – CWBS and Work Package Descriptions

DID Issue: IR **Date: 2013-12-18**

PURPOSE:

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

PREPARATION INSTRUCTIONS:

The Contractor must provide a Work Breakdown Structure (WBS) describing all the project elements that organise and define the total scope of the project, including subcontracted work, and must be deliverable-oriented.

The Contractor must prepare and maintain a WBS Dictionary made up of Work Package Descriptions (WPDs) for every element to the lowest level of the WBS. Each WPD must include, as a minimum:

a) A unique identifier traceable to the WBS;

b) A title;

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

d) The scope of the work package;

e) The start date and duration;

f) Required inputs and dependencies;

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

h) Assumptions;

i) Output and work package acceptance criteria;

j) Issue date;

k) Version number; and

l) List of deliverable with delivery milestone.

DID-103 – Phases B, C and D Project Cost Estimates

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

PURPOSE:

To provide cost estimates for Phases B, C and D.

PREPARATION INSTRUCTIONS:

The Phases B, C and D Cost Estimates may be prepared in the Contractor's format and must be based on the Phases B, C and D CWBS. The Cost Estimates must be provided by the Contractor at the end of each project Phase in order for CSA to refine the budget required for the succeeding phases with more detail. There are general requirements and specific requirements to be met by these estimates.

1. GENERAL REQUIREMENTS

The Cost Estimates must, as a minimum, contain the following information:

1) The costs must include the overall management of the project industrial activity by the Contractor including subcontract management;
2) The costs estimates must be consistent with the product tree and model philosophy required elsewhere in this SOW;
3) The costs estimates must include, but identify separately, costs for each separate payload, the bus and the Ground Segment, any special hardware that needs to be procured and the cost of verification and integration activities needed to integrate the payload on the bus;
4) The costs estimates must include costs of safety and mission assurance activities, including preparation for, attendance at and participation in launch provider safety reviews;
5) The costs estimates must also include inputs required by CSA to assess estimated mission operation costs;
6) The costing package must be prepared in a level of detail sufficient to support an analysis and assessment of the validity of the costs in relation to the programmatic and technical performance requirements of the program;
7) Financial assumptions such as inflation rates;
8) Assumptions regarding modelling, parts and materials, environmental testing, ground support equipment and other significant cost drivers must be clearly stated;
9) At the end of Phase A, the estimates for Phases B, C and D must be substantive;
10) The cost estimates must be provided in its electronic native format.

2. SPECIFIC REQUIREMENTS

The cost estimates must contain estimates by phase, by month, and by CWBS item, of:

1) Labor Hours in Person-Hours or Person-Days and in dollars;
2) Non-Labor costs;
3) Material costs;
4) Purchased Equipment;
5) Material Handling;
6) Subcontracts Cost Breakdown;
7) Travel and living;
8) General & Administrative (G&A) expenses;
9) Contractor overhead;
10) Contractor profit; and
11) Taxes.

The estimates must include total project costs for each phase and for the entire project.

DID-104 – Phases B, C and D Project Schedule

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

PURPOSE:

To provide a schedule estimate for Phases B, C and D.

PREPARATION INSTRUCTIONS:

The Phases B, C and D Schedule may be prepared in the Contractor's format, must be based on the Phases B, C and D CWBS, and must, as a minimum, contain the following information:

1) The Schedule must include all elements of the system.
2) All design reviews must be shown.
3) All spacecraft level readiness reviews must be indicated.
4) The schedule must be at a level sufficient to support project management reviews and interface activities between the organizations part of the GERI Project.
5) The Contractor must also prepare preliminary networks to a level indicating the critical path activities and events:
    a) This schedule must continue through spacecraft level assembly, integration, test, launch site and early operation activities again clearly indicating critical path activities and events.
    b) Modelling and environmental testing requirements for the instrument or payload, spacecraft bus and the full spacecraft must be clearly shown.
    c) The network must also identify any requirement for spacecraft level testing facilities other than those of the Contractor.
6) The network must go to a level sufficient for the Contractor to be able to evaluate and report on the status of the instrument/payload development and manufacturing activities at the major component and subsystem level and their progress relative to the requirements of the project schedule critical path.
7) The Contractor must also prepare a network indicating the critical path activities for the definition, documentation, design, development and production of ground station equipment and operations for the launch, early operations and post commissioning operation of the spacecraft.
8) Networks can be integrated if required.
9) Milestone events relating to the use of international ground stations must be included.

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 CWBS, 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 CWBS 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:

8) Schedule variance (current and cumulative), and
9) Schedule Performance Index (SPI).

The monthly progress status must 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-107 – Monthly Progress Report

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

PURPOSE:

The Monthly 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 must 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 must address the major activities of the reporting period and must 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, must also be reported.

Each progress report must 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 Monthly Progress Report must include the following information, as a minimum:

4) Summary outlook, including technical performance, work performed, schedule and cost status (at CWBS level 2), organization and key personnel changes and areas of concerns;
5) Financial status including actual and forecasted expenditures, by month, as compared to the original monthly planned expenditure profile;
6) *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);

7) *For fixed price contracts:* Updated milestones payment plan;

8) 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 must be provided, and

g) All other activities having an impact on WP delivery date must be provided;

9) Schedule variances from the plan, including deviations from schedule and proposed corrective actions for significant variances;

10) Major meetings schedule update;

11) Status of the work in progress, specifically the work performed in the previous calendar period; sufficient sketches, diagrams, photographs, etc. must be included, if necessary, to describe the progress accomplished;

12) The work projected for the next period, and estimated date of completion of next milestone;

13) Outline of technical and programmatic issues, with solutions recommended;

14) Contractual issues, including changes to activities and costs;

15) Subcontracts events, status and issues;

16) Equipment ordered, received, made and assembled;

17) Description of trips or conferences connected with the Contract during the period of the report;

18) 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;

19) 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

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

DID-108 – Kick-off Meeting Presentation

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

PURPOSE:

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

PREPARATION INSTRUCTIONS:

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

1) Review of major assumptions;
2) Review of contract deliverables;
3) Work requirements, WBS status and schedule;
4) Project's funding and expected cash-flow;
5) FIP and BIP;
6) Licensing issues if any;
7) Presentation to include the required copyrights and IP disclosure;
8) Other items as deemed appropriate

DID-109 – Project Development Plan

DID Issue: IR **Date: 2019-04-03**

PURPOSE:

To define the activities required to initiate and develop the mission. As such it describes the project development plans from Phase B through to D, including integration support to the Gateway International Partners. The development plan provides an outline for the project through delivery and integration to provide validity and context for the project cost and schedule assessment. This document describes the plan for the development lifecycle and verification. The plan begins with the kick-off of Phase B and follows through the definition, development and integration.

PREPARATION INSTRUCTIONS:

The Project Development Plan must include the content listed below. However when one of the items listed below is the subject of a separate document, the Plan must include a high level summary and a pointer to that document.

1) An introduction including the scope, the purpose and a list of assumptions (if any);
2) A description of the Project including goals and objectives;
3) Identification of stakeholders and their needs and expectations;
4) Implementation strategies
    a) Key assumptions
    b) Product assurance approach
    c) System verification approach
    d) Development and Manufacturing Approach
    e) Models Philosophy (e.g. breadboard, engineering model, etc.)
    f) Simulation
    g) Technology development
    h) Collaboration
5) Phase BCD substantive cost estimates;
6) Overall Schedule;
7) Overall Risk Assessment;
8) Overall Work Breakdown Structure and WBS Dictionary;
9) Long Lead items;
10) Canadian Capabilities Development strategies;
11) Commercialization Plan; and
12) Recommendations for follow-on activities.

DID-110 – Meeting Agenda

DID Issue: IR modified **Date: 2019-04-11**

PURPOSE:

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

PREPARATION INSTRUCTIONS:

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

1. DOCUMENT HEADER

a) Title;

b) Type of meeting;

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

d) Date, time, and place;

e) Chairperson;

f) Mandatory and desired attendance; and

g) Expected duration.

2. DOCUMENT BODY

a) Introduction, purpose and objective;

b) Opening Remarks: CSA;

c) Opening Remarks: Contractor;

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

e) Project technical issues;

f) Project management issues;

g) Other topics;

h) Review of newly created/closed action items, decisions, agreements and minutes; and

i) 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 must be prepared for each formal review or meeting in the Contractor's format and must, 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 Works and Government Services Canada (PWGSC), and
    d) Name and address of the Contractor.
2) Purpose and objective of the meeting;
3) Location;
4) Agenda;
5) Summary of the discussions, 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 must include the following statement:

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

DID-112 – Action Items Log (AIL)

DID Issue: IR modified **Date: 2019-04-11**

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. PDR 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, with the following valid entries : close, open, overdue, ready to close;
13) Closure evidence – upon readiness to close, this entry will track a referenced evidence that supports closure of the action;
14) Comments section.

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-113 – Review Data Package

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

PURPOSE:

The Review Data Package is a collection of all documents to be presented by the Contractor at a formal Technical Review.

PREPARATION INSTRUCTIONS:

The Review Data Package must contain the following:

1) The documents identified in the Milestone column of the CDRL Table as due for that review;
2) The presentations made at the meeting;
3) The meeting agenda;
4) The minutes of the previous meeting;
5) Copies of the comments/RIDs raised since the previous formal review;
6) The Action Item List (AIL).

For Test Readiness Reviews, the following additional items are required:

1) Test specifications and procedures;
2) Test support requirements and status;
3) Documentation status;
4) Functional and environmental test history of systems and subsystems;
5) Anomalies and their resolution;
6) Deviations and waivers.

DID-114 – Phase Closure / Final Report

DID Issue: Tailored for use in DSXR Phase 0 **Date: 2017-03-08**

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 must be a standalone document and must contain at least the following information:

1) Executive Summary.
2) Comparison of mission and system requirements against user 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-317 – Preliminary Hazard Analysis (PHA)

The following list is provided as a reference as the type of data which may be included in a Phase 0 Preliminary Hazard Analysis Report:

1) Introductions and Agenda
2) Scope and Objective
3) System Overview
    1. Organizational Structure
    2. System Description
    3. Interface Overview
    4. Operations
4) Presentation of Hazard Assessment/Analysis Approach
    1. Overview, Ground Rules, & Assumptions
    2. Hazard Analysis Approach
    3. Fault Tree Approach
5) Approach for Controlling Hazards
    1. FT
    2. List of candidate 0 FT areas
6) Special Topics (Including any Areas of Concern)
7) Forward Plan for Phase I

DID-318 – Preliminary Hazard List (PHL)

Example of PHL for Gateway:

Preliminary Hazard List for SRR

Hazard Analysis Title:				Revision:			DRM:		
Worksheet No:							Engineer:		
FFBD Version:				FFBD Block No:			Date:		
Project/Element/Subsystem:							Sheet:	XX of XX	
Hazard	**Cause(s)**	**Effect**	**Initiating/ Affected Element**	**Severity**	**Requirements**	**Hazard Elimination/ Control Provisions**	**Failure Tolerance**	**Recommendation**	**Verification Methods (optional)**
Use the checklist below to identify existing or potential hazards 1. Can the system fail to operate as intended? 2. Can the system operate inadvertently (untimely)? 3. Are there standard hazards? (See Table C1.4-1) Record the identi-fied hazards.	Enter brief description of how each hazard is created, i.e., rupture of the O2 tank; wiring insulation overheating and igniting; human error, etc.	Record the potential effect of each hazard on critical equipment, personnel or the general public, i.e.,; emergency landing in inhabited area; etc.	Identify the Project/ Element/ Subsystem that initiates the event or is affected	Identify the worst case severity level as one of the following for each hazard as Catastrophic, Critical, Severe, Moderate, or Minor Reference Severity Definitions in Table 5.4-1.	Identify the existing or proposed requirement that will eliminate or control the hazard by document and paragraph number	Identify proposed hazard reduction methods for hazards. For Level II - Identify transfer to Level III System if applicable.	Identify the level of failure tolerance required. How many levels of failure tolerance are currently in place? Does it meet the requirement?	Provide recommendations for additional requirements, trade studies, or other options which may be needed to control or eliminate the hazardous condition.	

DID-319 – PAR Applicability and Compliance Matrix

The PAR applicability and compliance matrix must have as a minimum the following columns. Each requirement in the review document must be listed and evaluated.

1. CSA PAR Requirement Identifier
2. CSA PAR Requirement Text
3. Applicable (Yes / No)
4. Compliance (C / NC)
5. If NC, proposed change
6. Justification for change
7. Risk impact on the mission
8. Cost/schedule impact on the mission
9. Other comment

DID-320 – Product Assurance Implementation Plan

PURPOSE

The Product Assurance Implementation Plan (PAIP) describes the organization, objectives, and PA activities planned for the project. The PAIP provides the Government with insight into the Contractor's PA organization, tasks, and activities and allows the Government to assess compliance with the governing PA requirements specified in the PAR Document and in this SOW.

PREPARATION INSTRUCTIONS

The PAIP may be prepared in the Contractor's format and must address all the requirements in the PAR.

DID-344 – Reliability Analysis

PURPOSE:

The Reliability Analysis identifies potential reliability problem areas and supports trade-off activities designed to satisfy maintainability requirements.

PREPARATION INSTRUCTIONS:

The Reliability Analysis Report may be prepared in the Contractor's format and must include all information necessary for a basic understanding and review of the analysis. If the design of certain subsystems is not sufficiently mature to support the requirements of this DID, a reliability allocation must be made for each of these subsystems. As a minimum, the report must contain the following information:

1. Identification of the configuration being analyzed;
2. Appropriate design information (e.g. functional block diagrams, parts lists, assembly drawings, etc., as far as they are necessary for understanding);
3. Identification of applicable functional and design descriptions and of the associated failure mode analysis;
4. Identification of operational and mission phases;
5. Definition of success and failure, any assumption or method applied;
6. Calculation approach, assumptions and simplifications used;
7. Reliability block diagrams and computations (to the extent necessary for basic review);
8. Sources of the reliability data (origin of used failure rates and parts quality level);
9. Reliability data Mean-Time Between Failure (MTBF) and Mean Time To Failure (MTTF) figures, for all deliverable hardware;
10. Analysis to demonstrate that the MTBF and MTTF of the system are concomitant with the expected use of the system, and satisfy the maintainability requirement;
11. Summary of results; and
12. Evaluation of results and design recommendations if applicable.

DID-400 – System Requirements Document

DID Issue: A **Date: 2017-04-11**

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

3) All requirements must be documented in the MBSE model and requirements documents expressed from the model *(Optional)*.

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

5) There must 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 must conform to the following standards for quality:

   a) They must be unambiguously clear to the intended readership;

   b) There must be one requirement per paragraph;

   c) Each requirement must have a unique identifier (e.g. an ID number or paragraph number);

   d) They must not define design solutions;

   e) They must define their source and/or rationale;

   f) They must be verifiable, preferably by test;

   g) They must specify the conditions under which they apply; and

h) Performance requirements must be quantified.

7) The Requirements Document must comprise a number of sections, each defining a specific set of requirements. The document must address all of the following categories of requirements, as applicable to the project:
    a) Functional and performance requirements (see item 8) below);
    b) External interface requirements (unless done in a separate document);
    c) Resource allocation requirements;
    d) Design requirements;
    e) Construction requirements (see item 9) below);
    f) Environmental requirements (see item 10) below);
    g) Qualification and/or verification requirements;
    h) Safety requirements;
    i) 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).
    j) Operational requirements, (unless done in a dedicated document);
    k) Ground Support Equipment requirements, if any (unless done in a separate document); and
    l) Other applicable requirements types.
8) Functional and performance requirements must include:
    a) Functional and performance requirements imposed on the system by the 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 must 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 must 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 must 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-455 – Breadboard Development and Test Plan

DID Issue: IR **Date: 2014-01-27**

PURPOSE

To present a set of pre-prototype activities to reduce risk and validate the requirements at all levels of the system to the extent practical prior to full system assembly.

PREPARATION INSTRUCTIONS

The document must present a list of planned breadboards and pre-prototypes, with test concept and goals, location, supporting resources needed, plan, schedule and suggested milestones.

DID-461 – Verification Plan

DID Issue: IR **Date: 2013-12-20**

PURPOSE:

To describe the activities planned to verify that the system or a unit conforms to its requirements, and to provide the verification matrix that traces the requirements to each activity.

PREPARATION INSTRUCTIONS:

NOTE: In the case of a Unit Verification Plan, the requirements below must be adapted as necessary.

The Verification Plan must, as a minimum:

1) Include a unique identification number, title, and brief overview of the system to which the Verification Plan applies;
2) Describe the relationship of this plan to other project management and engineering plans;
3) Provide an overview of the approach to verification and verification methodology to be employed on the program;
4) Identify the organizations and individuals responsible for verification;
5) Define the verification activities that will prove, at each phase, that the system and subsystems progressively meet all the specified requirements, including functional, performance, interface, environmental, etc. Requirements;
6) Describe the methods and techniques to be used to measure, evaluate, and verify the system; this is to include characterization of the system behaviour that is not controlled by requirements and but is important for understanding the system, and establishing the actual values of parameters that exceed requirements;
7) Describe the methods and techniques to be used to calibrate the system, including the payload;
8) Show how requirements verification progresses up the Hierarchical Tree from item and subsystem verification to system verification, and show that every requirement is verified using a Verification Matrix;
9) Explain how requirements verification will be traced from the upper level requirements through all mid-level documents to the closure documents (test results, analyses, similarity reports);

10) Define the requirements for supporting facilities, analysis tools and test equipment, both existing and needing to be constructed; assumptions on the use of government-furnished equipment (GFE) in testing are to be documented, including:
    a) The specific equipment and materials needed,
    b) The configuration of the equipment to be used,
    c) Any requirements on modification or upgrade of the GFE,
    d) The location in which it is to be used; and
    e) Define the schedule for verification activities (especially high-impact items such as full-system testing), and the schedule requirements for the government furnished facilities (e.g. DFL).
11) The scope of the document must include:
    a) Integrated Spacecraft testing for performance and environmental compliance;
    b) Spacecraft-Ground Segment compatibility testing, to check the two are compatible in terms of command and telemetry in both RF and baseband aspects;
    c) Commissioning phase testing; operational flow and processes for the commissioning phase must be defined;
    d) Life testing for life-limited items such as mechanisms and batteries;
    e) Life verification for critical components such as detectors and batteries; and
    f) Technical and operational qualification of the Ground segment; technical qualification means that the system is verified against requirements, i.e. Equivalent to verification; operational qualification means that the system has been exercised under realistic conditions and functions as intended (also known as validation).

This plan may be broken into sub-documents of more manageable size.

12) For each defined verification activity, the plan must contain, as a minimum:
    a) An identification number and a description of the activity;
    b) The objective, including requirements to be verified;
    c) A verification method, verification level (e.g. system, subsystem or unit) and verification milestone (e.g. PDR, CDR, AR, etc.);
    d) Supporting hardware and software; and
    e) Assumptions and constraints that apply to the activity.

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;
7) 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;
8) The following requirements apply to all interface requirements documents:
    a) All requirements applicable at the interface between the subject items must be documented. This should cover the standard items listed above;
    b) Requirements documents must define the requirements on the subject item (segment, subsystem, etc.) as a whole and must not contain specific requirements on sub-items. All requirements must be testable on the item as integrated.
9) Requirements must conform to the following standards for quality:
    a) They must be unambiguously clear to the intended readership;
    b) There must be one requirement per paragraph;
    c) Each requirement must have a unique identifier (e.g. An ID number or paragraph number);
    d) They must not define design solutions;

e) They must define their source and/or rationale;

f) They must be verifiable, preferably via a direct measurement;

g) They must specify the conditions under which they apply; and

h) Performance requirements must be quantified.

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

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

a) Spacecraft-to-Launch Vehicle IRD;

b) Spacecraft-to-Ground Segment IRD;

c) Spacecraft Internal IRD (e.g. between Bus and Payloads);

d) Ground Segment Internal IRD.

DID-501 – Interface Control Document (ICD)

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

PURPOSE:

To define and control the interface between several cooperating or attached Hardware Configuration Items (HWCI) or Configuration Software Configuration Items (CSCI).

PREPARATION INSTRUCTIONS:

The ICD may describe the interfaces between a system or subsystem and all external systems or subsystems with which it interfaces (External ICD), or it may define all interfaces amongst subsystems within a system (Internal ICD).

Examples of External ICDs are:

- Spacecraft-to-Launch Vehicle ICD
- Spacecraft-to-Ground Segment ICD

Examples of Internal ICDs are:

- Spacecraft Internal ICD (e.g. between Bus and Payloads)
- Ground Segment Internal ICD

Systems may be manned or unmanned; they may be space or ground systems such as Ground Segment facilities. The specific requirements below must be tailored accordingly.

The ICD may be structured by types of interfaces (as defined above), or by subsystem and then by types of interfaces under each subsystem.

The ICD must contain the following information, as a minimum, tailored as required by the type of ICD as described above, and the particular system and interfaces being defined:

1. Purpose and Scope
2. Applicable and Reference Documents
3. Identification (name, number) and brief overview of the system and role within the system, of the interfaces to which the ICD applies
4. Interface diagrams showing by name and identifier all interfaces among the HWCIs and CSCIs to which this ICD applies
5. Identification (name, identifier) and purpose of each of the interfaces
6. Physical / Mechanical Interfaces
   - 6.1. Coordinate System
   - 6.2. Dimensions and tolerances
   - 6.3. Units of measurement

6.4. Envelope, Volume and Mass Properties

6.5. Attachment methods

6.6. Alignment features

7. Structural/Mechanical Interfaces

7.1. Applied Loads and Disturbances (including random vibrations, frequency spectrum)

7.2. Acoustics

7.3. Depressurization/Repressurization

7.4. Ground Handling Environment

8. Thermal/Fluids Interfaces

8.1. General Requirements (touch temperature, condensation prevention, etc.)

8.2. Thermal Environment

8.3. Payload/Subsystems Cooling

8.4. Vacuum Exhaust Interfaces

9. Electrical Power Interfaces

9.1. Electrical Power Requirements, Sources and Allocation

9.2. Power Supply characteristics and limits

9.3. Overload protection and limits

9.4. Power control

9.5. Electrical connectors (types, pinouts, locations, mating and demating)

9.6. Cable schematics

10. Electromagnetic Compatibility (EMC)

10.1. EMC Classifications

10.2. Host system produced interference environment

10.3. Payload produced interference environment

10.4. Bonding and grounding

10.5. Power and signal circuits isolation

11. Command and Data Handling (C&DH)

11.1. Communications Technology (RS-422, Ethernet, Analog, Discrete, video, laptop, etc.)

11.2. Signal Characteristics

11.3. Response / Telemetry Format

11.4. Request/Command Format

11.5. Processing Requirements

11.6. Connector/Pin Interface

11.7. Data Acquisition, Storage and Management

11.8. Synchronization

11.9. Application Programming Interfaces

12. Environmental Interfaces

    Any environmental factors not addressed elsewhere in the ICD (e.g. radiation, atmosphere, illumination, etc.)

13. Materials and Processes Interfaces

14. Human Factors Interfaces

~~15. Propulsion Interfaces~~

~~16. Pyrotechnic Interfaces~~

~~17. Fire Prevention~~

18. Ground Operations and scientific data processing

    18.1. Facilities

    18.2. Payload Handling

    18.3. Ground Support Equipment (GSE)

    18.4. Communications Requirements

    18.5. Power Requirements

    18.6. Special Equipment

    18.7. Storage

DID-526 – Documentation Tree

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

PURPOSE:

To establish the hierarchical structure of the documents developed to design, build and test a system and to manage the project.

PREPARATION INSTRUCTIONS:

This Documentation Tree must be prepared in the form of a tree, establishing traceability from the lowest-level documents to the highest. The applicability of each document to others must be shown. A hierarchical address code must be used. Each document must refer to a specific CI within the Product Tree, if applicable; otherwise it must be identified as “system wide”.

The Documentation Tree must include, as a minimum:

1) Requirements Documents and specifications;
2) Analyses;
3) Technical plans;
4) Test reports;
5) Design Documents; and
6) Other data that applies to the CI.

The Documentation Tree must be updated as the project evolves through Phases B, C, and D.

DID-527 – Drawing Tree

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

PURPOSE:

To establish the hierarchical structure of the drawings developed to design and build a system.

PREPARATION INSTRUCTIONS:

This Drawing Tree must be prepared in the form of a tree, and must include drawings (including Source Control Drawings) that define the CI within the Product Tree. The Drawing Tree must identify the breakdown of assemblies from the top level to the lowest assembly level. For each assembly, all detailed drawings must be identified. Parts lists, electrical schematics and wiring diagrams at all levels must be identified in the tree.

For each drawing identified in the tree, the title and number must be specified.

DID-529 – Long Lead Items List

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

PURPOSE:

To identify hardware and software items with long procurement schedules. It supports cash flow planning by the Government.

PREPARATION INSTRUCTIONS:

The Long Lead Items List must identify, as a minimum:

1) All long lead items;
2) The time frame, relative to the project schedule, when these items need to be ordered or fabricated; and
3) The estimated cost of all identified items.

DID-530 – Technical Performance Measures Report

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

PURPOSE:

The purpose of this document is to identify and track Technical Performance Measures (TPMs) during system development. It is issued periodically to show the current performance expectations of the system with respect to key performance and resource parameters, and the comparison of current predictions versus the defined requirements and allocated resources. It allows trends in the program technical progress to be discerned.

PREPARATION INSTRUCTIONS:

The TPMs must include the following parameters, as appropriate:

1) Physical resources
    a) Mass: this section must indicate the current allocated Spacecraft mass, the current estimated mass, and the current mass margin; mass estimates should be broken down to the unit level.
    b) Power (steady-state and transient peaks): this section must provide estimates of power consumption (maximum, minimum) and available load power (maximum, minimum) against the Requirements Document or Specification.
    c) Volume: this section must indicate the current allocated Spacecraft volume, the current estimated volume, and the current volume margin; volume estimates should be broken down to the unit level.
2) Computer resources
    a) Processor usage: for each microprocessor used, this section must allocate a processing capacity budget and estimate the average and peak loading on the processor, as well as calculate the processing margin.
    ~~b) Memory usage: for each microprocessor used in the Spacecraft, this section must allocate a Random Access Memory (RAM) and Electronically Erasable Programmable Read-Only Memory (EEPROM) usage budget and estimate the current memory margin.~~
3) Communication bandwidth: for each onboard data equipment (bus or payload), this section must allocate a communication bandwidth budget between subsystems (down to the unit level) and estimate the current margin against the data Instrument bandwidth.
~~4) Radio-frequency link margin: this section must allocate a communication bandwidth budget between the Spacecraft and the Ground Segment.~~
~~5) Command and Telemetry: this section must allocate a Command and Telemetry budget and estimate the current rate and volume of commands and telemetry in each subsystem.~~

6) Synchronization and timing;

7) Thermal margins (including model uncertainty): this section must present the equipment temperature limits (down to the unit level), and the current estimated operational temperature range for the equipment based on an analysis of the mission states.

8) Mechanism torque margin: this section must present the torque margin allowed over the minimum design torque.

9) EMC/EMI: this section must allocate the Spacecraft Electromagnetic Compatibility / Electromagnetic Interference (EMC/EMI) budget conducted susceptibility, radiated emissions, and radiated susceptibility for the components (down to the unit level). The margin against the GDIR requirements must be calculated.

10) Reliability (probability of success): this section must present an estimate of reliability (nominal and Safe-hold modes), and a calculation of the reliability margin against the Requirements Document or Specification.

11) Payload-specific performance criteria and parameters. This must include an error budget, which must present the error budget for the overall instrument performance and the allocations to the various sources of measurement errors.

12) The report must show a history of changes, and must highlight the change since the last issue.

13) The report must show the decomposition of the TPM requirement into allocations for subsystems and different sources and should follow the Product Tree. Similarly the report must show the parallel roll-up of current estimates for the TPM values.

14) The report must show:

    a) the historic trend of requirements and estimates,

    b) all the margins being carried on the estimates, and

    c) the source of the estimates (e.g. allocation, estimation, analysis, measurement).

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 must 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.
9) 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.
10) Software Verification and Compliance Matrices must be developed within the Unified Modeling Language (UML) model and the deliverable document expressed therefrom.

DID-532 – System Traceability Matrix

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

PURPOSE:

To show how the system requirements flow into subsystem, sub-sub-system, unit, and SCD/CDD requirements.

PREPARATION INSTRUCTIONS:

The Traceability Matrix must, as a minimum:

1) Contain all requirements in the project, down to Source Control Documents requirements;
   a) At every requirement level, the parent requirements must trace all of its children requirements;
   b) At every requirement level, the child requirement must trace all of its parent requirements;
2) Show how requirements are allocated to subsystems, and how they are decomposed and derived before application to subsystems; and
3) Point to analysis or budgeting documents as sources of requirements based on derivation and decomposition; the analysis is a step in between the parent requirement and the derived child requirement.
4) The requirements trace must be delivered in a Requirements Interchange Format (ReqIF).

DID-451 – Design and Development Plan

DID Issue: IR **Date: 2014-01-27**

PURPOSE:

To define and detail all technical/engineering activities to be performed during the project's lifetime.

PREPARATION INSTRUCTIONS:

The Design & Development Plan (D&D Plan) must 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 Design & Development activities. It is applicable to all Contractor deliverable hardware or for the system as a whole if applicable.

If requested separately in the CDRL, the following plans must be considered as sub-plans to the D&D. In such cases, the D&D Plan must merely include a pointer to those documents.

a) Qualification Program Plan;

~~b) Audible Noise/Human Vibration Control Plan;~~

c) Electromagnetic Compatibility (EMC) Control Plan;

d) Fracture Control Plan;

e) Microgravity Control Plan;

f) Contamination Control Plan;

g) Assembly, Integration, Testing and Verification Plan; and

h) Software Development Plan.

2. CONTENTS

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

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

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

c) A detailed time-correlated sequence of 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 development activities;

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

f) Long Lead items must be identified and the schedule for procuring these items must be presented;

g) Qualification Program in terms of Model Philosophy, Model Definition, Test Programs, Analysis and Verification Program, to be further detailed in the Assembly, Integration and Test (AIT) Plans; and

h) Margin philosophy to be applied in the course of the development flow and its associated review milestones.

3. TABLE OF CONTENTS

This document must be prepared in accordance with the following Table of Content, as a minimum:

a) Introduction;

b) Overall Approach;

c) Technical Organisation;

d) Approaches, Techniques and Tasks;

e) Model Philosophy;

f) Manufacturing;

g) Assembly, Integration, Testing and Verification;

h) Critical Technologies;

i) Commonality and Standardisation;

j) Long Lead Items, Critical Items;

k) EEE Parts Procurement

l) Spares Philosophy;

m) Ground Support Equipment; and

n) External Facilities.

DID-600 – Computer-Aided Design Models

DID Issue: A **Date: 2017-02-20**

PURPOSE:

To provide a virtual model of a product to support the performance of various analyses (mechanical, electrical, thermal, optical) and virtual testing.

PREPARATION INSTRUCTIONS:

All models developed must be delivered.

Models must be delivered in the following formats:

a) Mechanical design: STEP AP203 (.stp), JT2GO (.jt), and PDF (with 3-D viewing);

b) Additive manufacturing design: Sterolithography (SLA) and native files;

c) Electrical design: .dsn, .sch, Pspice and Gerber formats;

d) Thermal Design: TMG universal file format, or I-Deas Archive file format;

e) Software design: UML 2.0 or XML;

f) Model-based Systems Engineering Model: Artisan Studio.

g) Optical design models: Zemax

h) Kinematic model: project specific

i) Dynamic model: project specific

In cases where a different tool is used from the one CSA uses, the model and outputs must be supplied in native format in addition to the required format. For generic modeling and analysis that don't use a specialty tool, CSA will accept Matlab, Excel and MathCad format data. Where a highly specialized tool is used (e.g. bearing analysis, EMC analysis) delivery format must be negotiated with the CSA. Translation from the Contractor's tool to the required format is only acceptable where the results can be repeated in CSA's tool. Translation that corrupts the model, loses data, or produces data that is interpreted differently, is not acceptable.

Assumptions that are used must be stated, along with resulting limits on model accuracy.

DID-604 – Mechanical Models and Analyses

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

PURPOSE:

To support the design of mechanisms and fluid systems (such as heat exchangers), establish feasibility of the design to meet the requirements in the design phase, and in some cases provide verification of compliance to requirements where this cannot be demonstrated directly by test or inspection.

PREPARATION INSTRUCTIONS:

1. GENERIC FORMAT AND CONTENT FOR ALL ANALYSES

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

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

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

Each report must 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 must contain at least example outputs so that the user can check their function, and should contain the main outputs used in the analysis documents.

2. SPECIFIC CONTENTS

The analysis must include torque margin, lubricant loss and contact stress, including external loads and thermally induced stresses. Examples of other issues to be covered are preload analysis, binding and jamming, and mechanism life. Deployment mechanisms must be included in this analysis.

DID-605 – Structural Model and Analysis

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

PURPOSE:

To demonstrate that the design is compatible with the system requirements, when subjected to the worst-case mechanical, thermo-mechanical, and man-induced loads including launch and landing loads, establish feasibility of the design to meet the requirements in the design phase, and in some cases provide verification of compliance to requirements where this cannot be demonstrated directly by test or inspection.

PREPARATION INSTRUCTIONS:

1. GENERIC FORMAT AND CONTENT FOR ALL ANALYSES

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

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

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

Each report must 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 must contain at least example outputs so that the user can check their function, and should contain the main outputs used in the analysis documents.

2. SPECIFIC CONTENTS

Analyses and models must be provided in the following areas, as applicable:

1) Design loads and dynamic analysis
2) Coupled loads analysis
3) Strength and stress analysis
4) Thermo-structural analysis
5) Modal analysis
6) Microgravity Analysis

Comprehensive Finite Element Modeling (FEM) must be used to perform the foregoing analyses. Analysis must cover at least the following sources of loads: launch, deployment and mechanisms.

Models must be subjected to standard quality checks (e.g. total mass = mass analysis, static reaction loads equals mass, no extra rigid-body modes, rigid-body stiffness is zero to within tolerance, temperature-induced loads are zero when temperature is zero, reaction loads are zero when unconstrained model undergoes temperature change.)

The FEMs must be delivered in NASTRAN format (.bdf or .dat).

The structural analysis must cover fracture mechanics analysis. Fracture models must be delivered in NASGRO format.

DID-606 – Mass Model and Analysis

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

PURPOSE:

To establish the mass properties of the system, which would result from the proposed design, support the Launch Vehicle Selection analysis, establish feasibility of the design to meet the requirements in the design phase, and in some cases provide verification of compliance to requirements where this cannot be demonstrated directly by test or inspection.

PREPARATION INSTRUCTIONS:

1. GENERIC FORMAT AND CONTENT FOR ALL ANALYSES

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

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

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

Each report must 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 must contain at least example outputs so that the user can check their function, and should contain the main outputs used in the analysis documents.

2. SPECIFIC CONTENTS

The Mass Model and Analysis must contain the decomposition and allocation process of mass to subsystems, with rationales. As the design progresses, the mass analysis must provide the detailed estimates used to support the Mass TPM report. Mass analysis must consider the whole life of the system, if the design is such that mass properties change.

Mass analysis must cover zeroth, first and second moments of mass (i.e. mass, centre of mass and moments of inertia including cross-products.)

Mass analysis must be complete, showing all calculations and assumptions used for every item estimated.

The mass model must be delivered in one of the generic formats: Excel, Matlab, or MathCad.

The Mass Model and Analysis is required for the Space Segment only, not for the Ground Segment.

DID-607 – Thermal Model and Analysis

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

PURPOSE:

To support the feasibility of the design at system, subsystem, unit, module and assembly levels, by predicting operating temperatures and the amount of heat transferred to the external environment, and in some cases provide verification of compliance to requirements where this cannot be demonstrated directly by test or inspection.

PREPARATION INSTRUCTIONS:

1. GENERIC FORMAT AND CONTENT FOR ALL ANALYSES

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

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

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

Each report must 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 must contain at least example outputs so that the user can check their function, and should contain the main outputs used in the analysis documents.

2. SPECIFIC CONTENTS

The Thermal Model and Analysis must predict the touch temperature of accessible parts of the system, the operating temperature of the electronic or other heat-sensitive components, allowable flight temperature margins, and internal and external heat exchange breakdown. The analysis must cover the worst case of the operating environment (i.e. on-orbit) using beginning and end of life properties. Furthermore, sensitivity analyses must be performed on critical and marginal components.

A comprehensive analysis of heat balance must be completed for cryogenic sub-systems, to clearly demonstrate appropriate margin in heat lift versus heat dissipation, considering all uncertainties related to material properties, heat dissipation, contact resistances and cooler performance (active or passive). A clear strategy must be communicated whereby reserve power is maintained to address anomalous behaviour in any non-redundant cooling equipment.

Two levels of thermal balance are required as a minimum:

a) Spacecraft thermal balance:

The spacecraft thermal balance must define worst-case and nominal budgets for heat exchange of key dissipation sources, sinks and fluxes both internally and externally.

b) Cryogenic region thermal balance:

The cryogenic region thermal balance must describe in detail, dissipation, radiation and other parasitic sources versus the available heat lift. Heat lift margin must be expressed versus worst-case predicted conditions. The cryogenic region includes all equipment with a temperature less than 180K.

Thermal analysis and budgeting must include allowance for contamination build-up for cryogenically operated equipment and radiative surface. Sources of thermal and thermo-optical properties, including contact conductances must be provided.

Specific attention must be given to account for thermal contact resistance variation with key parameters of contact (pressure, material, surface finish, flatness) as they vary with temperature.

Margins for temporal stability must be determined both for spatial and temporal variations, and must cover transient events such as pointing manoeuvres worst-case orbital variations, and spacecraft operational states.

Comprehensive Finite Element Modelling (FEM) must be used to perform this analysis. The Thermal Models must be delivered in TMG universal file format, or I-Deas Archive file format.

DID-629 – Design Trade-off Study

DID Issue: IR **Date: 2014-01-30**

PURPOSE:

To document studies performed to make design decisions.

PREPARATION INSTRUCTIONS:

The Design Trade-off Study may be used for decisions related to architecture, functionality, design, production, etc. The Design Trade-off Study may be prepared in the Contractor's format, and must, as a minimum, contain the following information:

1) Purpose of the study;
2) Cases considered;
3) Criteria definitions;
4) Analysis description;
5) Analysis results;
6) Decisions.

DID-700 – System Conceptual Design Document

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

PURPOSE:

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:

The baseline and 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;
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-754 – Test Procedure

DID Issue: IR **Date: 2013-12-20**

PURPOSE:

To define the procedure to be followed for each test to be performed on Space Segment and Ground equipment, at unit level and higher.

PREPARATION INSTRUCTIONS:

This DID is applicable to systems, hardware and software.

The test procedures must contain the following information, as a minimum:

1. **SCOPE**

   This section must include a brief description of the test and the objectives of the test.

2. **TEST REQUIREMENTS**

   This section must define the measurements and evaluations to be performed by the test, including test cases.

3. **TEST ARTICLE**

   This section must define in detail the test article configuration that is to be tested.

4. **TEST FACILITIES**

   This section must identify the test facilities to be used, including their physical location, coordinates and contact points.

5. **PARTICIPANTS REQUIRED**

   This section must provide a listing of the individuals (position titles, trade or profession) required to conduct or witness the test.

6. **TEST SET-UP AND CONDITIONS**

   This section must include description/sketches of test articles in test configuration illustrating all interfacing test/support equipment. Instrumentation/functional logic must be shown where applicable. The section must include any environmental and cleanliness requirements.

7. **INSTRUMENTATION, TEST EQUIPMENT AND TEST SOFTWARE**

   This section must provide a listing of the instrumentation, test equipment and software that are to be used during the test.

8. **PROCEDURE**

   This section must define the step-by-step procedure to be followed, starting with the inspection of the test article, and describing the conduct of the test up to and including post-test inspection. Each test activity must be defined in sequence and task-by-task, including test levels to be used and measurements/recordings to be made. It must include any necessary malfunction and abort procedure.

9. DATA ANALYSIS

This section must define the methods to be used in the analysis of the results, along with the uncertainty range in the results. Data presentation format must be defined.

10. ACCEPTANCE/REJECTION CRITERIA TABLE

This section must provide data sheets needed during execution of the test specifying acceptance/rejection criteria, including identification of the associated requirements from the Requirements Documents or Specifications. These sheets will be in a tabular form allowing columns for measured values and deviations to be recorded. A computer printout generated by test software is acceptable provided it supplies the same information, however the test criteria must be stated in the Test Procedure.

DID-759 – Test Report

DID Issue: IR **Date: 2013-12-20**

PURPOSE:

To document the results of all tests done on Space Segment and Ground equipment, at unit level and higher.

PREPARATION INSTRUCTIONS:

This DID is applicable to systems, hardware and software.

The test report must document all tests performed to verify that the unit will meet the functional and operational requirements specified in the Requirements Documents or Specifications applicable to the unit.

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

1. **APPLICABLE DOCUMENTS**

   This section must include test procedures and system requirements/specifications being tested.

2. **TEST ARTICLE OR SYSTEM UNDER TEST**

   This section must define in detail the test article configuration tested.

3. **PURPOSE**

   This section must describe the purpose of the test and the specific requirements/specifications that it is intended to verify.

4. **SUMMARY OF TEST RESULTS**

   This section must present a summary of test results, including non-conformances, where applicable.

5. **TEST FACILITIES**

   This section must identify the test facilities used, including their physical location, coordinates and contact points.

6. **TEST SET-UP AND CONDITIONS**

   This section must include descriptions/photos/sketches of test articles in test configuration illustrating all interfacing test/support equipment. Instrumentation/functional logic must be shown where applicable. The section must describe the environmental and cleanliness conditions present, as well as operating conditions (e.g. supply voltage).

7. **INSTRUMENTATION, TEST EQUIPMENT AND TEST SOFTWARE**

   This section must provide a listing of the instrumentation, test equipment and software used during the test.

8. DETAILED TEST RESULTS

This section must record actual test data obtained on tabular sheets prepared in the Test Procedure (or software-generated) during the test performance, and deviations from the criteria.

9. TEST DATA ANALYSIS

This section must document analyses required to relate the detailed results to the requirements to be verified.

10. NON-CONFORMANCES

This section will provide all Non-Conformance Reports generated during the tests. The Non-Conformance Reports will be dated and stipulate the latest NCRB dispositions.

11. CONCLUSIONS AND RECOMMENDATIONS

This section must identify deficiencies, limitations or constraints and propose alternative design solutions and planned corrective action to be evaluated in order to resolve problems encountered in testing.

12. PROCEDURE SIGN-OFF SHEET

A statement that the test article has been tested in accordance with the approved procedure must be signed and dated by the Test Conductor, the Quality Representative and the Customer Representative (where applicable).

DID-800 – Operations Requirements Document

DID Issue: IR **Date: 2014-02-24**

PURPOSE:

To define the operations requirements for the entire mission.

PREPARATION INSTRUCTIONS:

1) Requirements documents must 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 must define the requirements on the mission as a whole and must not contain specific requirements on sub-items. All requirements must be verifiable at the mission level.

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

4) All operations requirements, including operational interface requirements, must be defined and must be verifiable, preferably by test.

5) The operations requirements must respond to the mission requirements and the Concept of Operations (ConOps).

6) The operations requirements must be complete and sufficiently accurate to proceed with the preliminary design.

7) Traceability from operations requirements to mission requirements must be established and maintained throughout the system life cycle.

8) Operational requirements must be derived from the following:

   a) Mission requirements (driver);

   b) ConOps (driver);

   c) Feedback from Requirements Analysis;

   d) Feedback from Validation activities; and

   e) Existing constraints and assumptions.

9) In the development process, new constraints and assumptions must be identified, if any.

10) Requirements must conform to the following standards for quality:

a) They must be unambiguously clear to the intended readership;

b) There must be one requirement per paragraph;

c) Each requirement must have a unique identifier (e.g. an ID number or paragraph number);

d) They must not define design solutions;

e) They must define their source and/or rationale; and

f) They must specify the conditions under which they apply.

D CONTRACTOR DISCLOSURE OF INTELLECTUAL PROPERTY

D.1 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.

This is not to be confused with the identification of the FIP and BIP that will be generated throughout the entire project, which is documented in Section 4.16.

D.2 DEFINITIONS

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

D.3 INSTRUCTIONS FOR COMPLETING IP DISCLOSURE TABLES

Identification

- The Contractor must respond to the 7 questions in Table D-1 when Foreground Intellectual Property (FIP) is created under the Contract with the CSA.

BIP

- If the Contractor intends to use Background Intellectual Property (BIP) to develop the FIP, the Contractor must complete Table D-2 (Disclosure of BIP brought to the project by the Contractor) and forward it to the CSA Project Manager before the beginning of the Contract if any.
- At the end of the Contract, the Contractor must review and update the BIP disclosure (Table D-2) when applicable.
- Only the BIP elements that were used to develop the FIP elements should be listed.

FIP

- At the end of the Contract, the Contractor must complete Table D-3 (Disclosure of the FIP developed under the Contract).
- If Canada is the owner of the FIP and identifies some FIP elements that would benefit from being patented by Canada, the Contractor must also complete Table D-4 (Canada's Owned FIP Additional Information).

General Instructions for BIP and FIP tables

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

TABLE D-1: CONTRACTOR DISCLOSURE OF INTELLECTUAL PROPERTY

1.	Contractor Legal Name:	
2.	Project Title supported by the Contract:	
3.	CSA Project Manager of the Contract:	
4.	Contract #:	
5.	Date of the disclosure:	

6. Will there be Contractor's Background Intellectual Property brought to the project:
   - ☐ Yes – Complete Table D-2 – Disclosure of Background Intellectual Property
   - ☐ No

7. For Canada's owned IP, are there any IP elements that, to your opinion, would benefit from being patented by Canada?
   - ☐ Not applicable, FIP resides with the Contractor
   - ☐ Yes – Complete Table 5 5 – Canada's Owned Additional Information
   - ☐ No

For the Contractor:

Signature Date

For CSA Project Manager:

Signature Date

TABLE D-2: BIP DISCLOSURE

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

TABLE D-3: FIP DISCLOSURE

1 **FIP ID #**	2 **Project Element**	3 **Title of FIP**	4 **Type of FIP**	5 **Description of the FIP**	6 **Reference documentation**	7 **BIP used to generate the FIP**	8 **Owner of the FIP**	9 **Patentability**
Enter an ID # specific to each FIP element *(e.g.FIP-CON-99, where CON is the contract acronym)*	*Describe the system or sub-system for which the FIP element was developed (e.g. a camera, ground control, etc.)*	*Use a title that is descriptive of the FIP element.*	*Specify the form of the FIP e.g. invention, trade secret, copyright, industrial design*	*Specify the nature of the FIP e.g. software, design, algorithm, etc.?*	*Provide the full title and number of the reference document where the FIP is fully described. The reference document must be available to Canada*	*BIP referenced in Table D-2 (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 D-4 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 D-4 only for this IP.*

TABLE D-4: CANADA'S OWNED FIP ADDITIONAL INFORMATION

1 **FIP ID #**	2 **Title of FIP**	3 **Aspects of FIP that are novel, useful and non obvious**	4 **Limitations or drawback of the FIP**	5 **References in literature or patents pertaining to the FIP**	6 **Has the FIP been prototyped, tested or demonstrated? (e.g. analytically, simulation, hardware)? Provide results**	7 **Inventor(s)**	8 **Was the FIP disclosed to other parties?**
ID# should be same as corresponding FIP element in Table D-3.	*Title of FIP should be same as corresponding FIP element in Table D-3.*	*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.*

E NEXT GENERATION SMALL CANADARM (NGSC) DESCRIPTION

The Next Generation Small Canadarm (NGSC) shown in Figure E-1 is a robotic testbed designed for the testing of on-orbit servicing and related tasks. The testbed features a 2.6[m] long arm based on the original Special Purpose Dextrous Manipulator (SPDM) topology, consisting of yaw-pitch-pitch-pitch-yaw-roll configuration (6 joints). This arm is capable of reaching a peak speed of 0.1[m/s] and 7[deg/s] anywhere in its workspace and can hold a payload of up to 10[kg] with a center of mass of 0.1[m] away from the robotic end-effector while fully out-stretched. Built in to the arm is fully integrated robotic force control with force limiting and a force moment sensor designed for peak loads of 70[N] and 18[Nm] (though it is capable of more).

In addition to the arm and joints, the NGSC features a ‘space-like’ End Effector (EE) which includes a grapple mechanism for quick payload changeover, a torque drive for robotic tool operation, and an electrical umbilical that allows for the electrical attachment and detachment of compatible tools. This electrical umbilical can be quickly configured to support direct control of select brushless DC motors through the EE’s internal electronics or re-wired to support Ethernet and power connections to the attached payload.

Running the testbed is an integrated Engineering User Interface (EUI) coupled with a real-time robotic arm control segment that supports both automated and manual operation of the NGSC arm and EE. Automated operations are enabled via a variant of the Lua scripting engine which can operate the arm in all modes and fully supports EE integration. Available arm control modes include:

1. joystick operation modes (single joint and tip space velocity);
2. tool centre point positioning;
3. joint space positioning;
4. tool centre point dynamic trajectory tracking (scripting only), and;
5. visual servoing modes are also supported.

Built-in EE functions available through the EUI include payload grappling, electrical umbilical connection, and manual operation of the torque drive motor.

FIGURE E-1: NGSC TESTBED

F ACRONYMS AND ABBREVIATIONS

AD	Applicable Document
AI	Action Items
AIL	Action Items Log
BIP	Background Intellectual Property
CA	Contract Authority
CASCA	Canadian Astronomical Society
CDRL	Contract Data Requirements List
CM	Configuration Management
ConDR	Concept Design Review
ConOps	Concept of Operations
CSA	Canadian Space Agency
CWBS	Contract Work Breakdown Structure
DID	Data Item Description
DSXR	Deep Space Exploration Robotics
EE	End Effector
ERTS	Environment Requirements and Test Specification (ERTS)
FIP	Foreground Intellectual Property
GER	Global Exploration Roadmap
GERI	Gateway External Robotics Interfaces
GFE	Government Furnished Equipment
GS	Ground Segment
GSE	Ground Support Equipment
ICD	Interface Control Documents
IDD	Interface Design Document
IDR	Interface Design Review
IP	Intellectual Property
IRD	Interface Requirements Document
IRDD	Interface Requirements and Design Document
ISS	International Space Station
IVR	Intra-Vehicular Robotics
JPEG	Joint Photographic Experts Group
KoM	Kick-off Meeting
LEOP	Launch and Early Operations
LPEE	Low Profile End Effector

PGF	Low Profile Grapple Fixture
LoE	Level of Effort
LRP	Long Range Plan
LV	Launch Vehicle
MAR	Mission Assurance Requirements
MCR	Mission Concept Review
MDP	Mission Development Plan
MIPS	Manipulator Interface Plate System
MM	Mission Manager
MRD	Mission Requirements Document
MRR	Mission Requirements Review
NGSC	Next Generation Small Canadarm
NASA	National Aeronautics and Space Administration
OGD	Other Government Departments
PA	Product Assurance
PAR	Product Assurance Requirements
PAIP	Product Assurance and Implementation Plan
PFR	Performance and Functional Requirements
PM	Project Manager
RD	Reference Document
RID	Review Items Discrepancy
SCD	System Conceptual Design
SLA	Stereolithography
SOW	Statement Of Work
SRD	System Requirements Document
SRR	System Requirement Review
TM	Technical Manager
TB	Treasury Board
TBC	To Be Confirmed
TBD	To Be Determined
TRRA	Technology Readiness and Risk Assessment
TRL	Technology Readiness Level
TRM	Technology Roadmap
WBS	Work Breakdown Structure
WPD	Work Package Description