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

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

SPACECRAFT DO

ATTACHMENT D

CONTRACT DATA REQUIREMENTS LIST (CDRL) ICESat-2-SCPM-CTR-0300

Revision (-)

Effective Date: February 22, 2011

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 signature-controlled document. Changes to this document require prior approval of the applicable Product Design Lead (PDL) or designee. Proposed changes shall be submitted in the ICESat-II Management Information System (MIS) via a Signature Controlled Request (SCoRe), 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 425
Goddard Space Flight Center
Greenbelt, Maryland 20771

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

CHANGE RECORD PAGE

Document Version	Document Release Date	SCoRe Number	SCoRe Approval Date	Pages Affected	Description
Rev -	02/22/2011	TBD	02/22/2011	All	Initial release of document.

Table of Contents

SECTION 1 - INTRODUCTION

1.1 Scope

This Contract Data Requirements List (CDRL) is the ICESat-2 Delivery Order set of all required data to be provided by the Contractor on the ICESat-2 DO.

The Government has modified the CDRL list from the baseline RSDO III CDRL list, including the MAR related CDRL items.

All data shall be prepared, maintained, and delivered to the Government in accordance with the requirements of the ICESat-2 CDRL and the associated Data Item Descriptions (DIDs).

1.2 Contract Data Requirements List (CDRL) Description

This CDRL is divided into multiple lists; one defining the CDRLs required by the RSDO III Contract and modified for the ICESat-2 DO, one defining CDRLS specific for the ICESat-2 Statement of Work (SOW) and one, defining the CDRLs required by the ICESat-2 Safety and Mission Assurance Requirement (MAR) document and listed in Appendix D, MAR Data Items Description (DID) List. Although contained in the MAR for reference purposes, the MAR DID List is a continuation of this CDRL.

Each CDRL contains the following information:

a) CDRL # (or DID #)
The RSDO III Contract modified for ICESat-2 data items are sequentially numbered. ICESat-2 DO specific DIDs are numbered sequentially based on the technical area of interest. Alternatively, the MAR required items have a DID number associated with the MAR section that calls out the CDRL (DID) item. (For example, DID 3-1, 3-2, etc. are required by Section 3 of the MAR.)

b) SOW or MAR Section Reference:
Indicates where the CDRL item is called out in the SOW or MAR.

c) Title

d) CDRL Delivery Information:

'Yes' in the Prop (Proposal) column of Table 1 indicates the CDRL Data Item is to be delivered with the ICESat-2 DO Proposal in accordance with the Attachment L Proposal Instructions (Section L.22).

The contract baseline schedule for delivery of SOW CDRL items on delivery orders is shown in the next seven columns of CDRL Table 1 associated with acronyms for the various program reviews that form the contract baseline set of payment milestones (reference: Contract Clause H.15, Performance-Based Payment Events and Completion Criteria; H.16, Acceptance and Final Payment; and SOW Section 4.3.1.4.2, Spacecraft Systems Reviews).

For the ICESat-2 mission specific DO CDRLs, maturity and due dates are provided in Column 4.

The following Codes apply:

I or P: Indicates required submission of the **Initial** (or **Preliminary**) version of the data or document.
U: Indicates required submission of an **Updated** revision.
F: Indicates required submission of the **Final** version of the document.
A/R: Indicates the item delivery is "as required" and is not tied to a specific milestone review.

Note that the MAR CDRL item delivery requirements are often stated in terms of days before or after the milestone event.

e) **"Purposes"** and "Submission" are defined as follows:

Approval: The document is submitted for Government **Approval.** Starting when the Government receives the data, the Contractor shall wait 14 calendar days for written approval from the Government Contracting Officer (CO) before proceeding with the associated work. If a response is not received in the prescribed time, the Contractor may proceed as though approval was received, after notifying the Government of the intention to proceed.

Review: The document is submitted to the Government for **Review.** Starting when the Government receives the data, the Contractor shall wait 14 calendar days, for Government review and comment; to be sent in writing from the Government Contracting Officer (CO). If a response is not received in the prescribed time, the Contractor may continue with the effort after notifying the Government of the intention to proceed. The contractor may proceed with the associated work while preparing a response to the Government's comments.

Information: Deliverables are sent to the Government for **Informational** purposes. The Government may request changes on deliverables where errors or omissions are noted.

The Contractor shall notify the Government Contracting Officer (CO) and Government Project Management in writing or by email when transmitting each CDRL Data Item.

1.3 Data Item Descriptions (DID) Overview

a) Each data requirement listed on the CDRL is defined by a corresponding DID. The CDRL item DIDs required by the SOW are found in Section 3 of this CDRL. Those required by the ICESat-2 MAR are found in APPENDIX E of the MAR.

b) The DID describes the title, number, document reference, use, purpose and required preparation information.. The delivery requirements and "Purpose" (defined above) of the CDRL-DID list may also be reiterated in the MAR DIDs.

c) **Much of the information requested in the DIDs may already exist in your documentation and format. Existing documents and formats may be used if they meet the intent of DID requirements.** In this case, a matrix or notation shall be supplied in the DID that indicates where in your document the information that satisfies the requirement can be found.

1.4 Delivery Instructions

The Contractor shall deliver each data item via the indicated media (see below), in the specified quantities, in accordance with any special instructions indicated in the CDRL/DID List and in accordance with the Contract or mission specific Delivery Order (DO) requirements and provisions. "H" indicates hardcopy delivery, and "E" indicates electronic delivery.

Mission Specific CDRL data shall be delivered to the following address:

Mission Project Office Contracting Officer
Goddard Space Flight Center
Attn: ICESat-2 Contracting Officer
ICESat-2 Project Office
Code 420
Greenbelt, MD 20771

In addition to the above, the original transmittal letter for all deliverables shall be addressed to:

Goddard Space Flight Center
Attn: RSDO Contracting Officer
Rapid Spacecraft Development Office
Code 401.1
Greenbelt, MD 20771

The following shall be provided for each data item submission:

a) Electronic Data Delivery - Formats for electronic media delivery are defined in paragraph 1.5 of this CDRL.

1.5 Delivery Media

a) There are two media in which data may be documented and are defined as:

1. Hard Copy - Data typed, drawn or printed on paper by common conventional practices. By these means, the original, a reproducible copy or the record copy shall be reproduced for distribution as printed copies.
2. Electronic - Data which is recorded on CD ROM or provided by other electronic means.

b) Documentation delivery (in hardcopy or electronic format) shall be as specified in the CDRL/DID List. Additionally, all CDRL data which has been generated electronically shall be delivered via electronic transfer or electronic storage media.

c) The instructions to facilitate the use of electronic media will be supplied upon DO award.

1.6 Documentation Change Procedures

Unless otherwise defined in the mission specific DO:

a) The Contractor shall issue Documentation Change Notices (DCNs), starting with the number 001, whenever minor changes are made in "final" versions of data items that have been delivered to the Government.

b) Change bars or "change tracking" shall be used to indicate the locations of changes unless the particular file type does not have those features available. If not available, the details of the changes will be verbally described in a text file.

c) When major changes to a document are made, a complete revision of the document shall be issued and delivered to the Government in accordance with the DO instructions for the data item. A description of all changes incorporated into the new revision shall be included in the new document or otherwise documented. Major versus minor changes will be defined in the mission-specific DO.

d) No change bars are used when a document is updated by revision and the DCN numbers for that document shall be automatically recycled to 001.

SECTION 2

SOW
CDRL TABLE

2.1 CDRL TABLE 1: Rapid III SOW Data Items

(See CDRL Introduction for meaning of letter codes)

CDRL Reference Information			CDRL Delivery Information for DO								
			Due at 30 days prior to indicated review								
CDRL #	SOW Ref.	Title	Prop	SRR	PDR	CDR	IIRR	PER	PSR	OAR	Purpose (See Note 3)
1		Reserved									Approval
2	4.3.2.2.1 4.3.4.4	Reserved	-				-	-	-	-	Approval
3	--	Reserved	--	--	--	--	--	--	--	--	--
4	--	Reserved	--	--	--	--	--	--	--	--	--
5	4.3.2.2	Telemetry and Command Requirements Documentation	-	-	I	U	U	F	-	-	Information
6	4.3.2.2	External Interfaces, Models and Analysis	-	-	I	U	U	U	F	-	Review
7	4.3.2.2.2	Flight Operations Ground System Interface Documentation	-	-	I	F	-		-	-	Review
8	4.3.2.2.3	Launch Vehicle Documentation	-	-	I	U	-	U	F	-	Review
9	4.3.4.5 4.3.4.6	Storage, Transportation and Handling Plan	-	-	-	U	-	F	-	-	Review
10	4.3.2.2.3	Observatory Launch Site Operations and Test Plan	-	-	-	U	-	F	-	-	Review
11	4.3.2.2.3	Observatory Launch Site Operations and Test Procedures Note: Safety related ("hazardous") procedures shall be provided per MAR section 3.1.2 and CDRL MA 3-2.	-	-	-	I	-	F	-	-	Approval

12	4.3.2.2.2 4.3.6.1	Flight Operations Support Plan	-	-	U	U	-	U	F	-	Information
CDRL Reference Information			CDRL Delivery Information for DO								
CDRL #	SOW Ref.	Title	Due at								Purpose (See Note 3)
			Prop	SRR	PDR	CDR	IIRR	PER	PSR	OAR	
13	4.3.2.2.2 4.3.7.2	Spacecraft Operations Description Manual	-	-	-	-I	U	F		-	Information
14	4.3.1.5	Engineering Change Proposals, Deviations and Waivers	-	A/R							Approval
15A	4.3.1.4.2	Spacecraft (S/C) Requirements Review (SRR) Information Requirements	-	F	-	-	-	-	-	-	Information
15B	4.3.1.4.2	S/C Preliminary Design Review (PDR) Information Requirements	-	-	F	-	-	-	-	-	Information
15C	4.3.1.4.2	S/C Critical Design Review (CDR) Information Requirements	-	-	-	F	-	-	-	-	Information
15D	4.3.1.4.2	Instrument Integration Readiness Review (IIRR) Information Requirements	-	-	-	-	F	-	-	-	Information
15E	4.3.1.4.2	Observatory Pre-Environmental Review (PER) Information Requirements	-	-	-	-	-	F	-	-	Information
15F	4.3.1.4.2	Observatory Pre-Shipment Review (PSR) Information Requirements	-	-	-	-	-	-	F	-	Information
15G	4.3.1.4.2 4.3.7.3	Observatory Acceptance Review (OAR) Information Requirements	-	-	-	-	-	-	-	F	Information
various	--	MAR CDRL Items (See MAR) (See Note 2.)	(See Note 4)	(As indicated in the MAR CDRL)							Various (see MAR)

Notes:

1. The DIDs for the above CDRLs are at the end of this CDRL Document.

2. Safety and Mission Assurance CDRL and DIDs are contained within the ICESat-2 MAR Document.

3. Purpose applies only to Final "F" version of these documents. Earlier versions are submitted "For Information"

ICESat-2 Mission Specific SOW Data Items Deliverables

DID #	TITLE	Submission	Due Date(s) / Maturity	Media	Copies
PM-1	Monthly Program Status Review Package (MPSR)	I	Monthly (nominally last Wed of each Month); Weekly (date TBP)	E	1
PM-2	Program Management Plan	A	Award + 30 days Updates as generated	E	1
PM-3	Integrated Master Schedule (IMS)	I	Preliminary w/ Proposal Rev: Award+45 days; Baseline: Award+60 days Updates Monthly	E, H	1
PM-4	Interface Engineering Drawings and Change Notices	I	PDR - 14 days CDR - 14 days Updates as generated	E	1
PM-5	Program Security Plan	A	Award + 30 Days Updates as generated	E	1
PM-6	Configuration Management Plan	A	Final: Award + 30 days Updates as generated	E	1
SE-1	Review Data Materials	A/I	7 days prior to Review Action Item Responses: Review + 30 days	E, H	1 30 (at review)
SE-2	Reserved				

DID #	TITLE	Submission	Due Date(s) / Maturity	Media	Copies
SE-3	Subsystem Review Materials	I	Review - 14 days	E	1
SE-4	Systems Engineering Management Plan	A	Preliminary: Award + 30 Days Final: Award + 90 Days Updates as generated	E	1
SE-5	Spacecraft Requirements Specification	A	Prelim SRR – 30 days Rev: PDR - 30 days Final: CDR - 30 days Rev: as generated	E	1
SE-6	Specification Tree	I	Final: SRR	E	1
SE-7	Photographs and Video	I	As Generated	E	1
SE-8	Final Report and Lessons Learned	I	Lessons Learned: At each major review Final: On-Orbit Acceptance	E	1
SE-9	Interface Control Documents	I, A	Prelim: PDR - 5 days Rev: CDR - 5 days Final: CDR + 60 days Updates as generated	E	1
SE-10	Key Management Plan	I	Prelim: PDR - 10 days Rev: CDR - 10 days Final: PER - 15 days Updates as generated	E	1
IT-1	Spacecraft Integration and Test Plans	A	Prelim: PDR - 10 days Rev: CDR - 10 days Final: PER - 15 days Updates as generated	E	1

DID #	TITLE	Submission	Due Date(s) / Maturity	Media	Copies
IT-2	Science Test Data	I	As Requested	E	1
IT-3	Observatory Integration and Test Plans	A	Prelim: PDR – 10 days Rev: CDR - 10 days Final: PER - 15 days Updates as generated	E	1
SMA-1	Laser Safety Plan	I	Prelim: CDR – 30 days Final: Instrument Integration - 60 days	E	1
LV-1	Launch Site Support Plan	I	LRD - 34 weeks Updates as generated	E	1
LV-2	Launch Commit Criteria	A	Prelim: PSR - 150 Days Final: LRR - 30 Days	E	1
SIM-1	Simulator Requirements Document	I	Prelim: Award + 60 Days Final: PDR - 15 Days Updates as generated	E	1
SIM-2	Simulator I&T Plan	I	Prelim: Award + 60 Days Final: PDR - 15 Days Updates as generated	E	1
SIM-3	Simulator Test Report	I	Test + 10 Days	E	1
SIM-4	Simulator User's Manual	I	Delivery - 30 Days Updates as generated	E	1

DID #	TITLE	Submission	Due Date(s) / Maturity	Media	Copies
SIM-5	Simulator Training Plan and Materials	I	Delivery - 60 Days Updates as generated	E	1
OPS-1	Flight Operations Team Training Package	I	Prelim: CDR - 15 days Final PSR -14 Days Updates as generated	E	I
OPS-2	On-Orbit Commissioning Plan	I	Prelim: CDR - 15 days Final: PSR -90 days	E	1
OPS-3	Flight Activation Operations Plan	I	Prelim CDR-15 days Final PSR-30 days	E	1
OPS-4	Operations Transition Plan	I	Prelim: CDR -1 5 days Final PER - 5 days	E	1
OPS-5	Sustaining Engineering Plan	I	Prelim: CDR - 15 days Final PER - 5 days	E	1
OPS-6	Operations Procedures and Scripts	I	Prelim: CDR - 15 days Rev: Test - 5 days	E	1
OPS-7	Acceptance Data Package	A	Prelim: CDR Rev: PER Rev: PSR Final: OAR-30 days	E	1
OPS-8	Command and Telemetry Database	I	Prelim: CDR - 15 days Updates as generated Final: PSR - 60 days	E	1

DID #	TITLE	Submission	Due Date(s) / Maturity	Media	Copies
SC-1	Observatory Thermal Model Delivery	I	Prelim: Mission PDR, Rev: Mission CDR, Final: PSR	E	1
SC-2	Mass Properties Report	I	Prelim: L-54 weeks Final: L-20 weeks	E	1
SC-3	Spacecraft Reduced Thermal Model Delivery	I	Prelim: Spacecraft PDR, Rev: Spacecraft CDR, Final: Observatory PSR	E	1
SC-4	Analyses	I	Rev as generated Final: CDR - 15 days	E	1
SC-5	Battery Handling Plan	A	Preliminary: PDR-30 days Final: CDR-30 days Updates as generated	E	1

DID #	TITLE	Submission	Due Date(s) / Maturity	Media	Copies
SW-1	Software Management and Development Plan	A	Preliminary: Award + 30 Days Final: Award + 90 Days Updates as generated	E	1
SW-2	Software Requirements Specification	A	Prelim: SRR-30 Days Final: PDR - 30 Days Update as generated	E	1
SW-3	Software Design Document	A	Prelim: PDR - 30 Days Final: CDR - 30 Days Updates as generated	E	1
SW-4	Software Test Plan	A	Prelim: SRR - 30 Days Rev: PDR - 30 Days Rev: CDR - 30 Days Final: TRR - 30 Days Updates as generated	E	1
SW-5	Software Test Procedures and Results	A	Prelim: CDR - 30 Days Final: TRR-30 Days Updates as generated	E	1
SW-6	Software User and Maintenance Manual	A	Prelim: CDR Final: Test Readiness Review	E	1

Notes:

1. The DIDs for the above CDRLs are at the end of this CDRL Document.

2. Safety and Mission Assurance CDRL and DIDs are contained within the ICESat-2 MAR Document.

3. Purpose applies only to Final "F" version of these documents. Earlier versions are submitted "For Information"

(End of SOW CDRL Table)

SECTION 3

SOW CDRL
DATA ITEM DESCRIPTIONS

Title: Reserved	**DID for CDRL #:** 1 – (Part 1)
Reference:	
Use:	
Related Documents:	
Preparation Information:	

Title: Reserved	**DID FOR CDRL #** 2
Reference:	
Use:	
Related Documents:	
Preparation Information	

Title: RESERVED	**DID FOR CDRL #:** 3
Reference:	
Use:	
Related Documents:	
Preparation Information	

Title: RESERVED	**DID FOR CDRL #:** 4
Reference:	
Use:	
Related Documents:	
Preparation Information	

Title: Telemetry and Command Requirements Document	**DID FOR CDRL #:** 5

Reference:

SOW Section 4.3.7.1, 4.3.2.2.

Use:

To describe (in detail) the ICESat-2 Spacecraft, its payload instrument ATLAS and launch vehicle interfaces telemetry and command features for launch and flight operations application.

Related Documents:

Preparation Information

Telemetry Requirements Document contents:

1. Detailed listing of all telemetry assignments.
2. Key parameters and information necessary for the description and interpretation of the telemetry requirements.
3. Summary of number and type of telemetry assignments, including spares.
4. Description of telemetry interfaces, format, and requirements data.
5. Listing of telemetry assignments that confirm commands.
6. Schematic reference for each telemetry assignment.
7. Transmission or sampling rates.
8. Methods of in-flight or ground-test verification.
9. Engineering units and calibration data, A to D for readout and calibration.

Command Requirements Document contents:

1. Detailed listings of all commands that can be applied to the Observatory that can affect a response or change in its configuration in anyway, either in test or in flight.
2. Key parameters necessary for description of commands.
3. Summary of number and type of commands used by each subsystem and the number of spares.
4. Description of command input, verification, rates, and filler commands.
5. Description of command requirements data and information necessary for interpretation.
6. Listing of commands verified by telemetry and resultant telemetry verifications.
7. Schematic reference for each command.

Title: External Interfaces, Models and Analysis	**DID FOR CDRL #:6**

Reference:

SOW Section 4.3.2.2.1, 4.3.4.1.4, 4.3.5.1

Use:

To provide the instrument and ground system teams with spacecraft interface data, models, and analysis needed to assist them in their designs and preparations to support the Observatory for launch and mission operations.

Related Documents:

Preparation Information

The offeror shall provide to the instrument developer and ground system team the required external interface information (data, models, and analysis) for the development of the instrument or ground system. This shall include as a minimum:

A. Core Spacecraft and Observatory reduced finite element models to support 2 coupled loads cycles. (@ CDR – 4 months, and @ PSR – 6 months).

B. Structural interface analyses

C. Pointing and alignment budgets

D. Core Spacecraft and Observatory thermal models analyses for instrument. (TMM Inputs for instrument to be provided at ATLAS PDR-3mos, and updated at ATLAS CDR-3mos)

E. Ground system protocols and data rates compatibility analyses

F. Data contact scenarios and optimization (contacts versus data recorder size trade study)

G. Flight dynamics and orbital maintenance analysis.

H. Reliability analysis (worse case, parts stress, single event effects).

I. Failure mode and effects analysis (FMEA) as described in section 4.3.1.2 of the SOW and MAR Section 4:1.2.

J. All other models and analysis the Contractor prepares or uses in implementing the ICESat-2 spacecraft.

K. Spacecraft power interface to the instrument power interface connector simplified models (provided at Spacecraft PDR)

Title: Flight Operations Ground System Interface Documentation	**DID FOR CDRL #:** 7
Reference: SOW Section 4.3.2.2.2	
Use: To document and define requirements and control all aspects of the interface between the Observatory and the Ground system to insure efficient integration and promote successful mission operations.	
Related Documents:	
Preparation Information A. Data formats, communications protocols, data rates. B. Compression algorithms, Error Detection and Correction schemes. C. Antenna patterns, Equivalent Isotropically Radiated Power (EIRP), Gain to Temperature Ratio (G/T), Beam width, Frequency, Polarization, and Link Margins. D. Command and Telemetry formats. E. Spacecraft contact scenarios for data transmission, operations, and maintenance. F. Link analysis for available ground station antennas. G. Interface requirements for RF compatibility test. H. Interface requirements for End-to-End test. I. Description of command and data time tagging. J. Description of Observatory operating modes and command events. K. Communications approach for maneuver planning and execution L. Command encryption/decryption algorithms and key descriptions M. CCSDS compliance	

Title: Launch Vehicle Documentation	**DID FOR CDRL #:** 8

Reference:

SOW Section 4.3.2.2.3

Use:

To document and define requirements the interface between the Observatory and the launch vehicle to insure efficient integration and promote a successful launch to the mission orbit.

Related Documents:

Launch Vehicle User Planners Guide

External Interfaces, Models and Analysis, CDRL #6

Preparation Information

This deliverable set of data defines the requirements of the Observatory for the launch vehicle provider and is to include the following as a minimum:

A. Spacecraft Questionnaire
B. Spacecraft Mathematical Model for Dynamic Analysis
C. Spacecraft Environmental Test documents
D. Safety Data Package (SDP) inputs (MAR DID 3-8)
E. Payload/Launch System Interface Specification (electrical, mechanical, data)
F. Mission Operations and Support Requirements
G. Payload Requirements Documents (PRD)
H. Payload Compatibility Drawings
I. Electrical Wiring Requirements
J. Fairing Requirements, including spacecraft environment controls
K. Launch Site Test Plan
L. Launch Site Operations and Test Procedures List (CDRL 11)
M. Spacecraft Integrated Test Procedure Inputs
N. Mission Analysis Requirements
O. Launch Intervals (Launch Windows)
P. Radio Frequency Applications
Q. Post-Launch Orbit Confirmation Data

Title: Storage, Transportation and Handling Plan	**DID FOR CDRL #:** 9
Reference: SOW Section 4.3.4.5 & 4.3.4.6	
Use: To understand the offeror's role, responsibility and plans to store and ship the integrated Observatory with flight instrument(s), along with the supporting equipment, from the Contractor's integration and test facility to the launch site.	
Related Documents:	
Preparation Information The data provided in the plan should address the following as a minimum: A. Definition of storage related activities including: locations; methods; GSE; environmental controls and monitoring; and pre-, post-, or intermittent storage testing required. B. Description of shipping container C. Methods of transporting the Observatory and ground support equipment (GSE) D. Bagging and purging requirements E. Environmental controls and monitoring equipment F. Expected roles and responsibilities of the Offeror and the Government. G. Who provides ground transportation at launch site H. Shipping crew support, convoy support I. Off-loading of Observatory at the launch site J. Movement between facilities at the launch site K. Fueling GSE L. Lifting slings M. Electrical and mechanical support equipment general description. N. Identify specific procedures available or needed.	

Title:	**DID FOR CDRL #:**10
Observatory Launch Site Operations and Test Plan	

Reference:

SOW Section 4.3.4.6, 4.3.2.2.3

AFSPCMAN 91-710, "Range Safety User Requirements Manual"

Launch Vehicle Payload Planner's Guides (as applicable)

Use:

(1) To provide a detailed understanding of the launch site activities, operations and testing planned for a particular mission, (2) to support requirements of the Safety Data Package (SDP) and (3) to obtain launch site procedure approvals.

Related Documents:

Preparation Information

Describe all aspects of the activities at the launch site beginning with arrival of the Observatory, including final testing and preparations, fueling, transportation between buildings and the launch vehicle, launch vehicle integration and testing, and removal of systems after launch. The data shall be originated to support launch site "test and inspection plans" requirements and the "ground operations plan" requirements as referenced in AFSPCMAN 91-710.

A. Layout a schedule and timeline of proposed activities

B. Specify what facilities and facility resources are needed

C. Show equipment placement and personnel area requirements

D. Fully explain staffing plan

E. Explain schedule and personnel contingency methods

F. Describe roles and responsibilities and the other equipment needed at each step of the plan

G. Describe fueling methods, crew training, SCAPE (Self Contained Air breathing Protective Equipment) operations, fuel storage locations

H. Address cleanness methods, purge gasses and lines, garments

I. Identify special test equipment needed on the launch tower or in the blockhouse

Identify specific communication links needed between locations at the launch site to perform Observatory end-to-end testing and to support the Observatory on the launch vehicle up to the point of launch.

Title: Observatory Launch Site Operations and Test Procedures	**DID for CDRL #:** 11

Reference:

SOW Section 4.3.2.2.3

Use:

To document the complete understanding of how the planned activities are to be carried out at the launch site to meet requirements of (1) SDP, (2) the ground operations plan, (3) test and inspection plans and (4) procedure approval specified in AFSPCMAN 91-710.

Related Documents:

AFSPCMAN 91-710, "Range Safety User Requirements Manual"

Missile System Prelaunch Safety Package (MSPSP), MAR DID 3-8

Launch Vehicle Payload Planner's Guides (as applicable)

Observatory Launch Site Operations and Test Plan CDRL # 10

Preparation Information

For all of the activities at the launch site, most of which are identified in the referenced Observatory Launch Site Operations and Test Plan, CDRL# 10, detailed procedures are to be prepared, reviewed, and approved before use. Hazardous activities shall be identified and included in the referenced MAR DID 3-8 SDP. Specify in the procedures, the test objectives, personnel and equipment requirements, environmental handling needs, Core Spacecraft and payload instrument(s) and electrical tests and operations to be performed, including the conditioning of batteries, special calibrations, end-to-end type testing, red tags, green tags, load cells, optical alignment equipment.

Particular interest will be paid to the period of time that the Observatory is mated to the launch vehicle to assure safety, smooth interaction between Observatory and launch vehicle activities and a successful launch.

Safety related (i.e. "hazardous") procedures shall be provided to the Government in accordance with MAR DID 3-10.

Title: Flight Operations Support Plan	**DID FOR CDRL #:** 12
Reference: SOW Section 4.3.2.2.2	
Use: To describe the contractor's plan for supporting the flight operations of the Observatory starting at integration and test, through launch, and throughout the life of the mission. Included is how the offeror intends to provide anomaly resolution support to the end of the mission, and how Flight Software will be supported through the mission life cycle.	
Related Documents:	
Preparation Information A. Description of roles and responsibilities and plans of how the offeror will support the operations of the spacecraft during test, launch, and on-orbit operations for the life of the mission. B. Description and designation of ground systems and responsibilities needed for spacecraft operations. C. Plan for anomaly identification, investigation, and resolution process. D. Plan for periodic performance assessments to determine spacecraft viability. E. Description of complement of skills needed to provide this support and how the offeror will provide these resources. F. Description of the Flight Software standards and practices through development, integration and Test, and in-orbit checkout. Describe the documentation system, how source and executable code is generated and used, and the method(s) of maintaining equipment. G. Description of the governments right to Flight Software source and executable code, and discuss how software maintenance and future mission modifications can be performed. Describe configuration control methods and safeguards, how emulators are accessed or dedicated, and how software corrections or changes are verified before uploading to the on-orbit Observatory.	

Title: Spacecraft Operations Description Manual	**DID FOR CDRL #:** 13

Reference:

SOW Section 4.3.2.2.2 & 4.3.7.2, 4.3.7.3

Use:

Provides a description of the operation of the Spacecraft to be used by the operations organization to develop detailed operations procedures.

Related Documents:

Flight Operations Support Plan CDRL #12, Flight Operations Ground System Interface Documentation; CDRL #7, Telemetry and Command Requirements Document CDRL #5

Preparation Information:

Operations Description Manual contents:

A. Overview and discussion of operations concept
B. Description of unique factors associated with the operation of the Observatory
C. Overview of internal and external Observatory interfaces
D. Unique ground system logistics, software, software maintenance, and sustaining engineering required for sustained Observatory operations
E. Sample operational scenarios
F. Operation of the Observatory and all Spacecraft subsystems
G. Contingency scenarios and procedures
H. Redundancy management
I. State of health maintenance
J. Listing of operations limits, cautions, and constraints.

Note: The Government will provide the instrument sections.

Title: Engineering Change Proposals (ECPs), Deviations and Waivers	**CDRL #:** 14
Reference: SOW Section 4.3.1.5	
Use:	
Related Documents:	

Preparation Information:

The Contractor shall prepare and submit Class I Engineering Change Proposals (ECPs). All ECP's shall contain, in addition to the change description, sufficient information in the form of attachments, drawings, test results, etc., to allow NASA's GSFC to evaluate the total impact of the proposed change.

For the purposes of this DID, a Class I ECP is a change that:

A. affects any NASA Contract specification, mission requirement or interface requirement

B. affects schedules of end item deliverables to the Project

C. impacts Government Furnished Equipment

The Government may direct the Contractor to prepare ECPs under the "Changes" clause of the contract.

The Contractor shall allow to the Government access to Class II changes.

Safety related waivers and deviations shall be submitted in accordance with ICESat-2 MAR section 3.4.6 and MAR DID 3-10

Waivers and deviation related to Material Review Board (MRB) actions shall be submitted in accordance with the ICESat-2 MAR section 2.3 and MAR DID 2-3.

Title: S/C Requirements Review (SRR) Information Requirements	**DID FOR CDRL #:** 15A

Reference:

SOW Section 4.3.1.4.2

Use:

To define the required information content of the SRR.

Related Documents:

GSFC-STD-1001, Criteria for Flight Project Critical Milestone Reviews

Preparation Information:

The Purpose, Timing, Objectives and Criteria for Successful Completion of the SRR shall be as delineated in Section 4.0 System Definition Review (SDR) of the referenced GSFC-STD-1001 Document and limited to the spacecraft related systems, requirements, interfaces and mission dependencies.

It is assumed that the Government Project has already completed its Mission Definition Review (MDR) (per GSFC-STD-1001) at this point and will supply MDR information to the Spacecraft Contractor.

Completion will be determined by the Government per SOW Section 4.3.1.4.2.

The Contractor shall research the requirements in SOW Paragraph 4.3.1.4. and MAR DID 8-1, and prepare an agenda no later than four weeks prior to the meeting for the Government to review , correct, and approve. The material to be presented at the reviews, tailored for the appropriate level of detail and maturity for the review, includes:

- System Budgets including updates to mass, power, alignment budgets or total system performance, command/telemetry, data rate, processor memory, and CPU margins.
- Determine Probability of Success for Controlled Reentry utilizing detailed analysis of current design performed to the subcomponent level
- Closure of actions from the previous review
- Changes since the previous review
- Spacecraft/Observatory modes, anomaly detection/autonomous response capability, and compliance with sun avoidance requirements
- Redundancy management
- Flight software design
- Pointing accuracy, knowledge, and system jitter analyses
- Grounding and fusing definitions
- Risk management items and mitigation plans
- Identification of special needs such as purge, cleanliness, sensor and instrument stimulus
- Instrument accommodations
- Completed Instrument ICDs
- Flight software architecture
- Final implementation plans including engineering models, prototypes, flight units, and spares

- Engineering model/breadboard status: plans, test results and design margins, as appropriate
- Stress and dynamics design analysis
- Thermal flight predictions
- Final attitude control system stability analyses.
- Qualification/Environmental test plans and test flow at the box, subsystem and system level
- System Performance Verification Reports per ICESat-2 MAR DID 9-6
- Integration and Test Plans
- Contamination Control Plan
- Launch vehicle interfaces
- Ground System interfaces
- Observatory Ops concept
- Preliminary Command and Telemetry Handbook
- Reliability analyses results: FMEA, worst case analysis, FTA, PRA per ICESat-2 MAR DID 4-1.
- Mechanical and Electrical Ground support equipment
- Plans for shipping containers, environmental control and mode of transportation
- Problem areas/Open items
- Schedules

Title: S/C Preliminary Design Review (PDR) Information Requirements	**DID FOR CDRL #:** 15B

Reference:

SOW Section 4.3.1.4.2

Use:

To define the required information content of the PDR.

Related Documents:

GSFC-STD-1001, Criteria for Flight Project Critical Milestone Reviews

Preparation Information:

The Purpose, Timing, Objectives and Criteria for Successful Completion, of the PDR shall be as delineated in Section 5.0 (PDR) of the referenced GSFC-STD-1001 Document.

Completion will be determined by the Government per SOW Section 4.3.1.4.2.

The Contractor shall research the requirements in SOW Paragraph 4.3.1.4. and MAR DID 8-1, and prepare an agenda no later than four weeks prior to the meeting for the Government to review , correct, and approve. The material to be presented at the reviews, tailored for the appropriate level of detail and maturity for the review, includes:

- System Budgets including updates to mass, power, alignment budgets or total system performance, command/telemetry, data rate, processor memory, and CPU margins.
- Determine Probability of Success for Controlled Reentry utilizing detailed analysis of current design performed to the subcomponent level
- Closure of actions from the previous review
- Changes since the previous review
- Spacecraft/Observatory modes, anomaly detection/autonomous response capability, and compliance with sun avoidance requirements
- Redundancy management
- Flight software design
- Pointing accuracy, knowledge, and system jitter analyses
- Grounding and fusing definitions
- Risk management items and mitigation plans
- Identification of special needs such as purge, cleanliness, sensor and instrument stimulus
- Instrument accommodations
- Completed Instrument ICDs
- Flight software architecture
- Final implementation plans including engineering models, prototypes, flight units, and spares
- Engineering model/breadboard status: plans, test results and design margins, as appropriate
- Stress and dynamics design analysis
- Thermal flight predictions
- Final attitude control system stability analyses.
- Qualification/Environmental test plans and test flow at the box, subsystem and system level

- System Performance Verification Reports per ICESat-2 MAR DID 9-6
- Integration and Test Plans
- Contamination Control Plan
- Launch vehicle interfaces
- Ground System interfaces
- Observatory Ops concept
- Preliminary Command and Telemetry Handbook
- Reliability analyses results: FMEA, worst case analysis, FTA, PRA per ICESat-2 MAR DID 4-1.
- Mechanical and Electrical Ground support equipment
- Plans for shipping containers, environmental control and mode of transportation
- Problem areas/Open items
- Schedules

Title: S/C Critical Design Review (CDR) Information Requirements	**DID FOR CDRL #:** 15C
Reference: SOW Section 4.3.1.4.2	
Use: To define the required information content of the CDR.	
Related Documents: GSFC-STD-1001, Criteria for Flight Project Critical Milestone Reviews	

Preparation Information:

The Purpose, Timing, Objectives and Criteria for Successful Completion of the CDR shall be as delineated in Section 6.0 (CDR) of the referenced GSFC-STD-1001 Document.

Completion will be determined by the Government per SOW Section 4.3.1.4.2.

The Contractor shall research the requirements in SOW Paragraph 4.3.1.4. and MAR DID 8-1, and prepare an agenda no later than four weeks prior to the meeting for the Government to review , correct, and approve. The material to be presented at the reviews, tailored for the appropriate level of detail and maturity for the review, includes:

- System Budgets including updates to mass, power, alignment budgets or total system performance, command/telemetry, data rate, processor memory, and CPU margins.
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- Changes since the previous review
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- Thermal flight predictions
- Final attitude control system stability analyses.
- Qualification/Environmental test plans and test flow at the box, subsystem and system level

- System Performance Verification Reports per ICESat-2 MAR DID 9-6
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- Contamination Control Plan
- Launch vehicle interfaces
- Ground System interfaces
- Observatory Ops concept
- Preliminary Command and Telemetry Handbook
- Reliability analyses results: FMEA, worst case analysis, FTA, PRA per ICESat-2 MAR DID 4-1.
- Mechanical and Electrical Ground support equipment
- Plans for shipping containers, environmental control and mode of transportation
- Problem areas/Open items
- Schedules

Title: Instrument Integration Readiness Review (IIRR) Information Requirements	**DID FOR CDRL #:** 15D
Reference: SOW Section 4.3.1.4.2	
Use: To define the required information content of the IIRR.	
Related Documents:	

Preparation Information:

The Contractor shall present at the IIRR:

1. The summary of results of Core Spacecraft Integration and Test in preparation for payload.
2. Resource allocations and margins (telemetry, commands, power, weight, data storage, processor capability, etc.)
3. A resolution plan for all failures, anomalies, and malfunctions encountered during system testing
4. Any remaining open integration issues and their proposed resolution
5. The readiness to perform Instrument integration (e.g. staffing, facilities, GSE, procedures, resources, etc.)
6. Plans to proceed to the Pre-Environmental Review (PER) (tests, activities, facilities, resources, schedule, flow)
7. I&T software readiness and verification status
8. Flight software development and verification status

Completion will be determined by the Government per SOW Section 4.3.1.4.2.

Title: Observatory Pre-Environmental Review (PER) Information Requirements	**DID FOR CDRL #:** 15E

Reference:

SOW Section 4.3.1.4.2

Use:

To define the required information content of the PER.

Related Documents:

GSFC-STD-1001, Criteria for Flight Project Critical Milestone Reviews

Preparation Information:

The Purpose, Timing, Objectives and Criteria for Successful Completion of the PER shall be as delineated in Section 8.0 (PER) of the referenced GSFC-STD-1001 Document.

. Completion will be determined by the Government per SOW Section 4.3.1.4.2.

The Contractor shall research the requirements in SOW Paragraph 4.3.1.4. and MAR DID 8-1, and prepare an agenda no later than four weeks prior to the meeting for the Government to review , correct, and approve. The material to be presented at the reviews, tailored for the appropriate level of detail and maturity for the review, includes:

- System Budgets including updates to mass, power, alignment budgets or total system performance, command/telemetry, data rate, processor memory, and CPU margins.
- Determine Probability of Success for Controlled Reentry utilizing detailed analysis of current design performed to the subcomponent level
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- Changes since the previous review
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- Redundancy management
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- Grounding and fusing definitions
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- Engineering model/breadboard status: plans, test results and design margins, as appropriate
- Stress and dynamics design analysis
- Thermal flight predictions
- Final attitude control system stability analyses.

- Qualification/Environmental test plans and test flow at the box, subsystem and system level
- System Performance Verification Reports per ICESat-2 MAR DID 9-6
- Integration and Test Plans
- Contamination Control Plan
- Launch vehicle interfaces
- Ground System interfaces
- Observatory Ops concept
- Preliminary Command and Telemetry Handbook
- Reliability analyses results: FMEA, worst case analysis, FTA, PRA per ICESat-2 MAR DID 4-1.
- Mechanical and Electrical Ground support equipment
- Plans for shipping containers, environmental control and mode of transportation
- Problem areas/Open items

Schedules

Title: Observatory Pre-Shipment Review (PSR) Information Requirements	**DID FOR CDRL #:** 15F

Reference:

SOW Section 4.3.1.4.2

Use:

To define the required information content of the PSR.

Related Documents:

GSFC-STD-1001, Criteria for Flight Project Critical Milestone Reviews

Preparation Information:

The Purpose, Timing, Objectives and Criteria for Successful Completion of the PSR shall be as delineated in Section 10.0 (PSR) of the referenced GSFC-STD-1001 Document.

Completion will be determined by the Government per SOW Section 4.3.1.4.2.

The Contractor shall research the requirements in SOW Paragraph 4.3.1.4. and MAR DID 8-1, and prepare an agenda no later than four weeks prior to the meeting for the Government to review , correct, and approve. The material to be presented at the reviews, tailored for the appropriate level of detail and maturity for the review, includes:

- System Budgets including updates to mass, power, alignment budgets or total system performance, command/telemetry, data rate, processor memory, and CPU margins.
- Determine Probability of Success for Controlled Reentry utilizing detailed analysis of current design performed to the subcomponent level
- Closure of actions from the previous review
- Changes since the previous review
- Spacecraft/Observatory modes, anomaly detection/autonomous response capability, and compliance with sun avoidance requirements
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- Engineering model/breadboard status: plans, test results and design margins, as appropriate
- Stress and dynamics design analysis
- Thermal flight predictions
- Final attitude control system stability analyses.
- Qualification/Environmental test plans and test flow at the box, subsystem and system level

- System Performance Verification Reports per ICESat-2 MAR DID 9-6
- Integration and Test Plans
- Contamination Control Plan
- Launch vehicle interfaces
- Ground System interfaces
- Observatory Ops concept
- Preliminary Command and Telemetry Handbook
- Reliability analyses results: FMEA, worst case analysis, FTA, PRA per ICESat-2 MAR DID 4-1.
- Mechanical and Electrical Ground support equipment
- Plans for shipping containers, environmental control and mode of transportation
- Problem areas/Open items

Schedules

Title: Observatory Acceptance Review (OAR) Information Requirements	**DID FOR CDRL #:** 15G
Reference: SOW Section 4.3.1.4.2 & 4.3.7.3	
Use: Define the required content for the OAR.	
Related Documents:	

Preparation Information:

The Contractor shall present the following at the OAR:

1. The OAR shall be in a presentation format and include, for each slide, facing page text detailed information
2. A timeline summary of all events following liftoff of the launch vehicle through the completion of on-orbit performance verification and readiness for handover to the operations team shall be included. The indicated performance of the Observatory in response to those events in comparison to the predicted performance.
3. A summary of the operating performance of each subsystem and component of the Observatory.
4. A summary of all performance discrepancies and their closure status. All issues potentially affecting mission success through the required mission lifetime shall be addressed. The more significant issues shall be discussed in the greatest detail.
5. A summary of the status of all deliverables including all required documentation.

Completion of the delivery of an acceptable MAR DID MA15-1 and CDRL OPS-7, Acceptance Data Package, is required for successful completion of the OAR.

Completion will be determined by the Government per SOW Section 4.3.1.4.2.

Title: Monthly Program Status Review Package (MPSR)	**DID No.:** PM-1
Reference: SOW Paragraph 4.3.1.7, 4.3.1.1 MAR Paragraphs 3.4.8, 2.0.2	
Purpose: To evaluate contract status. Reports will be used during face-to-face and telecon discussions between the contractor and the Government regarding project status, plans, and issues.	
Related Documents:	

Preparation Information

The Monthly Project Status Reviews (MPSR) shall include all aspects of the contract effort covering both programmatic and technical status and issues. The MPSR will usually be presented at a face-to-face meeting with the Government. These meetings will occur at the contractor's facility, unless modified by mutual agreement.

The MPSR shall include but not be limited to:

- Status of all work being performed including appropriate metrics.
- Detail status of schedule.
- Status of project staffing and any shortages.
- Milestone Monitoring – The Contractor shall report on the status of progress made toward accomplishing the next major milestone. Each report shall include a listing of major accomplishments and a discussion of any problems associated with each milestone as well as their resolution.
- Status of technical risks including the Risk List per ICESat-2 MAR DID 7-2
- Changes to design parameters such as weight, power profile, communications, system performance, etc.
- Engineering review board actions
- Software Status Report in accordance with ICESat-2 MAR DID 5-5
- Resource allocations and margins (telemetry, commands, power, weight, data storage, processor capability, depth of discharge etc.)
- Descriptions and status of technical issues and the resolutions.
- Subcontract technical performance, manpower resources, schedule, and milestone status.
- Performance assurance status including non-conformance and failure reports

Title: Program Management Plan	**DID No.: PM-2**
Reference: SOW Paragraph 4.3.1	
Purpose: Provide the details of how the contractor shall manage the ICESat-2 Spacecraft and Observatory effort.	
Related Documents: NPR 7120.5D, Program Project Management Processes and Requirements	

Preparation Information

Contents
This plan shall be organized into four major parts and shall contain, as a minimum, the following:

PROGRAM MANAGEMENT
This portion of the plan shall describe the contractor's management approach to the implementation of the ICESat-2 Program , including interrelationships of the contractor's project office with his functional and divisional groups. It shall describe how the program operates during all phases of the contract. This plan shall delineate the methods to be used and objectives to be met in complying with the Statement of Work (SOW), and shall, as a minimum, provide a description of planned activities for identifiable work statement requirements. The plan shall use flow diagrams, Work Breakdown Structure (WBS), logic networks, etc., as necessary. The plan shall address interfaces with the Government and with subcontractor and purchase order suppliers. The plan, as a minimum, shall also address cost management, security, property control, Government Furnished Equipment (GFE) requirements and health and safety.

ORGANIZATION CHART
A chart shall be provided showing the ICESat-2 Program organization with names, functions, lines of authority, coordination, etc.

TECHNICAL WORKING GROUPS
This portion of the plan shall describe the process of establishing and implementing Technical Working Groups. Each working group shall be separately identified along with the general description of its function and its planned lifetime. These formal working groups shall be composed of technical personnel responsible for developing and assuring the proper implementation of the technical requirements resident in all components delineated in the Specification Tree and the Contract Data Requirements List (CDRL). The plan shall explain how NASA technical personnel shall be provided interfaces and how they shall function within the Technical Working Groups. The contractor shall explain how documentation of these meetings shall be kept and distributed to NASA.

PROGRAMMATIC INTERFACE WITH THE GOVERNMENT
This portion of the plan shall describe the process by which the contractor will interface with the Government with respect to programmatic and technical status and issues. The plan will describe the information systems to be used for all types of program data and government access to those systems. The plan shall describe the contractor's plan for establishing systems for communication of unclassified but sensitive data and classified data with the Government.

PROGRAM FACILITIES
Describe the facilities to be used for all program activities, security and Government access to each.

SCHEDULE MANAGEMENT PLAN

The Schedule Management Plan shall be a top level plan that guides the scheduling system and shall include details of the contractor's management and control methods and techniques (including subcontractor schedules) for:

1. Maintaining the original IMS baseline on reports/listings, milestone charts, logic networks, etc. for comparison with the current planning/performance projections.
2. Relating activities and milestones to the WBS.
3. Defining:
    a. The relationships/interdependencies between and among activities and milestones.
    b. The time duration of all phases and activities/tasks.
    c. The planned start and completion dates for activities and milestones.
    d. The total schedule slack for all subsystems.
    e. The impact of early starts or slips on future activities, milestones and subsystems.
4. Providing in the MPSR:
    a. The status of each system/subsystem and/or black box by actual and planned dates.
    b. The status of all major test and integration articles by actual and planned dates.
    c. The critical path.

The plan shall identify and describe the contractor's automated scheduling system and methods/procedures for:
1. Developing, maintaining, and updating the schedule database.
2. Performing internal audits/reviews to ensure that scheduling data reported to the government provides an accurate status of work.
3. Configuring the scheduling system and summarizing data from intermediate networks to a summary network.
4. Performing audits to verify that start/completion dates included in the summary network are the same as in the intermediate networks; and integrating subcontractors schedule information in the schedule reporting system.

a. **Summary Schedule/Logic Network (Level 1)** - The plan shall describe the contractor's approach for using an automated summary/logic network that summarizes the intermediate networks. The summary schedule/logic network shall include overall program activities/milestones such as PDR and CDR and an overview of the entire program, e.g , design, procurement, manufacturing, integration and test, and launch.

b. **Intermediate Schedules/Logic Networks (Level 2)** - The plan shall describe the contractor's approach for developing intermediate schedules for each subsystem to provide a comprehensive layout of the schedule and performance baselines including:
1) Major activities/milestones during design, procurement, fabrication, integration and test, and launch.
2) For each event/milestone the baseline start and completion dates; the current projected/planned start and completion dates; the number of work days required to complete the task; the amount of total slack in work days; and a description of the event.
3) The critical path shall be derived from the intermediate schedules. The intermediate schedules/logic networks shall provide sufficient detail to permit close monitoring of the work. The contractor shall maintain detailed schedules (Level 3 and below) to support the intermediate schedules. The contractor shall verify the detailed schedules against the intermediate schedules at regular intervals to ensure full consistency when the detailed schedules are "rolled up" into intermediate schedules.

Title: Integrated Master Schedule (IMS)	**DID No.:** PM-3
Reference: SOW Paragraph 4.3.1.7	
Purpose: To track the spacecraft design, build, and I&T status over the contract lifetime with a coherent, integrated scheduling tool.	
Related Documents: NPR 7120.5D, Program Project Management Processes and Requirements	
Preparation Information The IMS shall be developed using the Critical Path Method-based scheduling technique. It will consist of the schedule baseline and the current schedule updated each monthly reporting period. The IMS shall relate actual progress to the baseline, and contain the current forecast for the remaining tasks. The IMS will be used to plan, monitor, communicate issues and control all activities, including pertinent resources and facilities necessary to accomplish assigned tasks in compliance with the ICESat-2 SOW. The IMS will provide the contractor's time-phased plan, current status, key milestones, task interdependencies, and major development phases necessary to accomplish the total scope of work. Schedule will be used to provide management insight into contractor status, potential problem areas and critical path identification which will serve as the basis for evaluating contractor performance. The baseline IMS will be the basis for evaluating the impact of Government-directed changes to the Launch date. The IMS shall be submitted in electronic format, in *Microsoft Project 2000* or later.	

Title: Interface Engineering Drawings and Changes Notices	**DRD No.:** PM-4

Reference:
SOW Paragraph 4.3.2.3

Purpose:
To provide interface layouts and engineering drawings to serve as the basis for technical discussions, evaluations, manufacturing , fabrication, assembly, test, operations and maintenance. To satisfy some of the Observatory drawings requirements of the launch services provider.

Related Documents:

Preparation Information
The contractor shall submit all engineering drawings used to procure, manufacture, assemble, integrate, test and control interfaces. Included in this engineering drawing package shall be all reference type drawings such as layouts, schematics, diagrams, mechanical drawings, electrical schematics, logic diagrams, and block diagrams. The logic diagrams shall cover the system, subsystem and component electronics and shall identify the signal inputs and outputs, internal signal flow, and the next level external connections.

Sketch type drawings shall not be used. Interface control drawings and applicable Instrument layouts shall include the stowed, extended, and critical intermediate positions of the moving mechanical assemblies and deployables with respect to fields of view and surrounding structure, components or other hardware. All drawing changes and change notices are included under this requirement.

This delivery includes wiring diagrams. These wiring diagrams shall cover the system, subsystem, component electronics, and interface with electrical/mechanical ground support equipment. It shall identify each wire by its classification:

- Ground (differentiate between power return, shield, and chassis grounds)
- Signal
- Power
- Wire type, ratings, material, etc.
- Connector/Backshells
- Harness bundle braids and termination w/backshell
- Harness between subsystems and EGSE

The diagrams shall trace each wire's runs identifying all path connections (by connector/pin number). Wire designators shall be clearly delineated for legibility.

An indentured drawing list (including drawings from subcontractors) shall be provided to the Government. An explanation of company procedures for locating drawings in this package shall be provided with this list.

All engineering drawings shall be delivered in the contractor's designated format.

Drawing Trees shall be provided to the Government to show quick-reference relationships between drawings and next level of assembly. One set for the flight hardware, and one set for the EGSE is sufficient. The drawing trees shall also include parts lists, firmware, and PROM versions.

Title: Program Security Plan	**DID No.:** PM-5
Reference: SOW Paragraph 4.3.1 MAR Paragraph 3.6	
Purpose: The purpose of the Program Security Plan is to address operational security and Physical, Information/Information Technology (IT), Personnel, and Industrial Security aspects of the program.	
Related Documents:	

Preparation Information

Provide a Program Security Plan detailing your complete approach to program security. This plan should address all requirements, including those contained in the SOW, the DD254, the Space Network (SN) Security Classification Guide, and the Information Assurance (IA). This plan should address, Physical, Information/IT, Personnel and Industrial Security, and Asset Protection requirements of the program, and should cover the following areas:

1. It should describe your Security Organization and Responsibilities.
2. Describe how your organization will prevent Foreign National (FN) Access to Classified Information.
3. Describe your organization's compliance with the National Industrial Security Program Operating Manual (NISPOM) and the Communications Security (COMSEC) Annex.
4. Describe your organization's hiring procedures for employees requiring clearance and employees not requiring clearances.
5. Describe your Security violation and corrective action program.
6. Describe your Physical Security program (description of area and facility to include floor plans where contracted work will be performed - classified and unclassified).
7. Describe access control, badge system, guard force (if any), storage facilities, equipment and document/material controls (for classified data).
8. Describe your approach to IT security for classified and unclassified systems.
9. It should address your orientation and training program to achieve an effective program.
10. It should address your approach to satisfying NASA GSFC Space Asset Protection – Concepts, Guidelines and Frequently Asked Questions (FAQ's) document for protecting hardware, software, operations' products and other facilities or equipment required for successful program implementation.
11. It should describe your approach to handling evolving government security requirements.
12. It should describe all program phases, including spacecraft shipping, launch site activities, and contingency plans and operations.
13. It should describe COMSEC custodianship requirements and the approach to ensuring security during sensitive COMSEC development/integration operations.
14. It should describe your approach to identifying and protecting spacecraft vulnerabilities, in compliance with the Security Classification Guide (SCG), including applicable vulnerabilities identified within your company but outside of the ICESat-2 Program.
15. It should describe any risks identified and the proposed mitigation approach.
16. It should describe your approach to interfaces with NASA Security, the Defense Security Service (DSS), the National Security Agency (NSA), and the launch provider as required.

Title: Configuration Management (CM) Plan	**DID No.:** PM-6

Reference:
SOW Paragraph 4.3.1.9
MAR Paragraph 3.6

Purpose:
The purpose of the CM Plan is to enable the government to understand the contractor's methods for implementing configuration management and to provide a common frame of terminology reference for efficient information exchange between the customer and the supplier.

Related Documents:

Preparation Information

The Contractor's CM Plan shall document and describe the CM organization, including:

1. The functions of Program-level and matrixed staffing in the various business units
2. Data management systems and functions
3. Product configuration identification practices
a. Including nomenclature and numbering systems
4. Change management
a. To include methods of obtaining customer approvals and the role of the NASA Resident Office
5. Configuration status reporting
6. Internal/external audits

Samples of all corresponding contractor-used forms and reports shall be included in this document.

Title: Review Materials	**DID No.:** SE-1
Reference: SOW Paragraph 4.3.1.4.4, 4.3.6.2.1 MAR Paragraph 2.1.1, 3.2.1, 6.5	
Purpose: To document the Contractor's review materials.	
Related Documents: MAR, NPR 7150.5D, NPR 7123.1A, NPR 7150.2, GSC-STD-1001, GPR 7120.5A, GPR 8700.6A, GPR 8700.4F	

Preparation Information

The Contractor shall research the requirements in SOW Paragraph 4.3.1.4. and MAR DID 8-1, and prepare an agenda no later than four weeks prior to the meeting for the Government to review , correct, and approve. The material to be presented at the reviews, tailored for the appropriate level of detail and maturity for each review, includes:

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- Final attitude control system stability analyses.
- Qualification/Environmental test plans and test flow at the box, subsystem and system level
- System Performance Verification Reports per ICESat-2 MAR DID 9-6
- Integration and Test Plans
- Contamination Control Plan
- Launch vehicle interfaces
- Ground System interfaces
- Observatory Ops concept

- Preliminary Command and Telemetry Handbook
- Reliability analyses results: FMEA, worst case analysis, FTA, PRA per ICESat-2 MAR DID 4-1.
- Mechanical and Electrical Ground support equipment
- Plans for shipping containers, environmental control and mode of transportation
- Problem areas/Open items
- Schedules

The Contractor shall submit the Review Data Package, for the approved agenda, for the following events:
SE-1H Mission Preliminary Design Review
SE-1I Reserved
SE-1J Mission Critical Design Review
SE-1K Mission Operations Review
SE-1L Mission System Integration Review
SE-1M Flight Operations Review
SE-1N Reserved
SE-1O Mission Readiness Review
SE-1P Safety and Mission Success Review
SE-1Q Flight Readiness Review
SE-1R Launch Readiness Review
SE-1S Post Launch Assessment Review
SE-1T Critical Events Review

Post Review, the Contractor shall provide responses to Requests for Action per ICESat-2 MAR DID 8-2.

Title: RESERVED	**DID No.:** SE-2
Reference:	
Purpose:	
Related Documents:	
Preparation Information	

Title: Subsystem Review Materials	**DRD No.:** SE-3

Reference:
SOW Paragraph 4.3.1.4.3 4.3.6.2.2, 4.3.6.2.3
MAR Paragraph 2.1.1

Purpose:
Engineering Peer Reviews, Subsystem reviews, and I&T Readiness Review shall be held and documented at key milestones to ascertain readiness to transition into the next program phase.

Related Documents:
MAR, NPR 7150.5D, NPR 7123.1A, NPR 7150.2, GSC-STD-1001, GPR 7120.5A, GPR 8700.6A, GPR 8700.4F

Preparation Information

The Contractor shall define and implement comprehensive subsystem/unit level design reviews. The Contractor shall prepare Subsystem Review Data Packages in accordance with ICESat-2 MAR DID 8-2. A subsystem is a functional subdivision of a spacecraft consisting of two or more components. (Examples are attitude control, electrical power, propulsion subsystem, etc.). A unit is defined as a self-contained combination of items performing a function necessary for the subsystem operation. (Some examples of a unit level of assembly are gyro package, motor, actuator, receiver, transmitter, antenna, solar panel, etc.). These subsystem/unit level reviews will be held at a minimum 14 days before major program reviews. They are also to be completed prior to acceptance of a major subsystem/unit element or before a significant subsystem/unit test is to be performed. Whenever possible, the contractor can schedule multiple unit level reviews at one time.

These subsystem reviews provide information resulting from applicable unit or component level requirement and design activities. Information from Engineering Peer Reviews and associated unit and/or component design and integration reviews shall be provided at the subsystem review. This information includes minutes, actions, risks and current status. These subsystem reviews shall provide a current picture of the subsystems internal design, configuration, interfaces, requirement compliance, verification plans and the relationship of the subsystem to the overall ICESat-2 Program spacecraft.

The contractor can also combine the unit level reviews to be part of the subsystem review. The information from the unit level reviews can be less formally documented. However, the minutes, issues and actions from the unit level reviews need to be documented and delivered to the ICESat-2 Project Library.

The subsystem reviews shall be formally documented and delivered to the ICESat-2 Project Library 14 days after the review. The documentation shall include:

1. Minutes of the review
2. Review presentation materials
3. List of all action items.
4. Plan and schedule for closure of all action items from the review
5. All other support documentation requested at the review.

The final responses closing out all action items shall be submitted to the ICESat-2 Project Library in the form of a technical memorandum. The receiver of the action item must close the action item by providing an adequate response to the person who issued the action. All subsystem action items must be closed before the formal major project reviews. Subsystem review should occur before the formal spacecraft reviews. All action items that have been raised at the subsystem review must be closed and documented before the formal spacecraft reviews. At a minimum all subsystems should have a Subsystem Preliminary Design Review (SSPDR) and a

Subsystem Critical Design Review (SSCDR).

The subsystem PDR and CDR reviews should address the following:

- Requirements and Specifications
- Closure of Action Items from Previous Review/Changes since the last review
- Performance Requirements
- Error budget determination
- Weight, Power, Performance Budget
- Engineering Model/Breadboard Test Results and Design Margins
- Interface Requirements
- Mechanical/structural design, analyses, and life tests
- Electrical design and analyses
- Thermal design and analyses
- Ground Support Equipment design
- Design verification, test flow and calibration/test plans
- Test Plans
- Technology drivers
- Parts selection, qualification, and Failure Mode and Effects Analysis (FMEA) plans
- Electrical, Electronic and Electromechanical (EEE) Parts Checklist
- Contamination requirements and control plan
- Quality Control, Reliability and Redundancy
- Materials and Processes
- Parts control requirements and plans including radiation
- EEE Parts lists
- Reliability and risk requirements and plans
- Reliability analyses, single point failures, and redundancy
- GIDEP Alerts, GIDEP Safe-Alerts, GIDEP Problem Advisories, GIDEP Agency Action Notices, NASA Alerts, and
- NASA Advisories activities
- Contamination requirements and control plan
- Hardware and software quality assurance requirements and plans including nonconformance and problem/failure reports
- Materials and processes requirements and plans
- PWB coupon testing status
- Materials and processes lists
- Safety requirements and plans including hazards and waivers
- Acronyms and Abbreviations
- Safety
- Problem Areas
- Progress/Status
- Open Items

Software is considered a major subsystem. For NPR 7150.2A Class C Software this data package will be generated at the following reviews:

1. Software Requirements Review (SWRR) held at the completion of Software requirements allocation.
2. Software Preliminary Design Reviews (SWPDR) held at the completion of each SW preliminary design

3. Software Critical Design Reviews (SWCDR) held at the completion of the FSW detailed designs

Class B software shall have all the software reviews above plus:

4. SW Verification and Validation (V&V) Test Readiness Review (SWTRR) held to evaluate preparedness for acceptance testing.
5. SW V&V Review (SWAR) held to present all test data, designs, and results for compliance against specification requirements, variances, mission operations requirements, etc.

The contractor shall prepare sufficient documentation to assess the subsystem requirements, design, and/or verification of the program. The documentation shall identify any areas of significant implementation or operational risk to the program. For each identified risk, the contractor shall identify methods to be used to mitigate the overall risk to the program.

The software subsystem reviews shall be formally documented and delivered to the ICESat-2 Project Library 14 days after the review. The same delivery documentation and schedule for subsystem review stated above applies to software reviews.

The contractor shall define and implement a program of Engineering Peer Reviews (EPRs) for the hardware and software subsystems of the Spacecraft. The contractor shall conduct a comprehensive set of subsystem peer reviews prior to PDR and CDR which are considered to be part of the system review process. EPRs shall be documented informally and delivered to the Program Information System for Contractor and Government access. EPR Action Items shall be tracked to completion and reported at MPSRs.

Post Review, the Contractor shall provide responses to Requests for Action per ICESat-2 MAR DID 8-2.

Title: Systems Engineering Management Plan (SEMP)	**DID No.:** SE-4
Reference: SOW Paragraph 4.3.2	
Purpose: The contractor shall provide a SEMP to describe all aspects of the systems engineering effort throughout all phases of ICESat-2. The purpose of the SEMP is to document, clarify and communicate the systems engineering effort.	
Related Documents:	
Preparation Information The SEMP shall include descriptions of all system engineering processes and functions, system analysis tasks and the tools to accomplish these tasks, the methodology to monitor technical progress, and how systems engineering supports the time phased activities of the ICESat-2 project. The SEMP shall comply with both GPR 7120.5A, Systems Engineering, GPR 7123.1 Systems Engineering, and NPR 7123.1A, NASA Systems Engineering Processes and Requirements.	

Title: Spacecraft Requirements Specification	**DID No.:** SE-5
Reference: SOW Paragraph 4.3.2.1	
Purpose: To document the Spacecraft system and subsystem specification derived from the Spacecraft Requirements Document (SRD).	
Related Documents:	
Preparation Information The Contractor shall document the detailed, integrated system and subsystem requirements of the Spacecraft as derived from the Spacecraft Requirements Document (SRD) and all applicable documents therein. The Contractor shall provide traceability of each Level 4 requirement to the SRD Specification and all applicable documents (Level 3). "Level 4" for this CDRL item is the next level of design detail below the Level 3 Spacecraft Requirements Document	

Title: Specification Tree	**DID No.:** SE-6
Reference: SOW Paragraph 4.3.1.3	
Purpose: To provide a hierarchical allocation of requirements displaying all of the ICESat-2 performance, design and interface specifications.	
Related Documents:	

Preparation Information

The contractor shall submit a ICESat-2 Specification Tree. This tree shall present a hierarchical allocation of requirements displaying all of the ICESat-2 functional, performance and design specifications. The top of the tree shall begin with the high level performance specification for ICESat-2 and flow down to include each and all Hardware Configuration Items (HWCI) and CSCI used on ICESat-2. All external and Contractor internal Interface Control Specification/Documents shall be displayed on this tree.

As appropriate the following information for each specification shall be displayed:

1. Specification Number
2. Specification Title
3. CI or CSCI
4. CI assembly drawing number
5. CI Schematic drawing number

Title: Photographs and Video	**DID No.:** SE-7

Reference:
SOW Paragraph 4.3.4.3, 4.3.4.4
MAR Paragraph 2.3

Purpose:
Documents and provides a video history and real-time capture of the spacecraft build and I&T, and the Observatory I&T and launch.

Related Documents:

Preparation Information

A. Still Photography

1. Pictures shall be made at appropriate points in the development of the Observatory.
2. Pictures shall be made of the major subsystems, critical components, the full-up system, and major GSE items. These pictures shall be in color and provided in a digital format on appropriate medium
3. The pictures shall serve as a record of the build-up of a major component or subsystem; e.g., a typical electronic card, mother board, electronic subsystem with cover off, etc.
4. Pictures of environmental test fixtures shall also be provided.
5. Pictures of the final closeout at the S/C contractor's facility prior to shipping shall be provided.
6. Pictures at the launch site, including exterior of the s/c upon receipt at the processing facility, final stowage and encapsulation into the LV fairing, removal of all red tag items , exterior of the s/c prior to encapsulation, and prior to the fairing door closure shall be provided.
7. Full views of the completed Observatory will be provided, suitable for printing up to 4 x 8 foot size, for publication.

B. Video

1. Video media (DVD)

Assembly of the Observatory shall be video recorded in sufficient detail to be used for training and possible failure investigation, including all lifts and mechanism deployments.

Title: Final Report and Lessons Learned	**DID No.:** SE-8
Reference: SOW Paragraph 4.3.1.3	
Purpose: Documents a summary of the performance of the contract, and any lessons learned from those activities. The purpose of the Lessons Learned is to collect and make available for use by all who may derive benefit from the experiences of others.	
Related Documents:	
Preparation Information: The Final Report shall document the execution of the Contract in terms of progress vs plan, including problems that arose and their solutions. The Final Report shall include: Initial Integrated Schedule and Final Schedule as of launch date Spacecraft implementation flow, starting at subsystem integration through IIRR Observatory I&T flow through LRR. A table summary of all contract modifications (excluding administrative adjustments to the funding profile) All deviations and waivers All safety issues The Contractor shall accumulate and document a Lessons Learned History throughout the Contract and present the Lessons Learned at each major review. A Lesson Learned is knowledge or understanding gained by experience. The experience may be positive, as in a successful test or mission, or negative, as in a mishap or failure. Successes are also considered sources of lessons learned. A lesson must be significant in that it has a real or assumed impact on operations; valid in that it is factually and technically correct; and applicable in that it identifies a specific design, process, or decision that reduces or eliminates the potential for failures and mishaps, or reinforces a positive result. Each Lessons Learned entry shall include the following information: Lesson Date: Submitting Organization: Submitted by: Subject/Title/Topic(s): Description of Driving Event: Lesson(s) Learned: Recommendation(s): Evidence of Recurrence Control Effectiveness:	

Title: Interface Control Documents	**DID No.:** SE-9

Reference:
SOW Paragraph 4.3.4.4, 4.3.7.1, 4.3.2.2.1, 4.3.2.2.2

Purpose:
To coordinate and control all interface items between the Spacecraft to Instrument and Spacecraft to Ground in order to provide efficient electrical and mechanical integration

Related Documents:

Preparation Information
The Contractor shall provide detailed information regarding the Spacecraft interface to the ATLAS Instrument. Data provided by the Government, in the form of written words, drawings, and schematics, shall be incorporated into the ICD for applicable signatures.

The Spacecraft to Instrument interface is defined per the following topics as a minimum:

1. Physical Requirements – such as mass properties, dynamic propulsion (angular momentum, disturbance torques), footprint, clearance envelope, drill template, alignment, orientation, fields-of-view (optical, thermal, glint, RF), including tolerances. Electrical Connectors – regarding sex, type, orientation, pin assignments. Thermal control coatings, blankets, heat flow and operating limits. Red and green tag items for test and flight.

2. Electrical Power and Signals – such as timing clock pulses, data busses, signal (name, type, function), voltage and current limits, frequencies, waveforms, rise and fall time, duration, periodicity, shielding, grounding, formats, line driver/receiver characteristics. Power fusing, voltage, currents, ripple, regulation.

3. Data Interfaces – Data such as data formats, communication protocols, data rates, command and telemetry formats, time distribution formats

4. Software – such as codes, processors, memory storage, application description, uses.

5. Payload Environmental – such as vibration, shock, acoustic, EMI/EMC, ESD, thermal, contamination, purges.

6. Safety – such as laser, energy storage, trip-over, hazardous materials.

7. Ground Support Equipment – such as mechanical, electrical, test specific, targets, stimulators.

8. Operational Factors – such as ground contracts needed per day, data storage capacity and compression, general flight rules and limitations.

9. Cabling and RF Waveguide – such as routing and support brackets.

Show sufficient detail on both sides of each interface to provide a clear picture of the resultant mated interface. For example, electrical interfaces shall be presented to schematic detail (logic elements and piece parts) to the point where impedance and transfer characteristics no longer affect the interface.

The Ground interface control document(s) shall include, but not be limited to, the following information:

a. Communications protocols, data rates.
b. Compression algorithms, error detection and correction schemes.
c. Antenna patterns, EIRP, G/T, beam width, uplink/downlink, frequencies, polarizations and modulations for each channel.
d. Telemetry and command formats.
e. Spacecraft contact scenarios for data transmission, operations, and maintenance.
f. Link analysis for available ground station antennas.
g. Interface requirements for RF compatibility test.
h. Interface requirements for End-to-End test.
i. Description of command and data time tagging.
j. Description of Observatory operating modes and command events.
k. Communications approach for maneuver planning and execution
l. Command encryption/decryption algorithms and key descriptions
m. CCSDS compliance

The Contractor shall submit ICDs for the following interfaces:

SE-9A Spacecraft-ATLAS Instrument
SE-9B Spacecraft RF ICD
SE-9C Spacecraft-MOC

Title: Key Management Plan (KMP)	**DID No.:** SE-10
Reference: SOW Paragraph 4.3.4.1.5	
Purpose: The Key Management Plan (KMP) describes the use and control of all key management products and services used by a cryptographic capability. The KMP also documents the capabilities that the cryptographic application requires from the current and planned Key Management Infrastructure (KMI). This ensures that any lifecycle key management services are supportable by and available from the KMI.	
Related Documents:	
Preparation Information The Government will lead the development of the ICESat-2 Key Management Plan (KMP).. The Contractor shall review and provide inputs regarding the Contractor's specific roles and responsibilities related to COMSEC and key management.	

Title: Spacecraft Integration and Test Plans	**DID No.:** IT-1
Reference: SOW Paragraph 4.3.4.3	
Purpose: Provide information on how the spacecraft will be integrated, functionally tested and how the performance will be verified.	
Related Documents:	

Preparation Information

The contractor shall provide detailed integration and test plans to be used during Spacecraft Testing. Test Plans shall be written at a level above the test procedures and shall provide information sufficient to understand the purpose and methodology of all integration and test activities, and to provide the required environmental and configuration controls necessary for successful completion of the test. These plans shall be prepared for each test activity defined in the Performance Verification Plan and shall cover all spacecraft test operations, interfaces, and spacecraft performance requirements (e.g., electrical, structural and mechanical, EMC, etc), and shall cover specialized tests such as mechanical function and deployments, environmental exposure tests (e.g., vacuum, vibration), spacecraft calibration, GSE calibration and checkout, and pre-launch end-to-end tests. If tests are conducted in conjunction as part of a "group" test, for example, Limited Performance Test (LPT) or Comprehensive Performance Test (CPT), one test plan may encompass this group. At a minimum, the plans shall contain the following information:

a. Test Objectives
b. Test Methods
c. Applicable Documents and Software
d. Required spacecraft configuration, including any differences from flight configuration. Include plans for the testing of the gyro which will be mounted to the instrument bench
e. Test Equipment Configuration, including layout and interconnection of test equipment and articles including the grounding scheme. Location and identification of all measuring points on appropriate schematics and diagrams
f. Test Equipment and Facility Identification
g. Test Instrumentation
h. Safety Provisions and Cautions, including Identification of hazardous and potentially hazardous situations and operations and abort conditions
i. Environmental and/or other conditions to be maintained, including contamination controls
j. Responsibilities and chain-of-command for test performance
k. Expected results in telemetry and associated caution and warning levels.
l. Data Recording Requirements
m. Data Recording Forms and Tables
n. Accept/Reject Criteria
o. Any test phases and profiles
p. List the requirements for the test procedure and test report development
q. Description of any necessary functional operations required during the test (i.e. a CPT performed at hot and cold during thermal vacuum testing)

The Contractor shall support the FOT with spacecraft performance and functional information in the FOT's

generation of similar plans for MRTs.

Title: Science Test Data	**DID No.:** IT-2
Reference: SOW Paragraph 4.3.4.4.1	
Purpose: Ground segment personnel will use the files to represent the downlink science digital data flow as it would be seen recovered from the RF downlink at a ground station.	
Related Documents:	
Preparation Information The Contractor shall provide, on appropriate media, playback science data in the format it would be presented to the downlink modulator. The playback period will be defined by the Government. The data shall contain all spacecraft science frame formatting structure and content. Fill bits shall not be used for science data.	

Title: Observatory Integration and Test Plans	**DID No.:** IT-3

Reference:
SOW Paragraph 4.3.4.4, 4.3.4.4.4

Purpose:
To show the Contractor's plans and approach to I&T for the Observatory (to include final Observatory comprehensive performance testing). The plan includes Mission Readiness Testing with the appropriate ground system elements.

Related Documents:

Preparation Information

The Contractor shall provide definitive test plan for the Observatory integration and test which identify the scope, purpose, sequence (test flow), and success criteria for the activities below. The Contractor shall identify where in the test flow repeat activities occur to re-baseline system performance (e.g. Observatory full functional test). The minimum integration and test activities the Contractor shall address in the plans are:

Spacecraft level:
- Final Spacecraft comprehensive performance tests.

Observatory level:
- Instrument integration:
  - Mechanical integration.
  - Electrical integration.
  - Instrument comprehensive performance test. (GF Plan and Procedure)
- EMI/EMC/ESD test.
- Compatibility Test Van (CTV) tests
- Optical and mechanical alignments.
- Magnetic survey.
- Polarity checks of critical components.
- Attitude control subsystem phasing.
- Solar array integration (required only if integrated at the Observatory level).
- Flight payload attach fitting integration.
- Mass properties measurements.
- Vibration test.
- Acoustics test.
- Shock test.
- Solar array deployment.
- Thermal vacuum test.
- Thermal balance test.
- Cleanliness, control and monitoring.
- Launch vehicle interface tests
- Mission Readiness Tests.

Spacecraft Interface Simulator I&T with the Instrument
Observatory Operations Simulator I&T with the Instrument Simulators and the MOC

Title: Laser Safety Plan	**DID No.:** SMA-1
Reference: SOW Paragraph 4.3.4.4	
Purpose: The purpose of the Laser Safety Plan is to document the plans necessary to ensure safety of personnel, equipment and facilities once the ATLAS instrument has been delivered to the contractor for integration with the spacecraft.	
Related Documents:	

Preparation Information

The Contractor's Laser Safety Plan shall document and describe:

1. Identification of the hazards
2. Roles and responsibilities
3. Facility Plans, including physical access control plans, hazard markings etc.
4. Personnel protections plans
5. Training Plans
6. Laser Operating procedures
7. Incident Reporting and Emergency information and contacts

The contractor may use the ATLAS Instrument Laser Safety Plan as input to the Laser Safety Plan.

Title: Launch Site Support Plan	**DID No.:** LV-1
Reference: SOW Paragraph 4.3.5	
Purpose: To document and define requirements and control all aspects of the interface between the Observatory and the LV to insure efficient integration and promote a successful launch to the mission orbit.	
Related Documents: External Interfaces, Models and Analysis	
Preparation Information This deliverable set of data defines the requirements of the Observatory for the LV provider and shall include the following as a minimum: a. PRD, PGAA, Observatory Integrated Ops, and Observatory Environmental Test Results b. Observatory and launch site processing questionnaire. c. Observatory mathematical model for dynamic analysis. d. Observatory environmental test results. e. Observatory/launch system interface specification (electrical, mechanical, data) inputs. f. Mission operations and support requirements. g. Payload (Observatory) requirements h. Observatory drawings. i. Electrical wiring requirements. j. Fairing requirements. k. Observatory integrated test procedure inputs. l. Mission analysis requirements. m. Launch intervals (window). n. Radio frequency applications (provide by the Government with support from Contractor). o. Post-launch orbit confirmation data. p. Launch hold criteria – Observatory go/no go.	

Title: Launch Commit Criteria	**DID No.:** LV-2
Reference: SOW Paragraph 4.3.5	
Purpose: To define the procedures, and the critical processes and events to achieve launch.	
Related Documents:	
Preparation Information The launch commit criteria describe the status of all spacecraft, GSE, communication, staffing, and facilities as the countdown progresses toward launch. Each criterion is described in terms of Mandatory or Critical, at each countdown poll. The criteria includes a complete list of all flight and ground telemetry and other parametric measurements, including the red, yellow, and green limits for each, tolerances, and any condition that would require resolution prior to launch. This deliverable documents the launch commit criteria and the criteria to be used to commit the ICESat-2 Observatory for launch. The document shall address the ICESat-2 Observatory, the Observatory launch control center(s), and associated activities prior to liftoff.	

Title: Simulator Requirements Document	**DID No.:** SIM-1

Reference:
SOW Paragraph 4.3.4.2.1, 4.3.4.2.4

Purpose:
To describe the capabilities and performance requirements of the Spacecraft Interface Simulator and the Spacecraft/Observatory Simulator.

Related Documents:

Preparation Information

The Simulator Requirements Document shall address the requirements in SOW paragraphs 4.3.3.4 and 4.4.3, and shall include, as a minimum and as appropriate for the particular simulator, the:

1. Simulator capabilities
2. Installation and initialization
3. Startup and termination
4. Functions and their operation
5. Error and warning messages
6. Recovery steps
7. Minimum hardware platform and operating system requirements
8. Simulator external interfaces to other ICESat-2 elements – electrical, command/telemetry, data rates, protocol, packet structure/definition, power, etc.
9. Time maintenance and correlation
10. Fault detection and handling
11. Simulator modes of operation
12. Simulator displays
13. Allowable data types and data conversions
14. Simulator alerts and warnings
15. Access control requirements

The Contractor shall submit SIM-1 in two editions:

1. CDRL SIM-1A - Spacecraft Interface Simulator
2. CDRL SIM-1B - Spacecraft/Observatory Simulator

Title: Simulator I & T Plan	**DID No.:** SIM-2
Reference: SOW Paragraph 4.3.4.2.1, 4.3.4.2.4	
Purpose: The Simulator I&T Plan describes the integration and test activities for each of the simulators	
Related Documents:	

Preparation Information

The Simulator Integration and Test Plan shall:

1.Describe the test activities associated with each of the Simulators in detail along with expected outcomes and results. It lists the executables under test, describes the test environment in detail (so that tests may be duplicated) and the specific version of the executables under test.

2. List and describe the utilities and tools needed or recommended to setup the environment, load the database, convert output data into readable reports, generate test data, etc.

3. List the test cases to be run on each executable in the subsystem.

4. Indicate the input data to be used for each test case along with the location of the data, whether in a flat file or database table.

5. Indicate the name and location of output files used to verify the outcome of each test case.

6. Indicate any and all errors/defects found in the course of running each test case.

7. Indicate methods for verifying system timing, and time correlation (if applicable)

The Contractor shall submit CDRL SIM-2 in two editions:
1. CDRL SIM-2A - Spacecraft Interface Simulator
2. CDRL SIM-2B - Observatory Operations Simulator

Title: Simulator Test Reports	**DID No.:** SIM-3
Reference: SOW Paragraph 4.3.4.2.1, 4.3.4.2.4	
Purpose: Documents the results of each acceptance/interface/performance test completed by the Simulators	
Related Documents:	

Preparation Information

Each Simulator Test Report shall document the results of each integration and test simulator activity , including:

1. Simulator acceptance tests
2. Simulator interface tests
3. Simulator performance tests

The Contractor shall submit CDRL SIM-3 in two editions:

1. CDRL SIM-3A - Spacecraft Interface Simulator
2. CDRL SIM-3B - Observatory Operations Simulator

Title: Simulator's User's Guide (Manual) for Spacecraft Interface Simulator	**DID No.:** SIM-4
Reference: SOW Paragraph 4.3.4.2.1, 4.3.4.2.4	
Purpose: The Simulator User's Guide (or manual) describes the Simulator operation.	
Related Documents:	

Preparation Information

The Simulator User's Guide shall contain the information required to use the Simulator, including detailed procedures and functionalities. It shall show a screen-shot of all Simulator Graphical User Interfaces (GUIs) and detail the usage of each GUI. It shall give detailed descriptions of major Simulator functionality, then give step-by-step instructions (with the use of the screen-shots) on how to install and use the Simulator to achieve these functionalities. The User's Guide shall detail the various modes of operation based on access control, and show screen-shots indicating the difference in screen activations based on a user's input.

The Simulator User's Guide shall:

a. List all alerts or notifications produced by the Instrument Interface Simulator along with their meanings.
b. Indicate how to start the simulator, including cold and warm starts if applicable.
c. Indicate recovery methods in cases of irrevocable errors or faults.
d. Indicate data types and command arguments expected within each field of each GUI.

The Contractor shall submit CDRL SIM-4 in one editions:
1. CDRL SIM-4A - Spacecraft Interface Simulator

Title: Simulator Training Plan and Materials: Spacecraft Interface Simulator, Spacecraft/Observatory Simulator,	**DID No.:** SIM-5
Reference: SOW Paragraph 4.3.4.2.1, 4.3.4.2.4	
Purpose: Provides details of the training plan, materials, SC – instrument simulator, SC, and RF Suitcase data, interfaces and the ground data system.	
Related Documents:	

Preparation Information

The Simulator Document information, as a minimum, shall include details of the following:

Data interfaces: formats, communications protocols, data rates.
Administrative interfaces
Facility interfaces: space, power, lighting, air conditioning, security, network access

The Flight Software topics covered by the training materials shall include, but not be limited to, nominal execution, responses to anomalies, differences between the test environment and the actual performance of the ICESat-2 Flight Software, and constraints and software safety related information. Additional topics shall be included at the discretion of the ICESat-2 Project.

The OOS shall include all information and tutorials required such that the users of the facilities do not need routine support from the Contractor in order to successfully and safely execute their tests and simulations. In addition to training on the test procedure language and test script generation, topics shall include, but not be limited to, power up and power down, constraints, safety features, tools such as in-circuit emulators, bus monitors and logic analyzers, and offline analysis and display tools.

The Contractor shall submit CDRL SIM-5 in two editions:
2. CDRL SIM-5A - Spacecraft Interface Simulator
3. CDRL SIM-5B – Observatory Operations Simulator

Title: Flight Operations Team (FOT) Training Package	**DID No.:** OPS-1

Reference:
SOW Paragraph 4.3.7

Purpose:
Provides training material for classroom presentation to train and qualify the Flight Operations Team.

Related Documents:

Preparation Information

The FOT Training Package shall include the following items:

1. ICESat-2 Training Plan, including a course outline which addresses nominal and anomalous operation of the:
   a. Spacecraft
   b. Instrument
   c. MOC
   d. FOT qualification criteria
2. Training Materials, including:
   a. Functional descriptions
   b. All modes of operation
   c. Operating procedures and scripts
   d. Normal Imaging activities
   e. Time lines for launch and early operations
   f. On-orbit checkout
   g. Observatory on-orbit acceptance activities
   h. Operating constraints and rules
   i. Anomaly scenarios and procedures
   j. As-presented video recording of the training session(s)
3. Assessment and qualification of the FOT

Title: On-orbit Acceptance Plan	**DID No.:** OPS-2

Reference:
SOW Paragraph 4.3.7.3

Purpose:.
Details the steps to demonstrate that each subsystem and the spacecraft as a whole meet the post-launch nominal acceptance requirements.

Related Documents:
None

Preparation Information
Submit a timeline showing the notional sequence of post-launch operations. Detail the expected telemetry, the planned activities, and expected results.

Identify the Observatory sequences required for the MOC to support the operational events during the on-orbit acceptance phase of the mission. .

The procedure shall include a detailed flight time line and script of each communications stations' required action and response.

The On Orbit Acceptance Plan shall be the governing document for initialization and validation of the Observatory during the pre-operational check-out period. The plan shall include:

a. A summary of the initialization and verification methodology
b. The on-orbit acceptance criteria
c. A matrix or list of the Observatory requirements to be verified on-orbit which are cross-referenced to the appropriate Observatory On-Orbit Test Procedures or Calibration/Validation Procedures.
d. A list of the calibration of attitude determination hardware and propulsion system requirements to be verified on-orbit which are cross-referenced to the appropriate Observatory On-Orbit Test Procedures or Calibration/Validation Procedures.
e. The schedule of initialization and verification activities, including start times and durations.
f. Procedure numbers of the Observatory On-Orbit Test Procedures to be used during initialization and verification
g. Constraints to operations
h. The roles and responsibilities for conducting operations
i. Contact information for operators, engineers and system support
j. Plans for handling communications and decision-making in the event of non-nominal results during testing. These plans shall include, contact information for critical personnel, and identify contingency procedures.

Title: Flight Activation Operations Plan	**DID No.:** OPS-3
Reference: SOW Paragraph 4.3.7.3, 4.3.7	
Purpose: To describe the Contractor's plan for performing the flight operations of the Observatory starting at Observatory/LV integration and test, through launch, and throughout the on-orbit check out phase. Included is how the Contractor intends to perform anomaly resolution to the end of the check out phase.	
Related Documents: None	

Preparation Information

The Flight Activation Operations Plan shall include the following:

A. Description of roles and responsibilities and plans of how the Contractor will perform the operations of the Spacecraft during LV integrated test, launch, and on-orbit activation operations.
B. Description and designation of any unique ground systems and responsibilities needed for Spacecraft operations.
C. Plan for anomaly identification, investigation, and resolution process.
D. Plan for initial and periodic performance assessments to determine Spacecraft viability and compliance with specifications.
E. Description of complement of skills needed to perform this support and how the Contractor will provide these resources.
F. Representative anomaly situations and scenarios for resolution.

Title: Operations Transition Plan	**DID No.:** OPS-4
Reference: SOW Paragraph 4.3.7.3	
Purpose: To define the transition activities and schedule of Observatory operation and monitoring from Contractor personnel to Government personnel.	
Related Documents:	
Preparation Information The Operations Transition Plan shall define in detail the procedure for transitioning operation of the Observatory from Contractor personnel to Government personnel. The Plan shall include conditions to be met prior to transition, any phasing of transition, inclusion of over-the-shoulder monitoring on the part of both Government personnel prior to transition and Contractor personnel just prior to Government acceptance. The Plan shall include opportunities for the Flight Operations Team to participate in Observatory integration and test activities. The plan shall include steps taken to ensure safety of the Observatory is maintained through the transition process. The Plan shall include a transition schedule including milestone activities or events that must be completed prior to each transition phase.	

Title: Sustaining Engineering Plan	**DID No.:** OPS-5
Reference: SOW Paragraph.4.3.7.4	
Purpose: This plan shall describe all activities required to sustain the operation of the ICESat-2 spacecraft. The plan shall describe the contractor's plan for the timely resolution of satellite problems and potential problems. It also includes the analysis of satellite archived, trending and performance data.	
Related Documents:	
Preparation Information This plan shall describe all activities required to the spacecraft, spacecraft operations, ground operations and performance. This plan shall describe how the contractor will support the anomaly identification, anomaly resolution process and evaluation of suspect satellite performance trending data. This support is required during launch, deployment, and on-orbit operations of the ICESat-2 Program Spacecraft. The Plan shall describe the interfaces between the contractor's resolution team to NASA and Maintenance and Operations (M&O) personnel. In addition, the plan shall address the manpower support requirements, location of the resolution team and reports/documentation needed to ensure that the problem(s) is/are tracked and properly resolved. This includes delivery of records from launch through transition to operations that meets the established Spacecraft On-Orbit Anomaly Report (SOAR) document format.	

Title: Operations Procedures and Scripts	**DID No.:** OPS-6
Reference: SOW Paragraph 4.3.7	
Purpose: Provides spacecraft procedures and scripts for the FOT to use for mission operations.	
Related Documents:	

Preparation Information

The Operations Procedures and Scripts shall provide a detailed set of operations procedures for operating the ICESat-2 Observatory. These procedures shall include as a minimum:

A. Normal on-orbit command and control operations
B. Observatory State-of-Health Monitoring and management
C. Performing on-orbit maneuvers to maintain correct orbital parameters
D. Observatory mode transition and mode operations
E. Contingency and recovery procedures
F. Calibration
E. On-board Consumables Management

Each Operational Procedure shall contain the following information:

1. Procedure Purpose
2. Procedure Methodology
3. Support Resources Required
4. Observatory Configuration before and after the procedure is executed
5. Step-by-step commands to be issued and expected Observatory response after each step
6. Cautions and warnings

Title: Acceptance Data Package	**DID No.:** OPS-7

Reference:
SOW Paragraph 4.3.7.3, 4.3.4.4.4
MAR Paragraph 3.3.3, 2.4.1

Purpose:
To ensure that the deliverable contract end-items are in accordance with contract requirements prior to Government acceptance.

Related Documents:

Preparation Information

The Contractor shall provide the following information only to the extent it is not represented in other CDRL submissions and in accordance with ICESat-2 MAR DID 16-1,. The Contractor shall identify prior submissions in the appropriate section of the Acceptance Data Package by referencing the appropriate CDRL, and the date submitted.

This acceptance data package, as a minimum, shall be comprised of the following Spacecraft information:

A. Contract End Item Specification with waivers and deviations
B. As-built configuration list
C. Hardware parts lists
D. Hardware materials and processes lists
E. Test Log Book (including total operating time and cycle records)
F. Non-conformance or Open item lists (including reasons for being open)
G. Waivers
H. Safety compliance data package
I. Limited life items listings and status
J. Environmental tests results
K. Subsystem tests results
L. Calibration tests results
M. Critical parameters trend data
N. On Orbit Performance Report
O. Anomaly reports and FRB disposition information

Item A above, the Contract End Item Specification, establishes the architecture, configuration, function, and performance of the spacecraft, and shall address design compliance with and traceability to the Spacecraft Requirements Document, and other applicable requirements documents.

Item M above, the On Orbit Performance Report, shall contain the following:

1. Launch and early orbit operations results
2. On-orbit checkout results, including a summary of results of each of the tests and verifications performed per the On Orbit Initialization and Validation Plan. This includes the final System Performance Verification Report per ICESat-2 MAR DID 9-6
3. Algorithms and calibration coefficients used throughout the test period
4. Onboard environmental models (magnetic field, solar ephemeris, star catalog)
5. Instrument alignments, biases, scale factors, etc
6. The onboard Orbit Determination validation results, if performed

7.	Anomalous behavior and resolution including any anomaly reports
8.	Current Status of the ICESat-2 Observatory, including redundancy
9.	Lessons learned

Title: Command and Telemetry Database	**DID No.:** OPS-8
Reference: SOW Paragraph 4.3.7.1, 4.3.7.3	
Purpose: To provide command and telemetry data required to control and operate the ICESat-2 Observatory.	
Related Documents: None	

Preparation Information

The Observatory Database shall contain design, performance, and test operations information that could impact the observatory operations. This information shall include, as a minimum:

1. Database pre-launch parameters such as Observatory mass, fuel mass, pertinent pressures, gyro drift characteristics, etc.
2. Alignments, especially those included in error budgets for open-loop pointing and yaw attitude determination.
3. Any spacecraft calibration data necessary to satisfy mission requirements, e.g., Earth Instrument, fine Sun Instrument and/or star trackers, magnetometers, and gyros calibrations sufficiently accurate to enable attitude determination, smoothing coefficients, antenna gimbal limits, deadbeat intervals, calibration biases, torque rod/magnetometer coupling matrix, phase shifter calibration data, and the location of the multiple access elements in body-fixed Cartesian coordinates.
4. This database shall include all Telemetry, Calibration, Command Data and spacecraft unique information.
5. Space Ground Link and Space to Space recommended setting for transmitter power.
6. Tracking services absolute propagation time delays for all TT&C and Payload configurations.

Title: Observatory Thermal Model Delivery	**DID No.:** SC-1
Reference: SOW Paragraph 4.3.2.2.1	
Purpose: To provide the project team with the capability to exercise the full observatory thermal model.	
Related Documents: None	

Preparation Information

The offeror shall provide to the project team the detailed observatory thermal model. This shall meet the following criteria:

1) The thermal model shall be the most up-to-date model available at the time of delivery

2) The model shall be able to be run as delivered, including both the thermal math model and geometric math model

3) The model shall be in either Thermal Desktop or TSS/SINDA formats

4) The model shall be able to predict and report the temperature at every flight temperature on the observatory

5) The model shall be able to predict and report the power draw of all heater circuits on the observatory

6) The model shall include at least two sample analysis cases to verify the model's functionality upon receipt.

7) The model shall include a model description document that describes all necessary files, instructions of how to modify and run the model, a description of the outputs received from the model, a description of all logic written into the model, and a list correlating the temperature sensors to model nodes

Title: Mass properties Report	**DID No.:** SC-2

Reference:
SOW Paragraph 4.3.4.3.4, 4.3.4.4.2

Purpose:
To document all physical mass properties of the observatory, its subsystems and components from preliminary design through final assembly, launch and throughout all phases of the mission up to End of Life (EOL). To satisfy the mass properties reporting requirements of the launch services provider.

Related Documents:
None

Preparation Information

This document shall provide a mass properties database for the observatory. Mass properties shall include mass, center of gravity, moments of inertia, products of inertia, principal axis misalignment, and physical dimensions. The report shall be based upon calculated values and shall be updated as calculations are revised and actual measured data becomes available. Following environmental testing and prior to the observatory shipment, the report shall contain a complete mass properties summary of the final observatory mass properties as measured. The report shall also include the appropriate mass contingency for the current stage of hardware development, along with the allocated mass allowables.

The mass properties report shall contain the following:

a. An overall observatory mass summary, including total observatory dry mass, observatory subsystem dry mass, total observatory launch mass (including propellant), total observatory orbit insertion mass, and observatory mass at EOL.

b. A observatory mass properties summary for the various phases of the mission, including launch, deployments, separation, through EOL. This summary should also demonstrate mass changes due to propellant utilization throughout the mission through EOL.

c. A detailed mass properties summary of all observatory hardware organized by subsystem.

d. A summary of all mass properties changes incorporated into the observatory mass properties database since the last report.

The deliveries at L-54 weeks and L-20 weeks to satisfy launch services provider requirements shall include nominal and 3-sigma uncertainties for mass, centers of gravity, moments of inertia, products of inertia, and principal axis misalignment.

Title: Spacecraft Reduced Thermal Model Delivery	**DID No.:** SC-3
Reference: SOW 4.3.2.2	
Purpose: To provide the instrument team with the capability to model the thermal interfaces with the spacecraft.	
Related Documents:	

Preparation Information

The Contractor shall provide to the ATLAS instrument team with a reduced spacecraft thermal model. This shall meet the following criteria:

1) The thermal model shall be the most up-to-date model available at the time of delivery

2) The model shall be able to be run as delivered, including both the thermal math model and geometric math model

3) The model shall be in either Thermal Desktop or TSS/SINDA formats

4) The model shall be able to accurately represent the expected thermal interfaces from the spacecraft to the instrument, including radiator backloads and conductive interfaces across the ATLAS-to-Spacecraft and ATLAS-to-IMSC thermal interfaces

5) The model shall only use submodels, thermophysical properties, optical properties and symbols that start with the letters "SC"

6) The model shall have no more than 1000 nodes

7) The model shall include at least two sample analysis cases to verify the model's functionality upon receipt.

8) The model shall include a model description document that describes all necessary files, instructions of how to modify and run the model, a description of the outputs received from the model, a description of all logic written into the model, and a list correlating the temperature sensors to model nodes

Title: Analyses	**DID No.:** SC-4
Reference: SOW Paragraph 4.3.2.2.1	
Purpose: To provide detailed analyses and margins of safety calculations for all major components and functions in the observatory	
Related Documents: None	

Preparation Information

The following information shall be provided:

1. Mechanical stress analysis
2. Launch-to-orbit mission analysis
3. Structural and mathematical analysis
4. Load transformation matrices
5. Jitter analysis
6. Propulsion subsystem analysis
7. ACS analysis
8. Link analysis and BER analysis
9. Observatory Level Structural, Thermal, Optical Precision (STOP) analysis
10. Thermal analysis
11. Power subsystem analysis
12. C&DH performance analysis

The Contractor shall describe the analysis method used, assumptions, its constraints and execution, limiting cases, and the analysis results.

Title: Battery Handling Plan	**DID No.:** SC-5
Reference: SOW 4.3.4.3.6	
Purpose: To provide the plan for handling of the ICESat-2 battery throughout the DO.	
Related Documents:	
Preparation Information The Contractor shall provide a Battery Handling Plan which includes at a minimum the following information: 1) Storage Plans (Active and Inactive, Temperature, and Humidity), 2) Reconditioning Plans (Prior to Integration and Test, Preparation for Launch), 3) Transportation Plans 4) Maintenance Plans (During I&T, Launch Operations, Preparation for Launch), and Disposal. Note: Reconditioning Plans are not required for Li Ion batteries.	

Title: Software Management and Development Plan (SMDP)	**DID No.:** SW-1

Reference:
SOW Paragraph 4.3.6.2
MAR Paragraph 3.4.2, 3.4.3, 3.4.5

Purpose:
Documents the software development processes, activities, and procedures, software tools, resources, and deliverables throughout the development life cycle. This document describes the Contractor's overall systematic approach to managing the processes used in the design, development, testing (all phases), documentation, configuration management, risk management, assurance, and delivery of all NPR 7150.2A Class B & Class C software.

Related Documents:
The Software Management Plan shall be prepared IAW the full contents of NPR 7150.2A, NASA Software Engineering Requirements. Alternatively, the contractor may, with agreement from the government, use an alternative industry standard SMP approach such as MIL-STD-498 (DID DI-IPSC-81427A) or IEEE standards.

Preparation Information

The content shall include the following topics:

1) Introduction including purpose, scope, definitions, and references
2) A description of practices, tasks, and activities performed as a basis for Contractor effort and schedule determination.
3) Project organization and responsibilities including resources and schedules
4) Software development overview
5) Software development activities by life cycle:
    a. Development and test environment
    b. Tools, techniques, and methodologies
    c. Software standards and development processes
6) Software metrics
7) Software deliverables
8) Software-related training plans/requirements

In addition to the content required by NPR 7150.2, include the following topics as well:

1) A tailoring Requirements Mapping Matrix (as described in the Appendix D) to identify the contractor's responsibility to meet the NPR 7150.2 requirements.
2) A description of the software development organization including the organization chart, and a description of how the software personnel structure is integrated into the overall ICESat-2 Program development organization. Management, development and testing approach for handling any commercial-off-the-shelf (COTS), government-off-the-shelf (GOTS), modified-off-the-shelf (MOTS), reused, open source software component(s) that are included within a NASA system or subsystem.
3) An identification of the deviations from the standard life cycle to accommodate the integration of reuse software. Include specific justification that the reuse is applicable and preferable.
4) A description and justification of the safety criticality and classification and type for each software component.

5) A justification of the selected software language(s) and development methodologies.
6) A specification of software protection against vandalism, viruses, unauthorized access, and disaster risks.
7) The plan and approach for training personnel (Contractor staff, external maintainers, Flight Operations Team) in the use of all delivered software and supporting facilities.
8) A description of the establishment and maintenance of Software Development Files (SDFs) for Computer Software Unit (CSUs), Computer Software Components (CSCs), and CSCIs.
9) A description of the open source software usage and maintenance approach

10) A Risk Management plan describing the processes and methods by which technical, cost, and schedule risks will be identified, evaluated, and minimized.
11) A Configuration Management plan that complies with NPR 7150.2.
12) An identification of the constraints to which the development process is subject (for example, use of assembly language, resource limitations, external dependencies, etc.)
13) A build-delivery matrix describing the functionality and delivery schedule for software builds.
14) Engineering environment (for development, operation, or maintenance, as applicable), including test environment, library, equipment, facilities, standards, procedures and tools.
15) Work break down structure of the life cycle processes and activities, including the software products, services, non-deliverable items to be performed, budgets, staffing, acquisition approach, physical resources, software size, and schedules associated with the tasks.
16) Management of the quality characteristics of the software products or services. Subcontractor management, including subcontractor selection and involvement between the subcontractor and the acquirer, if any.
17) Subcontractor management, including subcontractor selection and involvement between the subcontractor and the acquirer, if any.
18) Verification and validation.
19) Acquirer involvement.
20) User involvement.
21) Process for scheduling, tracking, and reporting.

Class B software should also include:

- The plan for the level of embedded software support to be provided for the ICESat II software/hardware integration effort. The Plan shall address integration support concepts such as the capabilities of the embedded software under test during periods of variable hardware and software configuration, capabilities of the software to determine to determine the cause of anomalies (hardware verses software), and the capabilities of built-in tests.

- The method of tracking and correcting any software defects identified during ICESat II I&T and the organization responsible for correcting the defects. The plan shall address the procedures for re-installing non-volatile memory as part of the corrective process.

- A description of the hardware/software interface testing to take place on ICESat II.

Class C software should also include:

1) The Plan shall detail the method of tracking and correcting any software defects identified during

ICESat II I&T and the organization responsible for correcting the defects. In this instance, the term defect includes a discovery that the ICESat II flight hardware has different performance characteristics than expected and modeled.

Title: Software Requirements Specification	**DID No.:** SW-2
Reference: SOW Paragraph 4.3.6.1	
Purpose: Documents all software requirements (e.g., functional, performance, software safety, and security), assumptions and dependencies, design and implementation constraints, delivery and installation requirements, and complete requirements traceability to parent requirements or system requirements	
Related Documents: NASA-Software NPR 7150.2. Alternatively, the contractor may, with agreement from the government, use an alternative industry standard SRS approach such as MIL-STD-498 (DID DI-IPSC-81433A) or IEEE standards.	

Preparation Information

Software requirement characteristics shall be correct, unambiguous, complete, consistent, verifiable, modifiable, and traceable per IEEE Std 830-1998, "Recommended Practice for Software Requirements Specifications." The Software Requirements Specification shall meet the intent of IEEE/EIA 12207.1-1997 and include:

1. Introduction, scope, and applicable documents
2. Software functional overview and flow
3. Functional requirements
4. External and internal Interface requirements
5. Performance and timing requirements
6. Software safety requirements
7. Security and privacy requirements
8. Software quality requirements
9. Delivery, installation, and environmental requirements
10. Computer hardware and software resources and requirements
11. Assumptions and dependencies
12. Design and implementation constraints
13. Qualification methods and acceptance criteria (which may be referenced)
14. A traceability matrix that maps each software requirement to a system or sub-system (higher level) requirement from which it is derived. Additionally, the test method used to verify each requirement shall be identified. Required states & modes
15. Internal data requirements
16. Adaptation requirements (data used to adapt a program to a given installation site or to given conditions in its operational environment).
17. Personnel-related requirements.
18. Training-related requirements.
19. Logistics-related requirements.
20. Packaging requirements.
21. Precedence and criticality of requirements.
22. Personnel-related requirements.
23. Training-related requirements.
24. Logistics-related requirements.

25. Packaging requirements.
26. Precedence and criticality of requirements.

Title: Software Design Document (SDD)	**DID No.:** SW-3

Reference:
SOW Paragraph 4.3.6.1

Purpose:
The Flight Software Design Document describes in detail the architecture, structure, and organization of a particular CSCI, decomposing the top-level CSCI into CSC and lower levels of units as appropriate. The SDD describes each unit of software in terms of its interfaces (input/output), data architectures, and processing (e.g., logic, algorithms).

Related Documents:
The Software Design Document shall be prepared IAW the full contents of NPR 7150.2. Alternatively, the contractor may, with agreement from the government, use an alternative industry standard SDD approach such as MIL-STD-498 (DID DI-IPSC-81435A) or IEEE standards.

Preparation Information

The Software Design Document shall be prepared in accordance with NPR 7150.2A. Alternatively, the contractor may, with agreement from the Government, use an alternative industry standard SDD approach or IEEE standards. Content required shall include the following as well:

- A description of utility libraries and routines.
- Software Interface Control may optionally become a rolled- out volume. The information shall cover both the software-to-software and software-to-hardware interfaces.
- The Interface Design Description shall be prepared in accordance with NRP 7150.2A to describe the interface characteristics of one or more systems, subsystems, HWCIs, Ski's, manual operations, or other system components. An interface design description may describe any number of interfaces
- The Software Data Dictionary shall be prepared in accordance with NRP 7150.2A
- The Firmware Support Manual (FSM), as specified in NASA-DID-P410, may optionally become a rolled-out volume, and shall contain the information necessary for the firmware programmer to program, support, monitor, troubleshoot, and verify the contents and configuration of the firmware on the spacecraft or in the high-fidelity simulator facilities ,SDMS.

a) CSCI-wide design decisions/trade studies.
b) CSCI architectural design.
c) CSCI decomposition and interrelationship between components.
   1. CSCI components:
      a. Description of how the software item satisfies the software requirements.
      b. Software item I/O description.
      c. Static/architectural relationship of the software units.
      d. Concept of execution, including data flow, control flow and timing.
      e. Requirements, design, and code traceability.
      f. CSCI's planned utilization of computer hardware resources.

2. Rationale for software item design decisions/trade decisions including assumptions, limitations, safety and reliability related items/concerns or constraints in design documentation.
3. Interface design.

Note: The documentation of the architectural design of a software system identifies and describes the architectural elements of the software, the external interfaces, and the interfaces between elements. The description includes element responsibilities (constraints on inputs and guarantees on outputs), and constraints on how the elements interact (such as message and data sharing protocols). The architectural design documentation includes multiple views of the architecture identifies and supports the evaluation of key quality attributes of the planned software product. The key quality attributes will usually include performance, availability, maintainability, modifiability, security, testability and usability (operability).

Title: Software Test Plan (STP)	**DID No.:** SW-4

Reference:
SOW Paragraph 4.3.6.1

Purpose:
The STP describes the total strategy, methodology, and approach for the complete testing of a particular CSCI and each of the CSCs and units thereof, including Commercial-Off-The-Shelf (COTS). The STP details the formal acceptance testing strategy of the fully integrated CSCI. The STP shall identify and describe the test environment for each Software Element and for each phase of testing. Any software requirements that require the ICESat-2 Program spacecraft for testing shall be identified. An Appendix to the STP shall contain the individual test plans for each test procedure or groups of test procedures.

Related Documents:
The Software Test Plan shall be prepared IAW of NPR 7150.2A

Preparation Information

For Class C software the contents of the Test Plan should include:

a) Test types: (as applicable)
   1. Unit testing.
   2. Software integration testing.
   3. Systems integration testing.
   4. End-to-end testing.
   5. Acceptance testing.
   6. Regression testing.
b) Data recording, reduction, and analysis.
c) Planned tests, including items and their identifiers.

For Class B software the contents should include all the above plus:

a) Test levels (separate test effort that has its own documentation and resources, e.g., component, integration, and system testing).
b) Test classes (designated groupings of test cases).
c) General test conditions.
d) Test progression.
e) Test coverage (breadth and depth) or other methods for ensuring sufficiency of testing.
f) Test schedules.
g) Requirements traceabiity (or verification matrix).
h) Qualification testing environment, site, personnel, and participating organizations.

Title: Software Test Procedures and Results	**DID No.:** SW-5

Reference:
SOW Paragraph 4.3.6.1

Purpose:
The Software Test Procedures contain the step-by-step procedures for implementing each software test in the Software Test Plan. This includes the detailed procedures for data reduction and the analysis of test results. Computer-based automated test procedures/scripts implemented by the Contractor to automate the software testing shall be included in the document or as an appendix. The actual input and output files and plots created during the testing or during post-test analysis shall be included in this deliverable. See Preparation Information for the format of these test result products and the timeframe for their delivery.

Related Documents:

Preparation Information

The Software Test Procedures and Results shall be prepared in accordance with the full contents of 7150.2. Alternatively, the contractor may, with agreement from the government, use an alternative industry standard Software Test Procedure and Results (STPR) approach such as IEEE standards.

Content shall include the following:

1) Software Requirements Verification Matrix
2) The delivery format of the automated test scripts and test results, including test history logs and plots, shall be electronic, and hosted on a server with ICESat-2 Program Project access. Delivery shall be in place until the Contractor's responsibility for the software is concluded.
3) The contractor shall deliver the FSW Test Procedures at the Flight Software Validation Readiness Review (FSWVRR). (Information)
4) The contractor shall deliver the FSW Test Procedures modifications requested as a result of the FSWVRR 1 month after the review. (Information)
5) The contractor shall deliver the FSW Test Procedures and Results at the FSWVRR. (Information)
6) At the time of transition to software maintenance by the ICESat-2 Program, the automated test scripts and test results, including test history logs and plots, shall be delivered in electronic format.
7) Test preparations, including hardware and software.
8) Test descriptions, including:
    a. Test identifier.
    b. System or CSCI requirements addressed by the test case.
    c. Prerequisite conditions.
    d. Test input.
    e. Instructions for conducting procedure.
    f. Expected test results, including assumptions and constraints.
    g. Criteria for evaluating results.
    h. Requirements traceability.

i. Identification of test configuration.

Test Results should be include:

a) Overview of the test results.
   1. Overall evaluation of the software as shown by the test results.
   2. Remaining deficiencies, limitations, or constraints detected by testing (e.g., including description of the impact on software and system performance, the impact a correction would have on software and system design, and recommendations for correcting the deficiency, limitation or constraint).

b) Detailed test results:
   1. Project-unique identifier of a test and test procedure(s).
   2. Summary of test results (e.g., including requirements verified).
   3. Problems encountered.
   4. Deviations from test cases/procedures.

c) Test log:
   1. Date(s), time(s), and locations(s) of tests performed.
   2. Test environment, hardware and software configurations used for each test.
   3. Date and time of each test-related activity, the identity of the individual(s) who performed the activity, and the identities of witnesses, as applicable.

d) Rationale for decisions.

Title: Software User and Maintenance Manual (SUMM)	**DID No.:** SW-6

Reference:
SOW Section 4.3.6

Purpose:
The Software User and Maintenance Manual (SUMM) for each Software Element shall contain the information required to use and maintain the software, including detailed procedures for building and troubleshooting. For the Flight software Element, information on linking, and 'patching' (i.e. fixing / modifying / replacing portions of) the Flight software shall also be included.

Related Documents:
The SUMM shall be prepared IAW the full contents of NPR 7150.2A,. Alternatively, the contractor may, with agreement from the government, use an alternative industry standard SDD approach such as MIL-STD-498 (DID DI-IPSC-81443A) or IEEE standards.

Preparation Information

In addition to the content required by NPR 7150..2, include the following as well:

a) Plan activities for the following activities:
   1. Maintenance process implementation.
   2. Problem and modification analysis.
   3. Modification implementation.
   4. Maintenance review/acceptance
   5. Migration.
   6. Software Retirement.
   7. Software Assurance.
   8. Software risk assessment for all changes made during maintenance and operations

b) Specific standards, methods, tools, actions, procedures, and responsibilities associated with the maintenance process. In addition, the following elements are included:
   1. Development and tracking of required upgrade intervals, including implementation plan.
   2. Approach for the scheduling, implementation and tracking of software upgrades.
   3. Equipment and laboratories required for software verification and implementation.
   4. Updates to documentation for modified software components.
   5. Licensing agreements for software components.
   6. Plan for and tracking of operational backup software (e.g., backup flight software, backup to the primary operational software).
   7. Approach for the implementation of modifications to operational software (e.g., testing of software in development laboratory prior to operational use).
   8. Approach for software delivery process, including distribution to facilities

and users of software products and installation of the software in the target environment (including, but not limited to, spacecraft, simulators, Mission Control Center, and ground operations facilities).

9. Approach for providing NASA access to the software version description data (e.g., revision number, licensing agreement).

a) Software summary, including: application, inventory, environment, organization, overview of operation, contingencies, alternate states,, and modes of operation, security, privacy, assistance, and problem reporting.
b) Access to the software: first-time user of the software, initiating a session, and stopping and suspending work.
c) Processing reference guide: capabilities, conventions, processing procedures, related processing, data back up, recovery from errors, malfunctions, emergencies, and messages.
d) Assumptions, limitations, and safety-related items/concerns or constraints.
e) Information that is unique or specific for each version of the software (e.g., new and modified features, new and modified interfaces).

(End of SOW DIDs)

Note: The Safety and Mission Assurance CDRL and DIDs are contained with the Rapid III MAR document.