

ICESat-2 Controlled Document
Released by: N. Brown 02/22/2011

**ICE, CLOUD, and Land Elevation Satellite
(ICESat-2) Project**

**Mission Operations Center
(MOC)
Statement of Work
(SOW)**

ICESat-2-MOC-CTR-0472

Revision A

Effective Date: February 22, 2011

Expiration Date: February 22, 2016



**National Aeronautics and
Space Administration**

**Goddard Space Flight Center
Greenbelt, Maryland**

CM Foreword

This document is an Ice, Cloud, and Land Elevation (ICESat-2) Project (CM)-controlled document. Changes to this document require prior approval of the applicable Configuration Control Board (CCB) Chairperson or designee. Proposed changes shall be submitted to the ICESat-2 CM Office (CMO), along with supportive material justifying the proposed change.

In this document, a requirement is identified by "shall," a good practice by "should," permission by "may" or "can," expectation by "will," and descriptive material by "is."

Questions or comments concerning this document should be addressed to:

ICESat-2 Configuration Management Office
Mail Stop 420
Goddard Space Flight Center
Greenbelt, Maryland 20771

*** Signatures are available on-line at: <https://icesat-2mis.gsfc.nasa.gov> ***

Table of Contents

CM Foreword	i
CHANGE RECORD PAGE	ii
List of TBDs/TBRs	iii
Table of Contents	iv
List of Tables	vi
1.0 Introduction	1
1.1 Scope	1
1.1.1 Definitions	2
1.1.2 Applicable Documents	3
1.1.3 Reference Documents	4
1.1.4 Work to be Performed	4
2.0 Management	5
2.1 Project Management	5
2.1.1 Government Insight	5
2.1.2 Government Visitor Support	5
2.1.3 Access to Controlled Facilities	5
2.1.4 Risk Management	6
2.1.5 Software Management	7
2.1.6 Reviews and Meetings	7
2.1.7 Other Reviews and Meetings	11
2.2 Configuration and Data Management	13
2.2.1 Action Item Tracking	13
2.2.2 Problem tracking	13
2.2.3 Internal Technical Memoranda	14
2.2.4 Electronic Access	14
2.3 Schedule Management	14
3.0 Systems Engineering	15
3.1 Requirements Management	15

3.2	Interface Definition and Verification	16
3.3	Design and Performance Verification.....	16
4.0	Ground System and Software Assurance.....	18
4.1	Independent Verification and Validation (IV&V)	19
5.0	Mission Operations Center (MOC) Development	20
5.1	Design and Development.....	20
5.1.1	Telemetry, Command and Control.....	20
5.1.2	IT and Communication Security.....	20
5.2	Integrate and Test.....	21
5.3	Delivery Support	21
6.0	Integration, Testing, and Operations Readiness.....	24
6.1	Integration and Testing	24
6.1.1	MOC Facility Plan	25
6.1.2	Ground System and Mission Integration	25
6.2	Operations Readiness	25
6.2.1	MOC Training	25
6.2.2	Mission Simulations and Launch Rehearsals	26
7.0	Early Orbit Operations and Acceptance	27
7.1	MOC Early Operations Support	27
7.2	MOC Acceptance.....	27
8.0	Engineering Support.....	28
8.1	Nominal Operations Engineering Support.....	28
8.2	Task Support.....	28
9.0	Mission Operations.....	29
9.1	Flight Operations Team	29
9.2	Routine Operations Support.....	29
9.3	Non-Routine Operations Support.....	30
	Glossary/Acronyms	31

List of Tables

Table 5-1 MOC Delivery Capabilities 22
Table 6-1 ICESat Integration and Test Milestone Schedule..... 24

Released Version

1.0 INTRODUCTION

The Ice, Cloud, and land Elevation Satellite (ICESat)-2 mission is the successor mission to ICESat. The ICESat mission is the benchmark Earth Observing System mission for measuring ice sheet mass balance, cloud and aerosol heights, as well as land topography and vegetation characteristics. The ICESat-2 mission objective is to extend the ability to detect and quantitatively characterize changes on the global ice surface at a scale where natural and man-made causes of change can be detected and differentiated.

The ICESat-2 Mission has the following high-level goals:

1. To determine the contribution of the giant ice sheets to sea level rise;
2. To make direct measurements of sea ice thickness, in order to respond to concerns about the sea ice cover, especially in the Arctic, where sea ice is diminishing in both thickness and area; and
3. To determine the aboveground terrestrial biomass and carbon storage from measurements of vegetation canopy height.

1.1 Scope

This Statement of Work (SOW) defines the minimum effort required of the Contractor that shall include but is not limited to the design, engineering analyses, development, integration, test, evaluation, delivery, operations, sustaining engineering and support for the ICESat-2 primary Mission Operations Center (MOC) and the backup Mission Operations Center (bMOC).

The primary functions of the MOC include observatory command and control, mission planning and scheduling, trending and analysis, orbit and attitude determination and control, health and safety monitoring, on-board storage management, verification of the X band Science data capture statistics and flight software management.

The MOC shall interface with the Instrument Support Facility (ISF) and forward S/C and ATLAS housekeeping data obtained from S band realtime and playback housekeeping telemetry. The ISF shall provide the MOC with instrument activity requests including supporting information so that the MOC can insert instrument activities into the Observatory schedules and plans. The supporting information will include commands to execute, command and/or flight software loads, and constraints/contingencies for the activity. The ISF will also send the MOC ATLAS command information to be uplinked via the MOC T&C. The MOC shall provide an instance of the MOC S band Observatory housekeeping trending system to the ISF. The MOC to ISF interface requirements are specified in CDRL MO-2. The MOC provided ISF elements are specified in CDRL MO-23.

The Government is responsible for providing the ATLAS instrument and the Ground System, other than the MOC and bMOC. The Government is also responsible for mission systems integration and mission operations for non-MOC systems. The Contractor shall support the MOC-related portions of the Government's ground system integration and mission system

integration efforts. The Contractor shall have the capability to command and monitor the observatory during integration and testing (I&T).

ICESat-2 Mission Operations during the Launch and Early Orbit (LEO), observatory check-out, commissioning and throughout the mission life phases will be performed by the Contractor provided Flight Operations Team (FOT) and will be conducted from the MOC. The backup MOC will serve in a backup role during all mission phases including the Launch and Early Orbit, observatory checkout, and commissioning phases. The backup MOC (bMOC) shall, at a minimum, be able to perform health and safety monitoring, commanding, and mission planning.

This Statement of Work requires delivery of all contract deliverables associated with the MOC development, operations and sustaining engineering through decommissioning. The MOC shall meet the requirements of all contractual documents.

Provisional operational acceptance of the MOC shall take place prior to the launch of the ICESat-2, following the verification of all requirements, successful completion of all MOC testing, and the successful completion of the ICESat-2 Operations Readiness Review. Final acceptance of the MOC shall take place during on orbit commissioning phase of the ICESat-2 observatory, following successful verification of the post-launch MOC delivery/release (this release may or may not be required but should be planned for by the contractor).

After final acceptance of the MOC, the Contractor shall continue to maintain the MOC and perform all flight operations activities through decommissioning activities.

1.1.1 Definitions

The following definitions apply to this document:

Shall – Compliance by the Contractor is mandatory. Any deviations from these contractually imposed mandatory requirements require the approval of the Contracting Officer.

May – At the discretion of the Contractor or Government.

Will – Designates the intent of the Government. Unless required by other contract provisions, noncompliance with the will requirements does not require approval of the contracting officer and does not require documented technical substantiation.

Engineering Peer Review (EPR) – a meeting with approximately 2 to 5 Government representatives to discuss specific details of a given subsystem design or performance, subsystem test results, mode performance, etc. EPRs typically take place at the Contractor's facility and take a day. EPRs are the principal means to familiarize review team members prior to a major design review. EPR actions are formally tracked by the EPR organizer and status provided to the project to verify closure of action items.

Technical Interchange Meeting (TIM) – a meeting with approximately 5 to 10 Government representatives to discuss a system process or feature. For example, to reach understanding of an operation or analysis, presentation of test results, discuss planned interface changes, plan for an

upcoming test, etc. TIMs typically are held at the Contractor's facility and run no more than two days. Actions are informally tracked by the TIM organizer.

Design Review (DR). Design reviews are major milestones in the implementation where information is formally presented to a panel of Government experts and external reviewers. DRs can involve up to 30 Government representatives and run up to four days. Action items are formally logged and tracked by the Project Office.

1.1.2 Applicable Documents

The documents listed in this section apply directly to the performance of the ICESat-2 Mission Operations Center (MOC) Contract. These documents establish detailed specifications, requirements, and interface information necessary for the performance of the contract. Unless otherwise specified, the document version listed herein shall apply. In case of conflicting requirements, the order of precedence of documents not specifically called out in the Contract is: this Statement of Work, and then the Contract Data Requirements List.

- a. ICESat-2 Mission Operations Center (MOC) Contract Data Requirements List (CDRL) ICESat-2-MOC-CTR-0473.
- b. ICESat-2 Mission Operations Center Requirements Document: Document Number ICESat-2-MOC-REQ-0537.
- c. ICESat-2 Ground System Requirements Document (GSRD) ICESat-2-GSPM-REQ-0330
- d. ICESat-2 Mission Assurance Requirements (MAR) ICESat-2-SMA-REQ-0009
- e. ICESat-2 Spacecraft to Ground Interface Description Document ICESat-2-SYS-IFACE-0324
- f. ICESat-2 Acronym List and Lexicon, ICESat-2-MGMT-REVW-0234.
- g. Criteria for Flight Project Critical Milestone Reviews, GSFC-STD-1001
- h. NPR 2810.1, Security of Information Technology
- i. NIST Special Publication 800-53 Revision 3
- j. National Security Agency (NSA)/Central Security Service (CSS) Policy Manual No. 3-16
- k. NPR 7150.2A NASA Software Engineering Requirements
- l. Committee on National Security Systems (CNNS) Policy No. 12
- m. NASA Policy Directive 8010.2, Use of the SI (Metric) System of Measurement in NASA Programs
- n. GPR 1060.2, Management Review and Reporting for Programs and Projects
- o. GPR 8700.4, Integrated Independent Reviews
- p. NPR 5100.4, Federal Acquisition Regulation Supplement
- q. NPR 8000.4, Risk Management Procedural Requirements
- r. NPR 8715.3, NASA Safety Manual
- s. GPR 7120.4, Risk Management
- t. NPR 8715.6A NASA Procedural Requirements for Limiting Orbital Debris

1.1.3 Reference Documents

- a. ICESat-2 Mission Operations Concept, ICESat-2-SYS-PLAN-0006
- b. NASA NPR 7120.5D NASA Space Flight Program and Project Management Requirements
- c. ICESat-2 Mission Requirements Document, ICESat-2-SYS-REQ-0147

1.1.4 Work to be Performed

This section, along with the Contract Data Requirements List (CDRL) document ICESat-2-MOC-CTR-0473 describes the specific work to be accomplished by the MOC Contractor. In accordance with the requirements of this document, the contract, all associated requirements documents, and the other attachments and applicable documents to this contract, the Contractor shall provide the personnel, materials, equipment, and facilities necessary for the successful and on-time implementation of the design, analysis, development, integration, test, engineering data analyses, qualification, delivery, installation, operation and sustaining engineering of the ICESat-2 MOC.

The Contractor shall successfully operate and maintain the ICESat-2 observatory for all phases of the mission starting from LEO through decommissioning. This shall include observatory health and safety monitoring, mission planning, commanding, SSR management and monitoring, orbit and attitude determination and control, flight software maintenance, and anomaly resolution.

The Contractor shall deliver and install a primary and backup MOC that are fully tested and have demonstrated compliant and reliable end-to-end operation in accordance with the requirements of this contract. The Contractor shall also provide the FOT, train the FOT and operate the MOC and bMOC for the life of the mission.

2.0 MANAGEMENT

2.1 Project Management

The Contractor shall maintain a project office to manage the technical activities and resources of the MOC project. The Contractor shall appoint a Project Manager to direct and manage the MOC project. The Contractor's Project Manager shall have responsibility for the overall technical performance, resource management, and schedule management of the contractual effort and all subcontracts. The Contractor's designated Project Manager shall report to a level of company management appropriate to ensure prompt resolution of all problems.

The Contractor shall prepare a Project Management Plan, and a Final Report in accordance with CDRL PM-11, and CDRL PM-4, respectively.

2.1.1 Government Insight

The Contractor shall open to Government attendance all Contractor and subcontractor internal data, reviews, audits, meetings and other activities within the scope of the contract. For access and insight activity, "Government" includes Government personnel and Government contractor personnel. The Contractor shall allow and enable the use of Non-Disclosure Agreements with Government contractors where appropriate. The Contractor shall notify the Contracting Officer and the Contracting Officer's Technical Representative (COTR) of meetings, reviews or tests in sufficient time (nominally at least 10 working days for major reviews and formal tests) to permit meaningful Government participation.

2.1.2 Government Visitor Support

The Contractor shall provide facilities to support two visiting Government representatives at the MOC development site, including office space, telephones, and network access to the Contractor's electronic database, from the start of MOC integration with the ICESat-2 Ground System. The Contractor shall provide within this office space high-speed (broadband) internet access and the ability to use GSFC VPN to allow for access to the GSFC networks. Government representatives shall include government employees or technical support contractors, including but not limited to project management, technical and engineering staff.

2.1.3 Access to Controlled Facilities

The Contractor shall obtain all required access authorizations and submit any paperwork required for the Contractor to access Government controlled facilities.

The Contractor shall allow access by the Government to all Contractor facilities related to ICESat-2 MOC.

2.1.4 Risk Management

The Contractor shall establish and maintain a comprehensive risk management program. The Contractor shall generate a top risk report that is presented and reviewed at all Monthly Project Status Reviews (MPSRs). The Contractor shall provide an estimate of the potential cost impact if risks were to become real problems. The Contractor shall invite the Government to attend Contractor Risk Management Board meetings. The Contractor shall develop and implement a project-specific Risk Management Plan (RMP), in accordance with CDRL PM-12, as a means to anticipate, mitigate and control risks and to focus project resources to ensure success of the project.

The primary activities of the Contractor Continuous Risk Management (CRM) process are:

- a. Identify, analyze, plan actions/mitigations, track, control, and document reliability, quality, technical performance, schedule, and budget risks before they become problems.
- b. Evaluate, classify, and prioritize all identified risks.
- c. Develop and implement risk mitigation strategies, actions, and tasks and assign appropriate resources.
- d. Track risk being mitigated; capture risk attributes and mitigation information by collecting data; establish performance metrics; and examine trends, deviations, and anomalies.
- e. Control risks by performing: risk close-out, re-planning, contingency planning, or continued tracking and execution of the current plan.
- f. Communicate and document (via the risk recording, reporting, and monitoring system) risk information to ensure it is conveyed between all levels of the project.
- g. Report on outstanding risk items at all management and design reviews.

The GSFC Project Office and the MOC Contractor will agree on what level of detail is appropriate for each review.

The Contractor shall document the project-specific implementation of the CRM process in a RMP in accordance with CDRL PM-12. Preparation of the RMP is a requirement established by NPR 7120.5 and includes the content shown in NPR 8000.4, "Risk Management Procedural Requirements."

The Contractor shall document and report all identified risks in accordance with the project's RMP. The Contractor shall address identified risk areas at project status reviews and at Integrated Independent Reviews (GPR 8700.4). The Contractor shall make risk status available to all members of the project team for review. Although not all risks will be fully mitigated, the Contractor shall address all risks with mitigation and acceptance strategies agreed upon at appropriate mission reviews.

The Contractor shall maintain a Risk List throughout the project life cycle, along with programmatic impacts. The list should indicate which risks have the highest probability, which have the highest consequences, and which risks represent the greatest risk to mission success.

The list should also identify actions being taken to address each specific risk. The Contractor shall maintain the Risk List under configuration control.

For each primary risk (those having both high probability and high impact/severity), the Contractor shall prepare and maintain the following in the risk sections of the Project Plans:

- Description of the risk, including primary causes and contributors, current mitigation strategy, and information collected for tracking purposes.
- Primary consequences should the undesired event occur.
- Estimate of the probability of occurrence (qualitative or quantitative) together with the uncertainty of the estimate and the effectiveness of any implemented risk mitigation measures.
- Potential additional risk mitigation measures, which shall include a comparison of the cost of risk mitigation versus the cost of occurrence multiplied by the probability of occurrence.
- Characterization of a primary risk as “acceptable” shall be supported by a rationale (with the concurrence of the GSFC ICESat-2 Project Office) that all reasonable mitigation options (within cost, schedule, and technical constraints) have been instituted.

2.1.5 Software Management

The Contractor shall document in the Software Development and Management Plan (SDMP), in accordance with CDRL MO-9, the software management approaches and processes for software analysis, design, development, documentation, version control, test, validation, risk management, metric collection, and assurance of all software products. The Contractor shall adhere to the SDMP.

2.1.6 Reviews and Meetings

The reviews listed in this section shall not be considered a comprehensive set of reviews for the Contractor’s program. Additional reviews that the Contractor deems necessary to successfully execute the program may be conducted at the Contractor’s discretion. The Contractor shall notify the Government at least 10 working days in advance of lower level Contractor subsystem reviews to allow the Government time to attend the review as part of its insight activities.

2.1.6.1 Milestone Reviews

All milestone reviews will be convened and review boards appointed and chaired by the Government. The Contractor shall demonstrate compliance with the review success criteria of GSFC-STD-1001, Criteria for Project Flight Critical Milestone Reviews, as applicable to the MOC. The Contractor shall respond as required to action items assigned by the Government. The Government will convene a delta review if the success criteria for a review are not met to the Government’s satisfaction. The Contractor shall prepare and present their portion of these reviews, as appropriate.

2.1.6.2 MOC Reviews

The Contractor shall host, prepare and present the MOC Level independent milestone reviews and provide review packages in accordance with the stated CDRLs:

- MOC System Requirements Review (M-SRR), CDRL RE-1
- MOC Preliminary Design Review (M-PDR), CDRL RE-2
- MOC Critical Design Review (M-CDR), CDRL RE-3
- MOC System Integration Review (M-SIR), CDRL RE-5

The Contractor shall assume that each MOC review requires one day to complete. For planning purposes the Contractor shall assume the following dates for these reviews. The actual review dates will be negotiated after contract award with M-PDR and M-CDR tracking closely with the Ground System PDR and Ground System CDR dates.

Review	Date
M-SRR	ATP + 3 Months
M-PDR	ATP + 11 Months
M-CDR	ATP + 23 Months
M-SIR	ATP + 40 Months

MOC Reviews will be less formal than Ground System, Mission, Spacecraft, and Instrument independent reviews, and will be working-level in nature. The Contractor shall coordinate the review agenda and content with the Government. The Contractor shall respond to action items as requested by the Government. The Government will convene a delta review if the success criteria for a review are not met to the Government's satisfaction. The Contractor shall host these delta reviews, and prepare and present these reviews. For proposal purposes, the Contractor shall assume one delta review will be required during the contract duration.

2.1.6.3 Ground System Reviews

The Contractor shall prepare and present the Mission Operations Center (MOC) portion of the Ground System Reviews in accordance with the CDRL RE-6:

- Ground System Preliminary Design Review (GS-PDR)
- Ground System Critical Design Review (GS-CDR)

The Government will host and will also present material at Ground System reviews, to be conducted at GSFC. The Contractor shall support and attend the Ground System reviews. The

Contractor shall support and attend Ground System review dry-runs, which will be hosted by the Government. The Contractor shall respond to action items as requested by the Government. The Contractor shall participate in Ground System review dry-runs with the Government approximately three weeks in advance of each review. The Contractor shall assume the dry run location will be the same as that of the review. The Contractor shall assume that each Ground System review and each dry-run requires two days to complete.

2.1.6.4 ICESat-2 Mission Level Reviews

The Contractor shall participate in and support the Government in preparation for the following Mission Level independent milestone reviews:

- Mission Preliminary Design Review (Mission PDR)
- Mission Critical Design Review (Mission CDR)
- System Integration Review (SIR).
- Decommission Review (DR).

The Contractor shall prepare and present a portion of the following Mission Level reviews and provide their portion of the review packages in accordance with CDRL RE-6:

- Mission Operations Review (MOR)
- Flight Operations Review (FOR)
- Operational Readiness Review (ORR)
- On-Orbit Acceptance Review (OAR).

The Government will lead, host and present material at Mission-level reviews. The Contractor shall respond to action items as requested by the Government. The Contractor shall participate in a dry run of all Mission-Level Milestone Reviews with the Government starting three weeks in advance of each review. The Contractor shall plan to support the dry runs of reviews via telecon. The Contractor shall assume that the Mission Level reviews will take three days and that dry runs will take two days. The Contractor shall assume that Mission-level reviews and dry-runs will occur at the NASA Goddard Space Flight Center.

The Contractor shall also support as necessary the following additional Mission-Level Reviews:

- Safety and Mission Success Review (SMSR)
- Flight Readiness Review (FRR)
- Launch Readiness review (LRR)
- Post-Launch Assessment Review (PLAR)
- Critical Event Readiness Review (CERR)

It is expected that these additional reviews require a lesser degree of preparation and participation by the MOC Contractor than the other Mission-Level Reviews.

2.1.6.5 Instrument Milestone Reviews

The Contractor shall attend and support the ICESat-2 instrument Contractor(s) in preparation for the following instrument reviews:

- ATLAS Instrument Critical Design Review (ICDR)

The Contractor shall present MOC information and other material as appropriate. The Contractor shall assume two days of attendance at each review at the instrument Contractor's facility.

2.1.6.6 Spacecraft Reviews

The Contractor shall attend and support the Government in preparation for the following spacecraft reviews:

- Spacecraft System Requirements Review (SSRR)
- Spacecraft Preliminary Design Review (SPDR)
- Spacecraft Critical Design Review (SCDR)

The Contractor shall assume three days of attendance at the spacecraft Contractor's facility for each review.

2.1.6.7 Ground System Element Reviews

The Contractor shall participate in and support, via telecom, the Government at the following Ground System Element reviews:

- Science Investigator-led Processing System (SIPS) Critical Design Review
- ISF Critical Design Review

The Contractor shall assume one day for each Critical Design Review.

2.1.6.8 Engineering Peer Reviews (EPR)

The Contractor shall define and implement a set of Engineering Peer Reviews (EPRs) for the subsystems of the Mission Operations Center commensurate with the scope, complexity and acceptable risk of the product. The Contractor shall submit the Peer Review Plan in accordance with CDRL PM-5.

The Contractor shall chair and host EPRs at the Contractor's facilities with Government participation on the review panels. The Contractor shall document EPRs in accordance with CDRL RE-7, Engineering Peer Review Data Packages. The Contractor shall systematically and comprehensively peer review the product at the individual subsystem level and lower levels, as appropriate. Subsystem and software design reviews are considered to be EPRs and subject to this procedure. The Contractor shall conduct multiple peer reviews, as appropriate, over the lifecycle of each subsystem and component, with content consistent with the evolving design and

development. Applicable peer reviews shall be completed prior to and summarized at the corresponding MOC review (e.g. M-CDR). As a minimum, the Contractor shall complete an appropriate set of subsystem or lower-level peer reviews for customized portions of the MOC prior to MOC PDR and again prior to MOC CDR. Successful completion of these reviews and resolution of associated technical issues and actions is considered to be an important aspect of entry criteria in the formal review process.

The Contractor shall also use EPRs for the focused evaluation of concepts, designs, plans and processes associated with combinations of subsystems and system functions that cross traditional subsystem or discipline boundaries.

As a minimum, but not limited to, four EPRs shall be conducted to cover the following items prior to PDR and again prior to CDR:

- Planning and Scheduling/Command management system including any SW that is used to build observatory Load Files, Flight SW loads and to include the interface to SNAS, NEN WOTIS and ISF.
- Telemetry and Command System including the Front End Processor
- MOC automation and availability design & implementation
- MOC and bMOC Network and Security Implementation

The Contractor shall track action items from EPRs and maintain EPR presentation and closure documentation for the duration of the contract.

2.1.7 Other Reviews and Meetings

2.1.7.1 Scheduled Weekly Telecons

In addition to other informal communications, the Contractor shall participate in a scheduled weekly telecon with the ICESat-2 Project Office to communicate status, issues, and schedule progress and plans of the overall contract effort. The Contractor shall establish the meeting agenda and distribute meeting minutes and other documentation as required. The Contractor shall provide detailed status, description of issues, and schedule for each major element of the contract.

2.1.7.2 Monthly Project Status Reviews

The Contractor shall communicate the status of the MOC technical effort, schedule, and resource condition to the ICESat-2 Project on a monthly basis. The Contractor shall develop and deliver a monthly project status review package, in accordance with CDRL PM-1. The monthly project status review package shall include Integrated Master Schedules (IMS) prepared in accordance with CDRL PM-2. The Contractor shall participate in one-half day to one day face-to-face

project status reviews in conjunction with the spacecraft MSR's on a quarterly basis. The Contractor shall support monthly status reviews via telecon for the months' status that are not conducted in face to face meetings. The Contractor shall participate in splinter meetings with the Government for one additional half day immediately following each face-to-face quarterly-monthly project status review.

2.1.7.3 Technical Interchange Meetings (TIMs) and Working Groups (WGs)

2.1.7.4 The Contractor shall inform the Government at least one week in advance of technical interchange meetings resolving technical issues concerning critical MOC systems or sub-systems. In certain cases TIMs may be combined with monthly status meetings. TIMs shall also include discussion of prioritized development and delivery schedules. For planning purposes, the contractor shall assume up to six TIMs per year, conducted via telecom or combined with other element reviews or status meetings. The Contractor shall participate in Government-led working groups. At the time of the writing of this document, planned Government-led working groups likely requiring MOC Contractor participation include Systems Engineering, Integration and Test (I&T), MOC Interfaces, Mission Operations, IT Security, Communications Security (COMSEC), On orbit verification, data systems working group, ground operations launch site working group, and Space-to-Ground Interface. The Contractor shall assume for planning purposes participation in up to twelve working groups per year, requiring support equivalent to 2 person-days per month; Location will be via Telecon or combined with other reviews and status meetings Status and Planning Meetings

The Contractor shall notify and allow the Government access to Contractor status and planning meetings, including daily stand-ups and tag-ups.

2.1.7.5 Kickoff Meeting

The Contractor shall present for review the plans, schedules, and activities required to meet the Contract requirements. The agenda and information to be presented shall be coordinated with the Government prior to the meeting, and will largely be based on the Contractor's proposal, updated to reflect any changes since the offer submission, including any directed changes. The

Kickoff Meeting shall occur at the Contractor's facility 2 weeks following the MOC contract award. The Contractor shall provide a copy of the material presented at the Kickoff Meeting.

2.2 Configuration and Data Management

The Contractor shall perform configuration management (CM) in support of the MOC project. The Contractor shall develop and deliver the Hardware and Software Configuration Management Plan in accordance with CDRL PM-10. The Contractor shall notify the Government of CCB meetings and allow Government participation at all CCB meetings. The Contractor shall maintain configuration of all MOC deliveries/releases and all other deliverable items throughout all phases of development, test and operations of the MOC. The Contractor shall perform and document configuration verification as sub-systems are incorporated into higher-level systems and at major Project milestones. The CM system shall have a change classification and impact assessment process that results in Class 1 and Class 2 Configuration Change Requests (CCRs) being forwarded to the ICESat-2 Project in accordance with CDRL SE-1. Class 1 changes are defined as changes that impact mission science and performance requirements, system safety, cost, schedule, single point failures, and external interfaces. All other changes are considered to be Class 2 changes.

The Contractor shall submit for Government consideration a waiver or deviation for any item that is found to be non-compliant with the requirements of the contract Statement of Work (SOW) or the MOC-Requirements document and is not reworked to be compliant, or is not replaced with a compliant item.

The Contractor shall prepare and provide the following configuration control documentation:

- Configuration Control Board (CCB) status shall be reported at the Monthly Project Status Review and in all monthly status packages in accordance with CDRL PM-1
- The Configuration Item Identification List (CIIL) and the Computer Software Configuration Items (CSCIs) in accordance with CDRL SE-8.

2.2.1 Action Item Tracking

The Contractor shall develop and apply a process for capturing and responding to action items assigned by the review boards, at monthly meetings, technical interchange meetings, and working group meetings. Milestone reviews, as defined above, are not complete until actions are complete or a detailed plan for closure is submitted and approved by the Government.

2.2.2 Problem tracking

The Contractor shall develop a closed-loop problem tracking process that includes problem or discrepancy reporting, problem analysis, and corrective action, and closure. The process shall include: a protocol to review past performance to determine the incidence of identical or related discrepancies, an escalation procedure (to inform higher levels of management and the

Government) based on mission criticality, and a closeout process for root cause determination, anomaly mitigation, and recurrence control. The Contractor shall provide Government access to the Contractor's problem tracking process, including the ability to remotely view and submit problems (discrepancy reports), submit a recommended priority for action, and review problem status.

2.2.3 Internal Technical Memoranda

The Contractor shall provide all MOC-relevant technical internal memoranda as requested by the Government in accordance with CDRL SE-2, Contractor Generated Internal Technical Information. The correspondence can be informal to preserve timeliness. The Government shall have access to these memoranda on a timely basis via hard copy or the electronic library described below.

2.2.4 Electronic Access

The Contractor shall provide to the Government and Government contractor personnel, for review purposes, access via remote desktop computer to a general purpose MOC-specific electronic library. This library shall contain all completed reports, analyses, requirements documentation, internal technical memoranda, change requests and documentation, CDRLs, and all other MOC-specific documents prepared by the Contractor. Within this library the Contractor shall maintain an index of the material (updated monthly) and a search engine for document access. The non-CDRL material contained in these electronic databases may be in Contractor format. The Contractor shall make the contents of the electronic library remotely downloadable. The Contractor shall include engineering drawings in this library or provide some other storage/retrieval arrangement, at their option.

2.3 Schedule Management

The Contractor shall establish, implement, and maintain an integrated scheduling system consistent with their corporate procedures and documented in a CDRL PM-11. The Contractor shall provide and maintain an Integrated Master Schedule in accordance with CDRL PM-2. The Contractor shall obtain approval from the Government prior to changing the IMS baseline.

3.0 SYSTEMS ENGINEERING

The Contractor shall perform systems engineering to support all MOC-related activities during all stages of development, operations and sustaining engineering.

The systems engineering effort shall include, but is not limited to, requirements management, analyses of technical requirements, functional and performance allocation of derived requirements, traceability, definition and maintenance of all interfaces, MOC design and verification of all defined, allocated, and derived requirements, systems analyses and special studies as required, risk management support, and tradeoff analyses. This shall include but not be limited to the following specific activities:

- a. Providing systems engineering technical direction and oversight throughout all phases of the project.
- b. Leading and supporting all peer reviews, project milestone, and status reviews as defined in section 1.2, and preparing related documentation.
- c. Performing all necessary system studies, trades, and risk assessments necessary to develop the MOC design consistent with CDRL SE-20.
- d. Performing all necessary coordination, studies and analyses required to interface the MOC to the ICESat-2 observatory, observatory simulator, and all Government ICESat-2 ground assets, including support to ground system requirements development and mission operations consistent with CDRL SE-20.
- e. Performing systems engineering and analysis in support of tests at the MOC level and throughout ground system and mission integration consistent with CDRL SE-20.
- f. Supporting system level technical interface meetings, including technical issue resolution, performance verification plan buy-offs, pending configuration change requests (CCRs), CDRL data submission review/approval status, test data review, anomaly resolution activities, and test support planning.

3.1 Requirements Management

The Contractor shall provide the definition, allocation, derivations, and traceability of system and subsystem requirements, including software requirements, and the verification approach.

The Contractor shall conduct complete analyses and simulations in support of technical requirements compliance demonstrations to fully establish, define, maintain, and control budget allocations for all required performance and design parameters.

Tasks include the following as a minimum:

- a. Performing requirements management and traceability using a commercial software tool.
- b. Flow-down and traceability of MOC Requirements Document (MOC-RD) requirements to lower-level system and software requirements, and developing the MOC Lower-Level Systems Requirements Document (SRD) in accordance with CDRL MO-3.

- c. Ensuring that all requirements are forward and backward traceable (“parent/child” relationship traceable) between system and software requirements and between software requirements, design, and test.
- d. Functional and performance allocations and derivations.
- e. Maintaining and controlling critical MOC technical performance metrics, margins, budgets that are reported at the Monthly Status Reviews.

3.2 Interface Definition and Verification

The Contractor shall meet the interface requirements of the ICESat-2 Mission Operations Center Requirements Document and the ICESat-2 Spacecraft to Ground Systems IDD. The Contractor shall review and develop inputs to the MOC ICDs in accordance with CDRL MO-2.

3.3 Design and Performance Verification

The Contractor shall design the MOC system to meet the requirements of the Mission Operations Center Requirements Document. The Contractor shall develop and deliver the Specification Tree in accordance with CDRL SE-13. The Contractor shall maintain and manage MOC requirements in an electronic format.

The Contractor shall develop and maintain all necessary plans and procedures to verify that the MOC meets all requirements described in the ICESat-2 Mission Operations Center Requirements Document. The Contractor shall perform MOC requirements verification in accordance with approved plans and procedures. The Contractor shall also perform and document all analyses of the data and information from the design, development, testing, and acceptance of the Contractor’s hardware and software that are required to ensure that the MOC will meet its specifications and objectives. These tasks include, but are not limited to the following:

- a. Preparing and maintaining the System Performance Verification Plan and Matrix (CDRL SE-6) for use at the software, subsystem, and MOC system level, including the MOC integration with the observatory, observatory simulator, and Government ICESat-2 assets; and for use in interface verification.
- b. Performing MOC requirements testing and verification in accordance with the approved System Performance Verification Plan, Matrix, and all other test plans and procedures.
- c. Analyzing and making available for inspection the required lower level design specifications in order to meet higher-level performance requirements. All such analyses shall be identifiable and accessible for Government review.
- d. Preparing and maintaining verification test procedures for use at the software, subsystem, and MOC system level.
- e. Providing systems engineering support to development of installation procedures and interface checkout/testing procedures.
- f. Providing the necessary effort and support systems for MOC analysis during all levels of testing, interface verification, and during acceptance.

- g. Perform the necessary systems engineering tests and analyses to assure that all requirements of this contract are accomplished successfully and on time.
- h. Conducting test evaluation and test reporting, and providing MOC Verification Reports compliant with CDRL SE-7.
- i. Providing a MOC Users Manual in accordance with CDRL MO-15

Released Version

4.0 GROUND SYSTEM AND SOFTWARE ASSURANCE

For all MOC software, the Contractor shall demonstrate compliance with the NASA Software Engineering Requirements specified in the NPR 7150.2A, including providing all required documentation and deliverables. This document provides the minimal set of requirements established by the Agency for software acquisition, development, maintenance, operations, and management.

The Contractor shall develop, implement, and maintain a software assurance program that meets the requirements of the NASA-STD-8739.8. The Contractor shall assume the MOC software assurance classification is Class C, with mission critical subsystems (T&C and Front Ends) being Class B. The Contractor shall adhere to the requirements of Sections 6 and 7 of NASA-STD-8739.8, perform all required tasks, and deliver all documents and data required. The Contractor shall develop and deliver a Software Assurance Plan as part of the Software Development and Management Plan (CDRL MO-9).

The Contractor shall classify all MOC software at the functional element / application-level as belonging to one of the following criticality classifications and shall define the management approach of each class in the Software Development and Management Plan (SDMP) (CDRL MO-9):

- a. Mission Critical
- b. Mission Support
- c. Engineering Analysis
- d. Commercial
 - Commercial software acquired for integral use within planned operational elements shall be assigned a criticality equal to that of the element of which it is a part.

The Contractor shall classify all MOC software as belonging to one of the following types of software and shall define the management approach of each class in the Software Development and Management Plan (SDMP):

- a. Developed
- b. Reuse
- c. Heritage
- d. Off-the-Shelf (OTS)
 - OTS software is further defined as Commercial-Off-the-Shelf (COTS), Modified-Off-the-Shelf (MOTS) software, and Government-Off-the-Shelf (GOTS) software.

The Contractor shall meet the requirements of NASA Software Engineering Requirements specified in the NPR 7150.2A when choosing to use OTS software to satisfy all or part of the software requirements implementation. The details of OTS utilization and management of such shall be provided in the Contractor's SDMP.

- The Contractor shall develop a Mission Assurance Implementation Plan (MAIP) that is applicable to all MOC software in accordance with PM-6. This plan may be a subset of the Spacecraft MAIP. The MAIP will encompass, at a minimum, all MOC elements that interface with flight equipment to the extent necessary to assure the integrity and safety of flight items.

4.1 Independent Verification and Validation (IV&V)

The MOC development effort is required to support the activities of the Independent Verification and Validation (IV&V) office. The Contractor shall ensure that all software documentation and code required for the NASA Software Independent Verification and Validation (IV&V) effort is made available to NASA IV&V personnel. This includes access to all software reviews and reports, developer plans and procedures, MOC requirements, software code, software design documentation, test procedures, test results, and software problem reporting data. The Contractor shall permit electronic access to the required information or furnish soft copies of requested information to NASA IV&V personnel.

The Contractor shall review and assess all NASA IV&V findings and recommendations prior to the FOR or within two months from the receipt of the findings, whichever is shorter. The Contractor shall forward their assessment of these findings and recommendations via the Projects IV&V Point of Contact. The Contractor shall take necessary corrective action based upon their assessment and notify via the Projects IV&V Point of Contact of this correction action. Corrective actions will be approved by the project prior to any implementation activity. The contractor shall provide evidence (i.e. artifacts, etc.) that any corrective action agreed upon between the project, IV&V and the contractor has been implemented. The Contractor shall also notify via the Projects IV&V Point of Contact of those instances where they decided not to take corrective action on specific IV&V findings and recommendations. A Contractor point of contact shall be assigned and available to NASA IV&V personnel, as required, for questions, clarification, and status meetings.

5.0 MISSION OPERATIONS CENTER (MOC) DEVELOPMENT

The Contractor shall develop, deliver, and install the MOC and the backup MOC in accordance with the ICESat-2 Mission Operations Center Requirements Document (MOC-RD), ICESat-2-MOC-REQ-0537. The Contractor shall provide all necessary personnel, facilities, services, and materials to develop, integrate, test, operate and sustain the MOC and bMOC.

5.1 Design and Development

The Contractor shall design and develop the MOC, including requirements and interface analysis, which satisfies all the requirements of the MOC-RD. The Contractor shall deliver a MOC Design Specification and Description in accordance with CDRL MO-12.

5.1.1 Telemetry, Command and Control

The Contractor shall develop the MOC Telemetry, Command and Control capabilities in accordance with the MOC-RD.

The Contractor shall establish and maintain the ICESat-2 Project Database (PDB), which will combine spacecraft, instrument, and MOC command and telemetry databases and other database information required to operate and maintain the observatory and ground system in a common format. The Contractor shall verify any spacecraft and instrument translations from the ICESat-2 PDB.

5.1.2 IT and Communication Security

5.1.2.1 IT Security

The Contractor shall comply with NPR 2810.1A, Security of Information Technology (IT) in development, integration, and testing of the MOC. The Government will review the Contractor's implementation of IT security requirements. The Contractor shall coordinate with the Government in the implementation of IT security requirements. The Contractor shall provide security documentation in accordance with CDRL PM-7 to include Security Plans, Risk Assessments and contingency plans.

5.1.2.2 Communication Security (COMSEC)

The Contractor shall comply with all communication security (COMSEC) requirements related to the development, integration, and testing of MOC command encryption or authentication capabilities as implemented on the spacecraft. The Contractor shall develop and implement the capabilities to perform command encryption or authentication.

The Contractor shall review and provide input to the ICESat-2 Key Management Plan per CDRL MO-18.

5.2 Integrate and Test

The Contractor shall develop and deliver the following items in accordance with the stated CDRL to support MOC element-level testing:

- a. MOC Test Plans, CDRL MO-4
- b. MOC Test Procedures, CDRL MO-5
- c. MOC Test Reports, CDRL MO-6

The Contractor shall allow Government personnel access to all MOC testing and test planning meetings, including Contractor-led Test Readiness Reviews.

The Contractor shall participate in informal interface testing between the MOC and other ground system elements/facilities during MOC development. Informal interface tests include the network connection tests and use of test data in the formats defined by MOC Interface Control Documents informally exchanged (e.g. by email or FTP site) between the MOC and other ground elements/facilities. The Contractor shall exercise test data provided by other ground elements, and shall provide MOC test data to ground elements.

Prior to each MOC delivery, the Contractor shall perform application acceptance testing to internally verify the MOC meets the requirements of the MOC-RD. Application acceptance testing is defined to be MOC standalone testing without the actual interfaces to the ICESat-2 ground system elements, but using a method(s) to simulate the interfaces per the applicable ICDs. The Contractor shall allow Government personnel access to all MOC application acceptance testing data and result summaries at least 3 working days prior to each delivery/release. Test result summaries shall be included in the delivery package.

5.3 Delivery Support

The Contractor shall provide multiple deliveries/releases of the MOC, with each delivery/release demonstrating increased functionality leading to the final MOC functionality as defined in the MOC-RD. The Contractor shall propose a MOC/bMOC release schedule that supports the milestone capabilities shown in Table 5-1, at a minimum. Additional releases/deliveries may be proposed. For planning purposes, the Contractor shall assume delivery dates based on milestones dates provided within this document.

Table 5-1 MOC Delivery Capabilities

Release	Milestone	Capability
MOC-T&C	Beginning of spacecraft sub-system I&T - Telemetry and Command Support	Functionality developed by the Contractor for initial delivery, including but not limited to MOC telemetry and command functions and the interface to the bus developer's I&T ground system; capability to support telemetry and command processing with the spacecraft bus and instrument, validation of the initial Project Database, and FOT routine operations product development.
MOC-P&S	Interim Delivery – Planning & Scheduling Support	Additional functionality developed by the Contractor since previous delivery, including but not limited to stored command management, capability to produce flight dynamics mission planning products, perform planning & scheduling activities to support development of FOT products and operations procedures.
MOC-GSIT	Ground System Integration / MOC Integration	Complete MOC functionality including all interfaces and launch support room functionality; capability to support ground system integration, including subsystem integration of the MOC and interface connectivity testing of MOC interfaces. This delivery shall support formal MOC installation and Ground System integration.
MOC-GRT	Ground System Readiness Testing	Required updates/patches to previous delivery, as identified during ground system integration and interface connectivity testing, if any; capability to support Ground Readiness Tests (GRTs).
MOC-MRT	Mission Readiness Testing	Required updates to previous delivery identified as part of ICESat-2 Ground Readiness Testing, if any; capability intended to support ICESat-2 Mission Readiness Tests (MRTs).
MOC-PMRT	Post-Mission Readiness Testing	Required updates/patches to previous delivery identified as part of ICESat-2 Mission Readiness Tests, if any.
MOC-ORR	Operations Readiness Review	Represents required updates/patches to previous delivery needed to demonstrate ICESat-2 Operations Readiness, if any.
MOC-PL	Post-Launch	Represents required updates/patches to previous delivery identified during the on-orbit check-out and commissioning of the ICESat-2 observatory, if any.

The Contractor shall adhere to the approved MOC release schedule. The Contractor shall deliver, install, and configure all MOC releases, as shown in Table 5-1, at each of the facilities hosting a MOC subsystem element (bMOC, S/C I&T). The Contractor shall test and verify that each MOC delivery/release is complete.

The Contractor shall develop the MOC installation and test procedures.

The Contractor shall provide the hardware required to operate the MOC at each of the facilities hosting a version of the MOC as the facility becomes available.

With each MOC delivery, the Contractor shall provide MOC software or updated software.

All MOC deliveries shall consist of the following items:

1. User's Manual in accordance with CDRL MO-15
2. Version Description Document (VDD) in accordance with CDRL MO-10 to include:
 - Installation Instructions/Procedure
 - Hardware Inventory and intended usage description
 - Source Code (if provided)
 - Executables
 - Acceptance Test Results/Reports (CDRL MO-6)
 - Matrix of requirements addressed by this release,
3. Delivery Letter identifying the versions of the User's Guide, VDD, Installation Instructions/Procedure, Source (if applicable), and Executables
4. Other documentation as appropriate

6.0 INTEGRATION, TESTING, AND OPERATIONS READINESS

6.1 Integration and Testing

The Government is responsible for ICESat-2 ground system and mission systems integration. The Contractor shall support Government systems integration planning through participation in I&T and interface working groups.

The Contractor shall develop and provide a mini-MOC consisting of Telemetry and Command (T&C) and Front End Processor (FEP) functions to support integration and testing at the spacecraft vendor site.

The Contractor shall perform the following activities in support of the Government ICESat-2 systems integration testing, including mini-MOC to Observatory Integration & Test, and the MOC and bMOC installation, integration and test:

- a. Review and provide input to the ICESat-2 systems integration and test plans and procedures
- b. Participate in test readiness reviews (TRRs) approximately one week prior to the performance of each test that covers the test plan, procedures, scripts, and test support and coordination activities relevant to the MOC. Participate in delta TRRs, if needed.
- c. Execute the MOC Integration and Test procedures (MO-5)
- d. Collect, process, and document all MOC supporting data in a post test report
- e. Resolve anomalies and incorporate lessons learned for future integrations.
- f. Train the Flight Operations Team for system operational updates.

For planning purposes, the Contractor shall assume the following ICESat-2 Integration and Test Milestone Schedule:

Table 6-1 ICESat Integration and Test Milestone Schedule

Event	Start Date
MOC Command and Telemetry Tests with Spacecraft / Spacecraft Sub-system I&T	TBD
MOC Integration / Ground System Integration	TBD
Ground Readiness Testing	L-18 (7 GRTs)
Mission Readiness Testing	L-12 (6 MRTs)
Mission Simulations	7 Mission Simulations
Launch Sims	2 Launch Simulations
Launch	1/16

6.1.1 MOC Facility Plan

The Contractor shall prepare the MOC Facility Plan and ensure the MOC Facility is compliant with the MOC ICDs and applicable requirements documents.

The MOC Facility Plan shall document the MOC facility needs including power, contingency power, network connectivity, and system administration support for the MOC and bMOC installation, testing, L&EO support, operations and sustaining engineering. Elements of the MOC Facility plan will be reviewed during major MOC reviews including the SRR, PDR and CDR.

6.1.2 Ground System and Mission Integration

The Contractor shall participate in MOC and bMOC to ICESat-2 Ground System integration and interface connectivity testing. Ground System Integration will include the establishment of network connectivity between the MOC and other ground system elements. This will include tests between the MOC and all of the ICESat-2 Ground System Elements to demonstrate network connectivity and data flow. Integration and interface connectivity testing shall be performed from the MOC (and the bMOC). The Government will provide network connectivity between the MOC/bMOC and all other Ground System Elements.

The Contractor shall provide on-call engineering support for ICESat-2 Ground Readiness Testing to verify the functional requirements of the integrated ICESat-2 Ground System. The flight operations team shall serve as MOC test conductors for the Ground Readiness Tests in the MOCs.

The Contractor will participate in the integration of the ground system or segment to the space segment. The space segment encompasses the spacecraft and the instrument. Mission integration will include the development and testing of the interfaces between the ground segment and the space segment to support the end to end data flow of the Mission.

The Contractor shall provide on-call engineering support for ICESat-2 Mission Readiness Testing to verify the functional requirements of the integrated ICESat-2 Mission. The flight operations team shall serve as MOC test conductors for the Mission Readiness Tests in the MOCs.

6.2 Operations Readiness

The Contractor shall participate in Mission Operations Readiness Tests to include operator training, readiness exercises, and launch rehearsals.

6.2.1 MOC Training

The Contractor shall develop and execute a MOC FOT Training Plan in accordance with CDRL MO-13. For each training session the Contractor shall prepare and provide all course materials.

6.2.2 Mission Simulations and Launch Rehearsals

The Contractor shall support a minimum of seven (7), 1-day mission simulation exercises to simulate typical day-in-the-life on-orbit observatory operations. The exercises will simulate scenarios that include exercise of nominal command and control operations, mission scheduling, state-of-health (SOH) monitoring procedures, and anomaly recovery operations.

The Contractor shall support in the MOC a minimum of three (3), 12-hour launch rehearsals. The third Launch Rehearsal is a "full dress rehearsal" and includes participation by all ICESat-2 Space, Ground, and Flight Operations segment personnel and resources required to conduct launch and early orbit (L&EO) activities. The launch rehearsals will demonstrate nominal execution of timelines as well as simulated anomaly/contingency response scenarios. Flight operations team representatives will serve as test conductors for launch rehearsals.

For these mission simulation exercises and launch rehearsals, the Contractor shall participate in:

- Pre-activity briefings
- Post-activity debriefs and lessons learned review with participants
- Operations Readiness Exercises
- Operators Certification

7.0 EARLY ORBIT OPERATIONS AND ACCEPTANCE

7.1 MOC Early Operations Support

The Contractor shall provide MOC engineering personnel and FOT at the MOC on a round-the-clock basis from 24 hours prior to launch through the completion of early orbit time critical operations of the ICESat-2 observatory, nominally 7 days following launch. The Contractor shall provide on call support for any MOC operational problems or anomalies through MOC final acceptance.

7.2 MOC Acceptance

The Contractor shall participate in and support the MOC portion of the ICESat-2 On-Orbit Acceptance Review prior to Government final acceptance of the MOC in accordance with CDRL RE-6. The Contractor shall deliver an Acceptance Data Package in accordance with CDRL SE-23.

8.0 ENGINEERING SUPPORT

The Contractor shall provide engineering support for nominal operations after acceptance of the MOC. Additionally, the Government may authorize special tasks to be performed by the Contractor in support of continued operations of the ICESat-2 MOC.

8.1 Nominal Operations Engineering Support

The Contractor shall provide the following services after Government acceptance through the period of performance of the contract:

1. Maintain the MOC system in order to meet contract requirements. Any maintenance-related deliveries shall comply with the delivery process described in section 4.3.
2. Maintain and update all approved MOC software upgrades and vendor SW updates pursuant to NPR 2810.1A.
3. Provide on-call technical support of the MOC subsystems to the FOT to assist in anomaly resolution as needed.

8.2 Task Support

The Contractor shall perform tasks relating to the continued operational support of the ICESat-2 MOC. These tasks will include the following:

1. Support MOC operations as required. This support shall include but is not limited to supplying technical expertise to perform analyses, to review data, or to review changes to documentation.
2. Investigate anomalies of the Mission Operations Center and provide recommendations for resolution.
 - a. For non-critical anomalies, the Contractor shall acknowledge notification of the anomaly and provide an initial action plan within 48 hours of notification by the Government. A non-critical anomaly is one where degradation or failure does not impair mission performance in a manner that could jeopardize the health and safety of the ICESat-2 observatory.
 - b. For critical anomalies, the Contractor shall acknowledge notification of the anomaly and provide an initial action plan within 8 hours of notification by the Government. A critical anomaly is one where degradation or failure could jeopardize the health and safety of the ICESat-2 observatory.
3. Provide updates to MOC software to provide new or improved capabilities requested by the Government, including technical documentation, installation procedures, validation procedures and back-out procedures.

9.0 MISSION OPERATIONS

The Contractor shall provide the following services for a three-year on-orbit nominal mission duration plus a controlled re-entry

9.1 Flight Operations Team

The Contractor shall:

1. staff the FOT for the duration of the mission for mission operations
2. develop training material for training and certifying/re-certifying the FOT
3. lead Flight Operations anomaly resolution
4. support spacecraft/instrument anomaly resolution
5. command the observatory during Ground Readiness tests
6. command the observatory in ICESat-2 Mission Readiness tests
7. command the observatory in mission simulations and rehearsals
8. command the observatory for the life of the flight mission
9. participate in pre-launch activities, launch, commissioning, normal operations and decommissioning.
10. perform Command Authorization Meetings in conjunction with the S/C vendor, the IOT, and the Mission Operations Director to plan and approve non routine observatory activities.
11. support working groups with the ISF and/or ATLAS support team to plan for upcoming mission planning and scheduling activities that result in Instrument command load submission to the MOC P&S system.

9.2 Routine Operations Support

The Contractor shall perform tasks relating to the continued operational support of the ICESat-2 MOC.

The Contractor shall provide the following:

1. MOC Operations Procedures Plan in accordance with CDRL MO-19
2. FOT procedures review to support execution of the S/C Decommissioning Plan in accordance with CDRL MO-20
3. ICESat-2 MOC LEO Handbook in accordance with CDRL MO-21
4. ICESAT-2 Standard Operating Procedures (SOP's) and Contingency Operations Plan in accordance with CDRL MO-22

These tasks will include the following:

1. Support MOC operations as required. This support shall include but is not limited to mission planning and scheduling, observatory commanding, real-time contact support, housekeeping data monitoring and trend analysis.
2. Investigate anomalies of the Mission Operations Center and provide recommendations for resolution.
 - a. For non-critical anomalies, the Contractor shall acknowledge notification of the anomaly and provide an initial action plan within 48 hours of notification by the Government. A non-critical anomaly is one where degradation or failure does not impair mission performance in a manner that could jeopardize the health and safety of the ICESat-2 observatory.
 - b. For critical anomalies, the Contractor shall acknowledge notification of the anomaly and provide an initial action plan within 8 hours of notification by the Government. A critical anomaly is one where degradation or failure could jeopardize the health and safety of the ICESat-2 observatory.

9.3 Non-Routine Operations Support

The Contractor shall document all on-orbit mission anomalies per CDRL PM-13. The use of the SOARs system is required. The Contractor shall report to the Government in a timely manner any on-orbit anomaly that impacts mission operations and overall health and safety of the Observatory.

The Contractor shall provide 2,000 hours of support related to the continued on-orbit support of ICESat-2, as authorized by the Government. Each task will be initiated by written direction from the Government contracting officer. The Government will coordinate with the Contractor to define each task in detail, and establish manpower ceilings, performance schedules, and deliverables. This tasking shall also be used to address ICESat-2 anomalies referenced in section 8.2 and 9.3 that fall outside of routine operations support activities.

The Contractor shall support non-routine observatory operations as authorized by the Government and in accordance with the Contract. Non-routine operations may include special off-nadir pointing requests or calibration activities developed post-launch.

Glossary/Acronyms

ATLAS	Advance Topographic Laser Altimeter System
bMOC	Backup MOC
CCB	Configuration Control Board
CCR	Configuration Change Request
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CERR	Critical Event Readiness Review
CIIL	Configuration Item Identifier List
CM	Configuration Management
CNNS	Committee on National Security Service
COMSEC	Communications Security
COTR	Contracting Officer's Technical Representative
COTS	Commercial Off-The Shelf
CRM	Continuous Risk Management
CSS	Central Security Service
DR	Design Review
EPR	Engineering Peer Review
FEP	Front End Processor
FOR	Flight Operations Review
FOT	Flight Operations Team
FRR	Flight Readiness Review
GN	Ground Network
GOTS	Government Off-The-Shelf
GPR	Goddard Procedural Requirements
GS	Ground System
GS-CDR	GS-Critical Design Review
GSFC	Goddard Space Flight Center
GSIT	Ground System Integration
GSRD	Ground System Requirements Document
ICDR	Instrument Critical Design Review
IDD	Interface Definition Document
IMS	Integrated Master Schedules

ISF	Instrument Support Facility
ISP	Internet Service Provider
IV&V	Independent Verification and Validation
LEO	Launch and Early Orbit
M-CDR	MOC Critical Design Review
M-PDR	MOC Preliminary Design Review
M-SIR	MOC System Integration Review
M-SRR	MOC System Requirements Review
MAR	Mission Assurance Requirements
MOC	Mission Operations Center
MOR	Mission Operations Review
MOTS	Modified Off-The-Shelf
MPSR	Monthly Project Status Report
MRT	Mission Readiness Testing
NPR	NASA Procedural Requirements
NSA	National Security Agency
OAR	Operational Acceptance Review
ORR	Operational Readiness Review
OTS	Off-The-Shelf
P&S	Planning & Scheduling
PDB	Project Database
PDR	Preliminary Design Review
PLAR	Post-Launch Assessment Review
PMRT	Post-Mission Readiness Testing
RMP	Risk Management Plan
SCDR	Spacecraft Critical Design Review
SDMP	Software Development and Management Plan
SEI-CMMI	Software Engineering Institute Capability Maturity Model Integration sm
SIPS	ICESat-2 Science Investigator-led Processing System
SIR	System Integration Review
SMSR	Safety and Mission Success Review
SNAS	Space Network Access System
SOARS	Spacecraft On-Orbit Anomaly Reporting System

SOW	Statement of Work
SPDR	Spacecraft Preliminary Design Review
SRD	Systems Requirements Document
SSRR	Spacecraft System Requirements Review
T&C	Telemetry and Command
TIM	Technical Interchange Meeting
VDD	Version Description Document
WOTIS	Wallops Orbital and Tracking Information System

Released Version