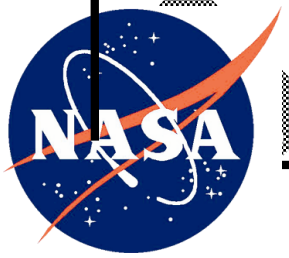
427-XX-XXX (TBD)

DRAFT

LANDSAT DATA CONTINUITY MISSION

CONTRACT DATA REQUIREMENT LIST (CDRL)

June 2, 2006



National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

LDCM PROJECT
DOCUMENT CHANGE RECORD

Sheet: 1 of 1

REV LEVEL	DESCRIPTION OF CHANGE	DATE APPROVED

Section	Type	Description	Resolution Due By	Responsible Party

Table of TBDs / TBRs / TBSs

The term "To Be Determined" (TBD) applied to a missing requirement means that the contractor shall determine the missing requirement in coordination with the Government. The term "To Be Supplied" (TBS) means that the Government will supply the missing information in the course of this contract. The term "To Be Reviewed" (TBR) means that the requirement is subject to review for appropriateness by the contractor or the Government, with approval by the Government. The Government may change TBR requirements in the course of this contract.

TABLE OF CONTENTS

LIST OF TABLES

1.0 INTRODUCTION

This Contract Data Requirements List (CDRL) document defines the requirements for deliverable documentation to be provided by the Landsat Data Continuity Mission (LDCM) Contractor. Section 2.0 includes definitions and instructions for mailing and/or distribution. Table 3-1 presents the CDRL item by item, with due dates, quantity, and media format. Section 4.0 provides the Data Item Description (DID), a description of each item and describes use, and preparation information. Except where specifically indicated to the contrary, the formats and drawing standards used shall be those normally used by the LDCM Contractor and/or by its subcontractors.

2.0 DEFINITION OF DUE DATES/MATURITY, DEFINITION OF CATEGORIES, AND MAILING DISTRIBUTION INSTRUCTIONS

2.1 DUE DATES/MATURITY - RELATED DEFINITIONS

The following definitions apply to the "DUE DATE, MATURITY" column in Table 4-1. Unless otherwise specified, deadlines are in working days.

(a) DUE DATE:

(1) PDR, ICDR, PER, etc: Mission Preliminary Design Review, Instrument Preliminary Design Review, Pre-Environmental Review, Pre-Ship Review, etc (all design reviews). Electronic distribution to be delivered to the Government 5 working days prior to review, unless otherwise stated.

(2) As Generated, Update As Required (UAR): After each initial edition, revision, addition, etc. Items that are critical to schedule, performance, or interface shall be transmitted to GSFC by facsimile or express mail within 48 hours of generation. When available, an electronic version shall also be provided.

(3) Monthly: Submitted on monthly basis.

(4) T: Launch Date

(5) DACA: (Calendar) Days After Contract Award

(6) E: Electronic copies are due at the same time as hard copies unless otherwise specified.

(b) MATURITY:

(1) Preliminary: The initial submission of an item. To be completed as is practicable at the time of preparation.

(2) Final: The complete, thorough submission of an item for approval, review, or information that, to the best of the contractor's knowledge and intention, will not require further revision or updates. However, this does not preclude updating if later found to be necessary. Any updates shall require the same "approval/review" process as was required for the previous submissions.

(3) Current: The best up-to-date information available at the time.

Other entries in the "DUE DATE, MATURITY" column are self-explanatory.

2.2 QUANTITY - RELATED DEFINITIONS

The quantities to be delivered shall be per the CDRL listing in column "Quantity (QTY)" in Table 3-1 of this document. If separate quantities are not specified for separate submission due date/maturity items, then the listed quantity applies to all submissions.

2.3 MEDIA - RELATED DEFINITIONS

The following definition applies to the ""MEDIA" column in Table 3-1.

H – Hardcopy(s) of this documentation shall be delivered to the Contracting Officer at GSFC Code 427.

E - Data items shall be delivered in electronic format to a GSFC Landsat specified web portal unless otherwise noted in Table 3-1. Quantities refer to hardcopies, not electronic copies. The Contracting Officer shall be notified of electronic submission of the deliverable in writing. Electronic deliverables shall be delivered in the following formats unless otherwise approved by the government:

Text Documents: PDF (searchable) or MS Word
Presentations: PDF (searchable) or PowerPoint
Spreadsheets: Microsoft Excel
Database: Delimited ASCII files accompanied with database schema document defining tables and entries.
Schedules: PDF and MS Project
Schematics and Drawings: Design Web Format (DWF) and PDF
Photographs: JPEG or current industry standard.
Video: Any readily-available open standard (e.g., AVI, MPEG)

R – For Reviews, hardcopies will be made available at the review site for government representatives. (Generally, this will be in addition to electronic copies being made available prior to the review.) The quantity specifies the number of hardcopies to be available at the review.

If separate distribution instructions are not specified for separate submission due date/maturity items, then the listed distribution applies to all submissions.

2.4 CATEGORY - RELATED DEFINITIONS

The following definitions apply to "Submission Category (CAT)" column in Table 3-1. If separate approval instructions are not specified for separate submission due date/maturity items, then the listed approval instruction applies to all submissions.

A Approval: Documents in this category require approval by the GSFC Contracting Officer's Technical Representative (COTR) prior to use by the contractor. Receipt by the Government shall occur within the time specified in the "Due Date" column of Table 1 of this document. Requirements for re-submission shall be as specified in the letters of disapproval. For most cases the contractor will be required to resubmit the document within 14 days of receiving comments from the Government. If the contractor has not received response from GSFC within 30 days of delivery of a CDRL item, the contractor may proceed as if the document has been approved.

R Review. Documents in this category require delivery to the Government prior to use and within the time period specified in the "Due Date" column of Table 1 of this document. They are subject to evaluation by the Government or its designated representatives to determine Contractor effectiveness in meeting contract objectives. Upon submission, the Contractor may proceed with associated work while the Government reviews the submission. If the Contractor has not received response from GSFC within 14 days of delivery of a "Review" CDRL, the contractor may assume the Government has found no inadequacies with the submission. When Government evaluations reveal inadequacies, the Contractor shall respond within 14 calendar days of receiving comments (3 days for calibration/validation procedures) or provide a plan within 7 calendar days (3 days for calibration/validation procedures), for approval by the Government, for closing deficiencies.

I Information. Data in this category shall be delivered to the Government within the time period specified in the "Due Date" column of Table 1 for the purpose of determining current program status, progress, and future planning requirements.

3.0 LDCM PRIME CONTRACT DATA REQUIREMENT LIST

Table 3-1 comprises the LDCM Prime Contract Data Requirement List.

The Table is in the following order:

Program Management (PM)
Reviews (RE)
Flight Software (SW)
Integration and Test (IT)
Calibration/Validation (CV)
System Engineering (SE)
Systems Assurance (SA)
Launch Support (LS)
Mission Operations (MO)
On-Orbit Operations (OO)

Table 3-1 Contract Data Requirement List (CDRL)

#	MANAGEMENT	DUE DATE, MATURITY	QTY	MEDIA	CAT
PM-1	Monthly Project Status Reviews (MPSR)	Monthly (the last Wednesday of each month)	10	E, R	I
PM-2	Focal Plane Array Status	Telecon with email agenda: Weekly from initial FPA peer review prior to IPDR until FPA delivery Written Monthly status: Monthly from initial FPA peer review until FPA delivery	- 3	E H, E	I I
PM-3	Integrated Master Schedules (IMS)	- Preliminary with proposal - Initial 45 DACA - Update Monthly, delivered 7 days prior to MPSR	1 3 3	H, E H, E H, E	I I I
PM-4	CADRE Technical Data	- 60 DACA, Preliminary - IPDR-30 days, Update - CDR+15 days, Update - Post-Launch, Final	2 2 2 2	H, E H, E H, E H, E	R R R R
PM-5	Configuration Control Board (CCB) Summary	- CCB summary: 2 days after every CCB meeting	1	H, E	I
PM-6	Engineering Peer Review Plan	- prior to MDR	2	H, E	R
PM-7	Responses to Formal Actions	As assigned for each action, Final	3	H, E	A
PM-8	Final Report	Delivered incrementally at: CDR + 60 days PER + 60 days PSR + 60 days Acceptance + 30 days	2	H, E	A
PM-9	Hardware and Software Configuration Management Plan	Final, 45 DACA	2	H, E	R
PM-10	LDCM Launch Data Briefing Book	Prior to delivery to launch site, Final	1	E	I

PM-11	Project Management Plan	- Preliminary with proposal - 30 DACA, Final	1 1	H, E H, E	I R
PM-12	Risk Management Plan	- 45 DACA, Final	1	H, E	R

#	REVIEWS	DUE DATE, MATURITY	QTY	MEDIA	CAT
RE-1	Instrument System Requirements Review (ISRR) Data Package	Electronic copy on database 5 days prior to review. Hard copies at review.	50	H,R,E	I
RE-2	Instrument Preliminary Design Review (IPDR) Data Package	Electronic copy on database 5 days prior to review. Hard copies at review.	50	H,R,E	I
RE-3	Instrument Critical Design Review (ICDR) Package	Electronic copy on database 5 days prior to review. Hard copies at review.	50	H,R,E	I
RE-4	Instrument Pre-Environmental Review (IPER) Data Package	Electronic copy on database 5 days prior to review. Hard copies at review.	50	H,R,E	I
RE-5	Instrument Pre-Ship Review (IPSR) Data Package	Electronic copy on database 5 days prior to review. Hard copies at review.	50	H,R,E	I
RE-6	Mission Definition Review (MDR)	Electronic copy on database 5 days prior to review. Hard copies at review.	75	H, R, E	I
RE-7	Mission Preliminary Design Review (PDR)	Electronic copy on database 5 days prior to review. Hard copies at review.	75	H, R, E	I
RE-8	Mission Critical Design Review (CDR)	Electronic copy on database 5 days prior to review. Hard copies at review.	75	H, R, E	I
RE-9	Mission Pre-Environmental Review (PER) Data Package	Electronic copy on database 5 days prior to review. Hard copies at review.	75	H, R, E	I
RE-10	Mission Pre-Ship Review (PSR) Data Package	Electronic copy on database 5 days prior to review. Hard copies at review.	75	H, R, E	I
RE-11	Mission Operations Review (MOR) Data Package	Electronic copy 10 days prior to review. Hard copies at review.	75	H,R, E	I
RE-12	Flight Operations Review (FOR) Data Package	Electronic copy 10 days prior to review. Hard copies at review.	75	H,R,E	I
RE-13	Operational Readiness Review (ORR) Data Package	Electronic copy 10 days prior to review. Hard copies at review.	75	H,R E	I

RE-14	Flight Readiness Review (FRR) Data Package	Electronic copy 10 days prior to review. Hard copies at review.	75	H,R E	I
RE-15	Launch Readiness Review (LRR) Data Package	Electronic copy 10 days prior to review. Hard copies at review.	75	H,R E	I
RE-16	On-Orbit Acceptance Review (OAR) Data Package	Electronic copy 10 days prior to review. Hard copies at review.	75	H,R,E	I
RE-17	Engineering Per Review Data Packages	Electronic copy on database 5 days prior to review. Hard copies at review.	10	H, R, E	I

#	SOFTWARE	DUE DATE, MATURITY	QTY	MEDIA	CAT
SW-1	Software Development and Management Plan	90 DACA	2	H,E	A
SW-2	Software Requirements Specification (SRS)	Software Requirement Review, Preliminary	2	H,E	R
		Software Post-PDR, Baseline	2	H,E	R
		Software Post-CDR, Update	2	H,E	R
		SWAR, Update	2	H,E	R
		Software Final Transition, Update	2	H,E	R
SW-3	Software Design Document/Users Guide	Due at: CDR, preliminary PSR, Final Update as Required	 3 3	 H,E H,E	 I I
SW-4	Software Test Readiness Review (SWTRR) Data Package	At review, Final	10	R	I
SW-5	Software Acceptance Review (SWAR) Data Package	At review, Final	10	R	I
SW-6	Software Test Reports	15 calendar days after Test, Final	-	E	I
SW-7	Flight Software Test Plan	IPDR (Instrument flight software) PDR (Observatory flight software)	2 2	H,E H,E	R R
SW-8	Software Delivery Package and Operations Transition Plan	With submittal of each software release. With delivery per SOW para. 5.4.5. Ops transition plan : prior to end of contract (~ L+5 yrs)	- -	E E	R R

SW-9	Software Requirements Peer Review Package	1 week prior to review, Final	10	R	I
SW-10	Software Post-PDR Peer Review Package	1 week prior to review, Final	10	R	I
SW-11	Software Post-CDR Peer Review Package	1 week prior to review, Final	10	R	I

#	INTEGRATION AND TEST	DUE DATE, MATURITY	QTY	MEDIA	CAT
IT-1	Spacecraft Test Plans	30 Days prior to test phase in plan, Preliminary	2	H, E	R
		14 Days prior to test phase in plan, Final	2	H, E	R
IT-2	Spacecraft Test Reports	15 days after test completion	2	H, E	R
IT-3	Sensor Integration and Test Plan	IPDR, Preliminary	2	H, E	A
		ICDR + 6 months, Final	2	H, E	A
IT-4	Sensor Test Plans	30 Days prior to test phase in plan, Preliminary	2	H, E	R
		14 Days prior to test phase in plan, Final	2	H, E	R
IT-5	Sensor Test Reports	15 days after test completion	2	H, E	R
IT-6	End-to-End Test Documentation	Plan: At PER	2	H, E	A
		Report: 30 days after test	2	H, E	R
IT-7	Observatory Integration and Test Plan	PDR, Preliminary	2	H, E	A
		CDR + 6 months, Final	2	H, E	A
IT-8	Observatory Test Plans	20 Days prior to test phase in plan, Final	2	H, E	R
		Launch site-specific tests: Draft: 60 calendar days prior to S/C PSR.	2	H, E	A
		Final: PSR	2	H, E	A
IT-9	Observatory Test Reports	15 days after test completion	2	H, E	R
IT-10	Packaging, Handling, Storage, and Transportation (PHS&T) Plan and Procedures	PDR, Preliminary	3	H, E	R
		21 days prior to CDR, Final	3	H, E	R
IT-11	As-Run Test Procedures	At OAR	-	E	I
IT-12	Observatory Simulator Integration and Test Plan	CDR, Preliminary	2	H, E	R
		CDR + 8 months, Final	2	H, E	R
IT-13	Observatory Simulator Software Test Reports	15 days after test	2	H, E	R
IT-14	RF Compatibility Test Documentation	Plan: At PER	2	H, E	A
		Report: 30 days after test	2	H, E	R

#	CALIBRATION/VALIDATION	DUE DATE, MATURITY	QTY	MEDIA	CAT
CV-1	Calibration/Validation Plan	IPDR (Draft), ICDR (Final), Updates as required	3	H, E	A
CV-2	Calibration/Validation Procedures	At instrument facility: 10 days prior to use. UAR At spacecraft facility (10 days prior to use) On-orbit (at L-90 days)	3 3 3	H, E H, E H, E	R R R
CV-3	Calibration/Validation Reports	Electronic Data 3 days post-test Test Report – 10 days post-test Analyses – At completion + 10 days, NLT IPSR.	- 3	E H, E	I R
CV-4	Calibration/Validation Summary Report	Pre-Ship Report, IPSR Post-Launch Report, IOC + 3 months	3	H, E	I
CV-5	Radiometric Math Model	15 days prior to ICDR, Final Update as required with measured data	3	H, E	R
CV-6	Optical Analytical Model	IPDR, Preliminary 15 days prior to ICDR, Final Update as Required	3 3 3	H, E H, E H, E	I I I
CV-7	Calibration Algorithms and Parameters	IPSR Update at IOC	3	H,E	A
CV-8	Data Processing Algorithms	ICDR, Preliminary IPSR, Final IOC, Update as Required	3 3 3	H, E H, E H, E	A A A
CV-9	Relative Spectral Response (RSR) Component Measurements and System RSR Analysis	Component Measurements: As generated System RSR Analysis: 30 days prior to sensor PER	1 3	H, E H, E	I I
CV-10	Sensor Data Sets	Prior to the end of Sensor Thermal Vacuum Testing	-	E	I
CV-11	Jitter Analysis Report	IPDR, Preliminary 15 days prior to ICDR, Final Update as Required	3 3 3	H, E H, E H, E	I I I

#	SYSTEMS ENGINEERING	DUE DATE, MATURITY	QTY	MEDIA	CAT
SE-1	ECPs, Deviations, and Waivers .	Class I, As Generated Class II, As Generated	2 -	H, E E	A I
SE-2	Contractor Generated Internal Technical Information	As Requested	2	Original format (H or E)	I
SE-3	Observatory Simulator User's Guide	PSR Update as Required	2	H, E	R
SE-4	Trend Analysis and Operations Log (List) (Reports) (Log)	CDR, Initial IPER, Final Monthly IPSR PSR	2 2 2 2 2	H, E H, E H, E H, E H, E	R R I I I
SE-5	Interface Control Documents	PDR, Preliminary CDR, Final	2 2	H, E H, E	R R/A* *All interfaces to Government Assets require Approval
SE-6	Thermal Math Models	See Table 3-2 All Deliveries	3	H, E	R
SE-7	Wiring Diagrams	5 days prior to harness fabrication Final at 5 days prior to PER Updates As Required	2	H, E	I

SE-8	Engineering Drawings and Change Notices	Electronic copy available at 5 days prior to CDR	-	Deliver in place	I
		Electronic copy available at 5 days prior to PSR (as built)	-	E	I
		Hardcopies and Electronic Final set at L+30 days	2	H, E	I
SE-9	System Performance Verification Plan	10 days prior PDR 10 days prior to CDR 15 days prior to PER, Final Updates As Required	5	H, E	A
SE-10	Verification Reports	Within 30 days after each verification, Final	1	H, E	R
SE-11	Configuration Item Identification List	PDR, Preliminary CDR, Final	2 2	H, E H, E	I I
SE-12	Space Segment Design Specification	MDR, Preliminary 30 days prior to PDR, Final	2 2	H, E H, E	I I
SE-13	Spacecraft Design Specification	MDR, Preliminary 30 days prior to PDR, Final	2 2	H, E H, E	I I
SE-14	Sensor Design Specification	ISRR, Preliminary 30 days prior to IPDR, Final	2 2	H, E H, E	I I
SE-15	Focal Plane Array Planning Documentation	Items 1-6, Prior to start of FPA manufacture Item 7, As generated Item 8, As generated, but NLT IPDR +10 days	2 2 2	H, E H, E H, E	I I I
SE-16	Launch-to-Orbit Mission Analysis	Preliminary, CDR Final, 60 days prior to PSR	2 2	H, E H, E	I I
SE-17	Specification Tree	MDR, Final	2	H, E	I

SE-18	LDCM Space Segment to International Cooperators Interface Control Document	Preliminary, 60 days prior to PDR Update, 60 days prior to CDR Final, 60 days prior PSR	2 2 2	H, E H, E H, E	I I A
SE-19	LDCM Space Segment to Government Assets Interface Control Document	Preliminary, 60 days prior to PDR Update, 60 days prior to CDR Final, 60 days prior PSR	2 2 2	H, E H, E H, E	I I A
SE-20	Observatory Database	PSR – 60 days	-	E	I
SE-21	Space Segment Operations Concept Document	Preliminary at MDR Final at PDR	2 2	H, E H,E	R R
SE-22	System Performance Verification Matrix	10 days prior PDR 10 days prior to CDR 15 days prior to PER Updates As Required	5	H, E	R
SE-23	Mass Properties Report	Quarterly	5	H, E	R
SE-24	Structural and Mechanical Subsystem Performance Analysis Report	PDR, Initial CDR, Final	5 5	H, E H, E	R R
SE-25	Structural and Dynamic Models and Model Verification Plan	Plan: MDR + 3 months Models and Matrices: PDR CDR L-52 weeks PER L-12 weeks, correlated model	3 - - - - -	H, E E E E E E	R R R R R R
SE-26	Stress Analyses	Initial, PDR Update, CDR Updates summarized twice per year thereafter	3 3 3	H, E H, E H, E	R R R
SE-27	Propulsion Subsystem Performance Analyses Report	PDR, Initial CDR, Final	2 2	H, E H, E	R R
SE-28	Attitude Control System Performance Analysis Report	PDR, Initial CDR, Final	2 2	H, E H, E	R R

SE-29	RF Communications Performance Analyses/Test Reports	PDR, Initial CDR, Final	2 2	H, E H, E	R R
SE-30	Thermal Analysis Report	PDR, Initial CDR, Final	2 2	H, E H, E	R R
SE-31	Power Subsystem Performance Analyses Report	PDR, Initial CDR, Final	2 2	H, E H, E	R R
SE-32	Command and Data Handling System Performance Analysis Report	PDR, Initial CDR, Final	2 2	H, E H, E	R R
SE-33	Observatory Simulator Subsystem Requirements Document (SRD)	SSR	2	H, E	R
SE-34	Observatory Simulator Architecture Document	CDR Update as Required	2	H, E	I
SE-35	Spare Parts Plan and List	PDR	2	H, E	R
SE-36	Acceptance Data Package	At OAR	2	H, E	A

#	SYSTEMS ASSURANCE	DUE DATE, MATURITY	QTY	MEDIA	CAT
SA-1	Quality Manual/Systems Assurance Plan	PDR, Initial CDR-45 days, Final	2 2	H, E H, E	A A
SA-2	Problem Failure Reports (PFRs)	Within 24 hours, Notification At closure	2 2	H, E H, E	I R
SA-3	System Safety Program Plan	MDR	2	H, E	A
SA-4	Preliminary Hazard Analysis	IPDR+30 days (Instrument) PDR+30 days (spacecraft)	2 2	H, E H, E	R R
SA-5	Operations Hazard Analysis	45 days prior to use, Prelim 15 days prior to use, Final	2 2	H, E H, E	R R
SA-6	Safety Requirements Compliance Checklist	With each SAR and MSPSP submittal	2	H, E	I
SA-7	Missile Pre-Launch Safety Package	PDR+30 days, Initial CDR+30 days, Updated PSR-60 days, Final	2 2 2	H, E H, E H, E	A A A
SA-8	Safety Assessment Report	IPDR+30 days ICDR-30 days IPSR-30 days	2 2 2	H, E H, E H, E	I I I
SA-9	Verification Tracking Log	With each MSPSP submittal	2	H, E	R
SA-10	Ground Operations Procedures	PDR-60 days, Initial PSR-60 days, Final	2 2	H, E H, E	I I
SA-11	Safety Variances	As identified	2	H, E	A
SA-12	Orbital Debris Assessment	MDR, Initial PDR-20 days, Update CDR-45 days, Final	2 2 2	H, E H, E H, E	R R A
SA-13	Probabilistic Risk Assessment	PDR – 30 days, Preliminary CDR + 30 days, Final Updates, As Generated	2 2 2	H, E H, E H, E	R A A
SA-14	Failure Modes and Effects Analysis	PDR – 30 days, Preliminary CDR - 30 days, Final Updates, As Generated	2 2 2	H, E H, E H, E	R R R
SA-15	Critical Items List	PDR – 30 days, Preliminary CDR - 30 days, Final Updates, As Generated	2 2 2	H, E H, E H, E	R R R

SA-16	Fault Tree Analysis	PDR – 30 days, Preliminary CDR - 30 days, Final Updates, As Generated	2 2 2	H, E H, E H, E	R R R
SA-17	Contamination Control Plan	PDR – 30 days, Initial CDR – 30 days, Final	2 2	H, E H, E	R A
SA-18	Printed Wiring Board Test Coupons	Prior to population of flight PWBs	As required	H, E	A
SA-19	Parts Control Plan	PDR, Initial CDR-45 days, Final	2 2	H, E H, E	A A
SA-20	Parts Identification List/ADPL/ABPL	PDR – 30 days: PIL CDR – 30 days: ADPL PSR – 60 days: ABPL	2 2 2	H, E H, E H, E	R R R
SA-21	Materials and Processes Control Program Plan	PDR CDR – 30 days	2 2	H, E H, E	R A
SA-22	As-Designed Materials and Processes List	PDR – 30 days, Initial CDR – 30 days, Final Updates as required	2 2 2	H, E H, E H, E	R A A
SA-23	Parts Stress Analysis	CDR – 45 days, Final Updates as required	2 2	H, E H, E	A A
SA-24	Worst Case Analysis	Pre-CDR Peer Reviews – 30 days Updates as required	2 2	H, E H, E	A A
SA-25	Limited Life Items List	PDR – 30 days, Preliminary CDR – 30 days, Final Updates as generated	2 2 2	H, E H, E H, E	R A A

#	LAUNCH SUPPORT	DUE DATE, MATURITY	QTY	MEDIA	CAT
LS-1	Inputs to Launch Vehicle Interface Requirements Document	SRR, Draft L-108 weeks, Update	2 2	H, E H, E	R R
LS-2	Observatory Mathematical Model for Dynamic Analysis	L-24 months L-18 months L-38 weeks	2 2 2	H, E H, E H, E	R R R
LS-3	Inputs to Launch Vehicle Interface Control Document	30 days after receipt of ICD	2	H, E	R
LS-4	Observatory Environmental Test Document	1 month before use: Test Plans L-36 weeks: Environment & Loads Test Report	2 2	H, E H, E	R R
LS-5	Electrical Wiring Requirements	L-80 weeks	2	H, E	R
LS-6	Fairing Requirements	L-68 weeks (TBR, depending on fairing material)	2	H, E	R
LS-7	Radiation Use Request/Authorization	L-58 weeks	2	H, E	R
LS-8	Inputs to Performance and Guidance Accuracy Analysis (PGAA)	L-94 weeks: TFA L-66 weeks: PMA L-38 weeks: DTO L-4 weeks: BET	2 2 2 2	H, E H, E H, E H, E	R R R R
LS-9	Mission Operational and Support Requirements	L-52 weeks	2	H, E	R
LS-10	Inputs to Program Requirements Document (PRD)	L-52 weeks	2	H, E	R
LS-11	Payload Processing Requirements Document (PPRD)	L-52 weeks	2	H, E	R
LS-12	Launch Window	L-39 weeks: Initial L-4 weeks: Final	2 2	H, E H, E	R R
LS-13	Observatory Drawings	CDR: Initial L-44 weeks: Final	2 2	H, E H, E	R R
LS-14	Observatory Launch Site Test Plan	L-34 weeks	2	H, E	R

LS-15	Observatory Launch Site Test Procedures	L-18 weeks	2	H, E	R
LS-16	Inputs to Observatory Integrated Operations	L-20 weeks	2	H, E	R
LS-17	Observatory Mass Properties Statement	L-54 weeks: Initial L-20 weeks: Final	2 2	H, E H, E	R R
LS-18	Input to Observatory /Launch Vehicle Separation Memorandum	L-60 weeks: Initial L-20 weeks: Final	2 2	H, E H, E	R R
LS-19	Post-launch Orbit Confirmation Data	L+1 day	2	H, E	R
LS-20	Radio Frequency Application	L-52 weeks	2	H, E	R
LS-21	Inputs to Observatory Venting Analysis	L-48 weeks	2	H, E	R
LS-22	Observatory Thermal Model	L-36 weeks	2	H, E	R
LS-23	Observatory Slosh Model	TBD	2	H, E	R
LS-24	Launch Commit Criteria	TBD	2	H, E	R
LS-25	Launch and Early Orbit Procedure	TBD	2	H, E	R
LS-26	Launch Telemetry Data	TBD	-	E	R

#	MISSION OPERATIONS ELEMENT	DUE DATE, MATURITY	QTY	MEDIA	CAT
MO-1	Mission Operations Element (MOE) Pre-Ground System System Requirements Review (GSRR) Peer Review Package	Electronic copy on database 5 days prior to reviews At Review	- 50	E H,R,E	I I
MO-2	MOE Pre-GPDR Peer Review Package	Electronic copy on database 5 days prior to reviews At Review	- 50	E H,R,E	I I
MO-3	MOE Pre-GCDR Peer Review Package	Electronic copy on database 5 days prior to reviews At Review	- 50	E H,R,E	I I
MO-4	Mission Operations Element Concept of Operations Document	Electronic copy on database 5 days prior to Ground Segment SRR Hard Copy	- 5	E H,E	R R
MO-5	Mission Operations Element Interface Control Documents (ICDs)	Draft version at PDR Final version at CDR	5 5	H,E H,E	R R
MO-6	Mission Operations Element Lower-Level System Requirements Document	Electronic copy 5 days prior to Ground Segment SRR	5	H, E	I
MO-7	MOE Ground System PDR (GPDR) Package	- Electronic copy 3 days prior to GPDR dry run - Electronic copy 4 days prior to GPDR	- -	E E	I I
MO-8	MOE Ground System CDR (GCDR) Package	- Electronic copy 3 days prior to GCDR dry run - Electronic copy 4 days prior to CPDR	- -	E E	I I
MO-9	MOE Subsystem Integration Test Plans	Draft 2 weeks after CDR Final 4 weeks after CDR	5 5	H,E H,E	R R

MO-10	MOE Subsystem Test Plans	Draft 2 weeks after CDR Final 4 weeks after CDR	 5 5	 H,E H,E	 I I
MO-11	Mission Operations Element Internal End-to-end Test Plan	Draft 2 weeks after CDR Final 4 weeks after CDR	 5 5	 H,E H,E	 I I
MO-12	Mission Operations Element Software Test Reports	15 calendar days after Test, Final		E	I
MO-13	Mission Operations Element Software Test Procedures Document	Draft 2 weeks after CDR Final 4 weeks after CDR	 5 5	 H,E H,E	 I I
MO-14	MOE Operations Handbook	Draft 6 weeks prior to ORR Final 2 weeks prior to ORR	5 5	H, E H, E	R R
MO-15	LDCM Observatory Handbook	Draft 6 weeks prior to ORR Final 2 weeks prior to ORR	5 5	H, E H, E	R R
MO-16	Mission Operations Element Pre-Launch and Commissioning Procedures	Draft 2 weeks prior to formal test Final at formal test	5 5	H, E H, E	A A
MO-17	On-Orbit Procedures	Draft 2 weeks prior to formal test Final at formal test	5 5	H, E H, E	A A
MO-18	MOE Design Specification and Description	Draft 2 weeks prior to PDR Final 2 weeks after CDR	5 5	H, E H, E	R R
MO-19	Flight Operations Team Training Plan	Draft 6 weeks prior to ORR Final 2 weeks prior to ORR	5 5	H, E H, E	R R
MO-20	MOE Requirements Facility Implementation Plan	Draft 2 weeks prior to PDR Final 2 weeks after PDR	5 5	H, E H, E	R R
MO-21	MOE Software Trade Study Report	Pre-GPDR + 30 days, Final	5	H, E	I
MO-22	MOE Hardware Trade Study Report	Pre-GPDR + 30 days, Final	5	H, E	I

#	ON ORBIT	DUE DATE, MATURITY	QTY	MEDIA	CAT
OO-1	On Orbit Commissioning Plan	90 calendar days prior to PSR	5	H, E	A
OO-2	Sensor Users Manual	Initial at IPDR Updated at ICDR Final at IPSR	5 5 20	H, E H, E H, E	R R R
OO-3	On Orbit Performance Report	30 calendar days following IOC	5	H, E	A
OO-4	Observatory On-Orbit Test Reports	10 Days after each test	5	H, E	R
OO-5	On-orbit Anomaly Resolution Support Plan	Preliminary at MOR Final at FOR	2	H, E	R
OO-6	Operations Transition Plan	PSR	5	H, E	A
OO-7	Telemetry and Command Requirements Document	Volume 1: 5 Days prior to CDR, Update as required Volume 2: Draft at start of I&T, Final at PSR, Update as required	5	H, E	R
OO-8	Observatory Simulator Training Plan and Materials	30 days prior to start of simulator training	10	H, E	R

Table 3-2: LDCM Thermal Math Model Deliverables (TBD)

Hardware	Model	Version	Event	+/- Days
Instrument	I-DTMM	Final/TV Report	I-TB/TV	+60
Observatory [1]	T-DTMM	1	CDR	0
Observatory [1]	T-DTMM	Final	T-TB/TV	-15
Observatory [1]	O-DTMM	1	O-TB/TV	-60
Observatory [2]	O-DTMM	Final/TV Report	O-TB/TV	+45
Observatory [3]	O-DTMM	Final Flight Predicts	Launch	-60
Observatory [4]	O-DTMM	Final+	Launch	+90

Notes: (interim model updates by mutual agreement between CDRL's)

1. B-DTMM with latest available version of I-RTMM, and the T-DTMM with models of? the environmental panels, heaters, etc.
2. O-DTMM with Final I-RTMM
3. O-DTMM with I-RTMM updated after O-TB/TV if required.
4. O-DTMM with O-DTMM updated after 90 days (TBR) on-orbit checkout period if required.

Abbreviations:

5. I = Instrument
6. B = Bus
7. O = Observatory (integrated bus+instr.)
8. T = Test (thermal equipment needed for ambient and TV/TB testing)
9. TB/TV = Thermal Balance/Thermal Vacuum
10. TMM = Thermal Math Model (Temperature and Geometry)
11. DTMM = Detailed TMM
12. RTMM = Reduced TMM

Usage Examples:

a. CDR = Mission CDR
b. I-TMM= Instrument TMM
c. O-TB/TV = Observatory TB/TV
d. T-TB/TV = TV chamber shroud, IR panels, etc.

4.0 DATA ITEM DESCRIPTIONS

MANAGEMENT DIDs

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
PM-1	MONTHLY PROJECT STATUS REVIEWS

3. Reference:

SOW 1.2.3.2

4. Use:
To evaluate contract status. These reports will be used to provide an opportunity for face-to-face discussions between the contractor and the Government regarding project status, plans and issues.

5. Preparation Information:

Scope: The MPSR shall include all aspects of the contract effort.

The Monthly Project Status Review (MPSR) will be presented at a face-to-face meeting with the Government. These meetings will occur at the contractor's facility, unless modified by mutual consent.

The Monthly Project Status Review shall include the following:

A. Report of Key Technical Parameters; including mass and power budgets, peak and average power budgets, pointing knowledge and control error budgets, and their current best estimated, calculated, and/or measured values for all parameters. The list of reported Key Technical Parameters shall be agreed upon with the Government and may be revised by the Government as the situation dictates. The values to be presented shall be at least to the major component level of the subsystems, e.g. Mechanism, Power supplies, heaters, cabling, etc. The accuracy of the values and units shall be identified. Margins and contingency based on maturity shall be identified.
B. Technical status for system and subsystem design and development activities, including subcontract technical performance
C. A comparison of planned versus actual accomplishments for the period of time since the prior report.
D. Summary of Integrated Master Schedule Status, including a brief description of the current status of each subsystem or subassembly along with descriptions of any existing or potential problems areas. The critical path and near critical paths shall be explained along with possible work-arounds being considered to maintain the schedule. The third MPSR shall include a schedule baseline review. The basis of the review shall be the Integrated Master Schedule.
E. A detailed 12-month "rolling-wave" schedule (3 months of actual, plus 9 months of forecast)

F. Problems encountered during the reporting period, and anticipated approaches for resolution (including, as appropriate, technical issues, manpower and staffing, supplier and subcontractor issues, etc.)
G. Status of open issues and problems from prior reporting periods
H. Status of action items
I. Significant plans and activities for the following month
J. Class I and Class II proposed and approved Configuration Control Board Changes
K. Risk Status for top 10 risks
L. Milestone events depicting critical items of project status for the succeeding month.
N. CDRL Status Report that includes the following information for each document delivered in accordance with the CDRL or overdue from previous reporting periods

a. Document Number.
b. Document Title.
c. Scheduled Due Date.
d. Actual Submittal Date.
e. Current Status
f. a list of documents planned for delivery during the next reporting period, listed by document number, title, and scheduled submittal date.

O. Business issues, including personnel changes

The contractor shall provide paper copies of the agenda, viewgraphs and other presentation material for all Government attendees at the time of the review. The contractor shall place MPSR material on the Government-access electronic database by the day of the MPSR. Presentation material may be in contractor format.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: 2. Title:

PM-2 FOCAL PLANE ARRAY STATUS

3. Reference:

SOW 1.2.3.5

4. Use:

To maintain visibility into status of the design and development of the sensor(s) focal plane array(s) (FPA).

5. Preparation Information:

The weekly FPA status telecon (or occasionally face-to-face meeting if agreed to by mutual consent) shall include:

a. schedule and technical status of FPA development
b. manufacturing status
c. qualification and test status
d. issues and concerns

An agenda shall be sent via email to the designated Government FPA point of contact.

The monthly status report shall be a written summary of the Focal Plane Array Status covering the FPA activities for the previous month and include:

a. schedule and technical status of FPA development
b. manufacturing status
c. qualification and test status
d. issues and concerns

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
PM-3	INTEGRATED MASTER SCHEDULE (IMS)

3. Reference:

- SOW 1.2.3.2
- SOW 1.8
- SOW 1.2.3.2
- NPR 7120.5C, Program/Project Management Processes and Requirement

4. Use:

Schedules are used to plan, monitor, communicate status, and control all activities, including pertinent resources and facilities, necessary to accomplish assigned tasks in compliance with the LDCM Statement of Work.

5. 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 reporting period. The Master Schedule shall be developed top-down to identify and incorporate program milestones that are meaningful in terms of the technical scope, schedule, risk and cost aspects of the contract. It shall provide schedules such that actual progress can be related to the plan and contain forecasts of expected future progress.

A monthly schedule analysis narrative shall be provided with the Master Schedule describing the overall schedule position of the LDCM project based on schedule float/slack analysis for each major subsystem/assembly/subassembly and compare current month completion date/float for that element with that of the prior month. The primary critical path shall be explained along with possible work around and/or schedule risk mitigation plans being considered to maintain the schedule. Causes for 5 days or more per month schedule improvement or degradation to the spacecraft bus readiness for instrument integration, the instrument readiness for integration to the bus, or the observatory delivery to the launch site shall be explained.

Intermediate and Detailed level schedules shall be maintained as separate entities or integrated with the Master Schedule in a single module, without loss of detail. The basic principle is that all lower level schedules must support the Master Schedule requirements and provide for program interdependencies as necessary. The instrument schedule shall be detailed to at least the instrument sub-assembly level and shall detail progress against the plan.

Subcontract and critical procurement schedule requirements shall be fully integrated into the overall contractor project schedule. It is important to plan and track all critical schedule requirements that constrain the successful conclusion of procurement actions.

The scheduling system shall establish relationships between technical achievement and progress statusing at all levels of scheduling.

The IMS baseline must be maintained through a revision control process which documents internal contractor-generated changes and external scope changes authorized by the government. These will be documented in the schedule change log.

The detailed Preparation Information instructions below shall apply to the instrument-level schedule as well as the Space Segment schedule. Instrument Level 1, 2, and 3 schedules shall be prepared, updated, and delivered with the same frequency as the Space Segment schedules.

The Integrated Master Schedule shall include:

A Activities detailed by task with early start and finish, and late start and finish dates

B With the exception of the project start and finish milestones, for any activity or milestone without a predecessor or successor activity a reason must be provided in the monthly narrative report.

C Clearly identified schedule reserve.

D Clearly identified Need dates for GFE.

E Documentation and explanation in the monthly schedule analysis narrative report of the use of activity or milestone constraints other than As Soon As Possible (e.g. contract requirement date).

F Activities associated with major items, components, or definable subassembly, such as printed wiring assembly (PWA).

G Fabrication schedules detailed to the subassembly level, and to the PWA level, and showing substantive milestones.

H An assembly/test flow diagram that shows sequences of fabrication, assembly, integration and test for components, subsystems, and system and includes quality assurance test points and associated inspection level requirements.

I The contractor shall provide the Government with a series of integrated network schedules and bar charts as described below:

(a) Master Schedule – The level-1 Master Schedule shall include programmatic milestones/events for the overall program from design, manufacturing, integration and test through launch including data on major procurements. The schedule shall be in a format suitable for viewgraph presentations that summarize the schedule data and status contained in the integrated logic network. This chart will be delivered directly from the integrated logic network and will include major program milestones such as Preliminary Design Reviews (PDR), Critical Design Reviews (CDR), Pre-Ship Review (PSR), Peer Reviews, etc. The Instrument Level 1 Schedule shall include major instrument program milestones such as Instrument Preliminary Design Reviews (IPDR), Instrument Critical Design Reviews (ICDR), Instrument Pre-Ship Review (IPSR), Instrument Peer Reviews, etc.

(b) Intermediate Schedule – A level-2 Intermediate Schedule by WBS shall be submitted. For each task/activity, the baseline start and completion dates; the current expected/planned start and completion dates, the number of work days required to accomplish the task, and the amount of float/slack in work days for each task, a unique activity identification number for each task, and a task description shall be included. Control milestones will be included on the Intermediate Schedule.

(c) Detailed Schedule – A Level-3 Detail Schedule at the lowest level of the working schedules shall be submitted. The WBS ID, Task Description, Start/Finish dates, and Percent Complete shall be identified

(d) Integrated Logic Networks – These networks shall be established for each subsystem or subassembly to the electronic board level. The contractor shall provide an electronic version of the detailed integrated logic network. The critical path shall be derived from the intermediate level logic network schedules.

(e) Control Milestone Trend Report – A control milestone trend chart shall be submitted. This report shall consist of the baseline control milestones that have been agreed upon by the contractor and government. The report will also contain a list of the control milestones expected to complete during the reporting period, their baseline completion dates, and their current status. A draft control milestone list shall be submitted to the government for review and concurrence. These milestones have to be derived from the IMS baseline, actual completion status and current forecast.

(f) End Item Float Report – A monthly report shall be submitted for each deliverables subsystem or subassembly comparing the current month total float/slack to the total float/slack of the previous month and explain any changes.

(g) Schedule log book – The contractor shall maintain a log book identifying all schedule changes (task additions, deletions, duration adjustments, changes to logic, including rationale, etc.) to the schedule baseline documentation and shall provide this data to the Government upon request.

These schedules shall be presented by a flow type network diagram, and by Gantt schedule milestone charts using Microsoft Project.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
PM-4	CADRE TECHNICAL DATA

3. Reference:

SOW 1.8

4. Use:

To provide the project technical data required for the Project Non-Advocate Review (NAR) process.

5. Preparation Information:

CADRe Part B (technical data in spreadsheet form) is required.

The spreadsheet format of the CADRe inputs is available at http://www.ceh.nasa.gov/downloadfiles/xls/cadrepartb10apr2005ver2.xls

The required data for submission of this Data Item are all non-cost technical data required for the LDCM Project to complete the full CADRe.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
PM-5	CONFIGURATION CONTROL BOARD (CCB) SUMMARY

3. Reference:

SOW 1.9

4. Use:

To permit visibility of all changes in configured items (CIs) and controlling documentation proposed by the contractor.

5. Preparation Information:

The CCB Summary shall consist of a summary of the contractor CCB meeting agenda, results, and further actions to be taken.

This delivery also consists of CCB minutes. These minutes shall include the date, time, location, item subject, change control number and CCB disposition of the changes reviewed. For approved changes, the change classification and effectivity shall also be specified. When changes are disapproved, a reason(s) shall be included.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
PM-6	ENGINEERING PEER REVIEW PLAN

3. Reference:

SOW 1.2.2

4. Use:

Early in project/product formulation, the Contractor shall identify subsystems, instruments, components, software and crosscutting functional elements to be subject to the Engineering Peer Review (EPR) process. The Peer Review Plan is used to identify the methodology and scope of the contractor's peer review process.

5. Preparation Information:

The Engineering Peer Review Plan shall:

a. Describe the methodology used to determine the scope of the EPR process.
b. Describe the peer review process, including personnel, nominal agenda, and Request for Action (RFA) generation, tracking, and closure process.
c. Identify the concepts, designs, plans, processes, subsystems, components, software, etc. that will be Peer Reviewed.
d. Identify a schedule or associated milestones for the EPRs.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: PM-7

2. Title: RESPONSES TO FORMAL ACTIONS

3. Reference:

SOW 1.3

4. Use:

Provides formal responses to Requests For Actions (RFAs) or to provide closure of an action assigned by the Government.

5. Preparation Information:

Preliminary responses may be in any form, such as email or telecon, to promote coordination with the Project. A plan for closure shall be provided within 5 days if the action cannot be closed within 5 days.

Responses shall include, as appropriate:

A. Engineering reports
B. Sketches (electronically reproducible)
C. Drawing changes
D. Documentation narrative changes
E. Test reports, graphs, etc.
F. Cost estimates

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
PM-8	FINAL REPORT

3. Reference:

Contract Clause C.3
SOW 1.1

4. Use:

To provide a summary of the performance of the contract.

5. Preparation Information:

The final report shall be written in increments so that the summary from each phase of development can be more accurately captured. The final report due at Acceptance + 30 days shall include all previously delivered reports plus updates from the period between PSR and Acceptance.

Refer to contract clause 1852.235-71 (Section C.3 of the contract) for additional instructions regarding the final report.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
PM-9	HARDWARE AND SOFTWARE CONFIGURATION MANAGEMENT PLAN

3. Reference:

- SOW 1.9

4. Use:

Defines the contractor's configuration management system (including policies and procedures) that will be implemented for the LDCM project.

5. Preparation Information:

The contractor's hardware/software configuration management plan shall be prepared in accordance with the contractor's standards. This plan shall describe in detail all configuration management processes, methods, and procedures the contractor intends to use on the LDCM project. This plan shall describe how hardware and software configuration management is accomplished and how consistency between product definition, the product's configuration, and the configuration management records is achieved and maintained throughout the applicable phases of the product's life cycle by the contractor.

The configuration management plan shall describe the contractor's approach, methodology, and application of configuration management principles and practices and shall include the following:

1. General product definition and scope
2. Description of configuration management activities and procedures for each of the following configuration management functions:
    a. Configuration planning and management
    b. Configuration identification
    c. Configuration Change management
    d. Configuration status accounting
    e. Configuration verification and audit
    f. Configuration management of digital data
    g. Configuration management of software
3. Organization, roles, responsibilities and resources
4. Definition of terms
5. Programmatic and organizational interfaces

6. Deliverables, milestones, and schedules
7. Subcontract flow down

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
PM-10	LDCM LAUNCH DATA BRIEFING BOOK

3. Reference:

SOW 7.2.1

4. Use:

To provide general information on the LDCM Mission, Observatory, and early mission profile.

5. Preparation Information:

The Launch Data Briefing Book shall provide general information on the LDCM Mission, Observatory, and early mission profile for visitors to the LDCM launch. It shall contain color illustrations.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: PM-11

2. Title: PROJECT MANAGEMENT PLAN

3. Reference:

SOW 1.1

4. Use:

Describes how the project is organized and managed by the contractor. It provides the management structure, its system of operation, responsible lines of communications, and key personnel assignments. The organization chart identifies the contractor's project organization with names, functions, lines of authority, coordination, etc

5. Preparation Information:

This plan shall address the overall organization, management approach, and structure of the contractor's project plus its interrelationships with the parent company and the subcontractors.

Describe how and where the project will operate during all phases of the contract.
This plan shall identify and describe interfaces with the Government, including NASA and USGS.

This plan shall include graphical displays such as flow diagrams, WBS, logic networks, etc., to reduce verbal descriptive material.

This plan shall provide an organizational chart(s) and sufficient supplemental narrative to describe fully the following:

(a) Organization proposed for carrying out the project showing interrelationships of technical management, business management, and subcontract management, from lower level through intermediate management to top-level management with detailed explanation of:

1. The authority of the Project Manager relative to other ongoing projects and applicable support organizations within the company structure. Discuss the Project Manager's control over essential resources and functions necessary to accomplish the work.
2. How and by whom interdepartmental work will be monitored and the authority of the Project Manager over interdepartmental work.
3. Process to be followed by the Project Manager in obtaining decisions beyond his/her

authority and in resolving priority conflicts for resources and functions not under the Project Manager's direct control such as personnel, finances, and facilities.

4. The project team members with names and functions.

(b) Implementation approach for the project. Describe in general how the requirements of the Statement of Work (SOW) will be achieved. Identify potential problems related to this work, and your approach to problem avoidance and/or solution. Identify how your risk management system and processes are integrated into the daily management, decision making, and strategic direction of the project. Address the degree to which your proposed personnel and overall management procedures are proven through similar experience. Describe such things as make/buy strategies, acquisition plans, sparing philosophy, project dependencies, facility requirements, internal review strategies and plans, significant work elements on critical paths, long-lead items, and significant milestones down to at least the lowest level of the WBS. Describe your instrument management approach and your approach to technical oversight of the instrument contractor. Indicate your needs for additional definition of instrument, spacecraft, and mission, and when this information is required to avoid schedule slippage.

(c) Contractual procedures proposed for the project to effect administrative and engineering changes, describing any differences from existing procedures.

(d) Management techniques to be employed to minimize 1) project costs and schedule overruns, and 2) risks of violating interface requirements and agreements. Describe associated controls to be exercised over subcontractors and suppliers. Describe how issues will be surfaced in a timely manner and at the proper levels. Identify the Key Technical Parameters the project will use to monitor and report on (see CDRL PM-4) interface compliance and resource status.

(e) The proposed Safety and Mission Assurance organizational structure, including staffing plans, reporting channels, authority and responsibilities, and management visibility. Discuss whether the technical, test, manufacturing and system safety/quality assurance/ reliability/ configuration management personnel required for this project (as indicated in your proposed labor hours) are presently on your payroll and immediately available for this work. State the number and disciplines/skills of persons who would have to be hired, and plans to obtain them.

(f) A comprehensive schedule plan, which describes the schedule system. This plan shall explain describe the schedule administration/control. It is the intent of the Government to use the contractor's in-house schedule system as the mechanism for reporting schedule status provided that the schedule control and monitoring system satisfies the deliverable requirements specified in CDRL element PM-3.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: 2. Title:

PM-12 RISK MANAGEMENT PLAN

3. Reference:

SOW 1.7
GPR 7120.4, Risk Management
NPR 8000.4 Risk Management Procedural Requirements w/Change 1 (4/13/04) ***e***

4. Use:

The Risk Management Plan is the basis for identifying and managing all performance, reliability, schedule, and safety risks on the contractor's project.

5. Preparation Information:

The risk management plan shall clearly describe:

- Overview of the risk management process
- Organizational responsibilities
- Risk identification approach
- Risk mitigation planning
- Interface of risk management to schedule
- Risk tracking/documentation
- Risk management list reporting

The risk management plan shall detail the risk management responsibilities delegated to the instrument developer(s) and the visibility of instrument risks in the overall risk management process.

REVIEW DIDS

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
RE-1	INSTRUMENT SYSTEM REQUIREMENTS REVIEW (ISRR) DATA PACKAGE

3. Reference:

SOW 1.2.1.1
GSFC-STD-1001

4. Use:
To evaluate the requirements, requirements flow-down, and the operational concepts and to validate the realism of the functional and performance requirements and their congruence with the system configuration selected to conduct the mission.

5. Preparation Information:

The ISRR shall contain the flow-down of requirements from the Space Segment to the Instrument.

The ISRR Data Package shall contain all relevant instrument information required to satisfy paragraph 4.4 (Criteria for Successful Completion) of GSFC-STD-1001, Criteria for Project Flight Critical Milestone Reviews.

The ISRR Data Package shall discuss contractor system level requirements, rationale, and flow-down plans to lower level requirements.

The ISRR Data Package shall show the allocation and traceability of requirements to major subsystems.

The ISRR Data Package shall address any identified Single Point Failures.

The ISRR Data Package shall address the identification and functionality of the Sensor EDU components.

The ISRR Data Package shall address the functionality of the Structural Thermal Model.

The ISRR Data Package shall show how the current concept meets all government specified requirements including interface requirements.

The ISRR Data Package shall discuss the preliminary operations concept of the instrument.

The ISRR package shall contain a matrix of the status of compliance with GSFC-STD-1000. The ISRR shall address compliance with GSFC-STD-1000.

Results of Review—As a result of successful completion of the ISRR, the system and its operation are well enough understood to warrant design and acquisition of the end items. Approved specifications for the system, its segments, and preliminary specifications for the design of appropriate functional elements may be released.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
RE-2	INSTRUMENT PRELIMINARY DESIGN REVIEW (IPDR) DATA PACKAGE

3. Reference:

SOW 1.2.1.1
GSFC-STD-1001

4. Use:

To demonstrate the Flight Equipment and GSE design meet the documented requirements.

5. Preparation Information:

The IPDR Data Package shall address all relevant instrument information required to satisfy paragraph 5.4 (Criteria for Successful Completion) of GSFC-STD-1001, Criteria for Project Flight Critical Milestone Reviews.

The IPDR package shall contain a matrix of the status of instrument compliance with GSFC-STD-1000. The IPDR shall address instrument compliance with GSFC-STD-1000.

The Instrument PDR data package shall contain information to cover the sensor data processing algorithm design.

The IPDR data package shall include Science/Technical Objectives, Requirements, General Specification.

The IPDR data package shall address the instrument compliance with the Space Segment Requirements Document.

The IPDR data package shall include responses to action items from previous reviews, including subsystem PDRs/Engineering Peer Reviews.

The IPDR data package shall include changes since the last review.

The IPDR data package shall address performance requirements and their flow-down to the card or equivalent level.

The IPDR data package shall address instrument performance budgets.

The IPDR data package shall address error budget determination.

The IPDR data package shall address mass, power, data rate, coding and format, commands, EMI/EMC.

The IPDR data package shall contain a detailed report of Key Technical Parameters down to a level below the one reported in the MPSR.

The IPDR data package shall address interface requirements, including the following information:

a. Preliminary analysis that will allow the Contractor to ensure that the "swept" or deployed volume is verified, accounting for all distortions and misalignments.

b. Preliminary estimates of gimbaled masses, inertia's, and to permit sizing the spacecraft control components to meet pointing and stability requirements.

c. Preliminary analysis of disturbances of the sum of any periodic disturbance torques, in order to produce the corresponding magnitude spectrum.

The IPDR data package shall address mechanical/structural design, analyses, and life tests.

The IPDR data package shall address electrical, thermal, optical, radiometric, and calibration design and analyses.

The IPDR data package shall address software requirements, design, and development environment.

The IPDR data package shall address Ground Support Equipment design and work flow, and describe how each item will be fabricated, tested and certified when needed.

The IPDR data package shall address design verification, test flow and calibration/test plans.

The IPDR data package shall address the instrument operations concept.

The IPDR data package shall address parts selection, and qualification.

The IPDR data package shall address preliminary Failure Modes and Effects Analysis (FMEA); Fault Tree Analysis; and reliability analysis and results.

The IPDR data package shall address redundancy and redundancy management.

The IPDR data package shall address single point failures.

The IPDR Data Package shall address the list of long lead items, and of items that may become obsolete prior to completion of all flight instruments, identify those items that must be procured

prior to ICDR (including a list of those that were ordered prior to IPDR and ISRR), and provide a plan for procuring these items and all parts.

The IPDR data package shall address contamination requirements and control plan

The IPDR data package shall delineate the status of each document required at PDR as to its acceptability for use as is.

The IPDR Data Package shall present all instrument risks and address their mitigation.

The IPDR Data Package shall provide the status of all sub-contracts and discuss the preliminary design status of critical assemblies and sub-assemblies.

The IPDR Data Package shall present a summary of all breadboard and brassboard testing and present the available test results.

The IPDR Data Package shall present the development status of sub-assembly engineering units, and available test data.

The IPDR Data Package shall present the planned and/or expected level of functionality of the components of the Engineering Development Unit.

The IPDR Data Package shall address the producability of the design solution.

The IPDR Data Package shall address mission assurance to be imposed including parts and materials usage as well and workmanship standards imposed.

The IPDR Data Package shall address software assurance process.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
RE-3	INSTRUMENT CRITICAL DESIGN REVIEW (ICDR) DATA PACKAGE

3. Reference:

SOW 1.2.1.1
GSFC-STD-1001

4. Use:

To present the Instrument Flight Equipment and GSE design and operation, and to demonstrate that all related manufacturing documentation, processes and fixtures are in place before hardware manufacture begins, and to demonstrate that the design meets all performance requirements.

5. Preparation Information:

The ICDR Data Package shall contain all relevant instrument information required to satisfy paragraph 6.4 (Criteria for Successful Completion) of GSFC-STD-1001, Criteria for Project Flight Critical Milestone Reviews.

The ICDR package shall contain a matrix of the status of instrument compliance with GSFC-STD-1000. The CDR shall address instrument compliance with GSFC-STD-1000.

The ICDR data package shall include responses to action items from previous reviews, including subsystem CDRs/Peer Reviews.

The ICDR data package shall include changes since the last review.

The ICDR data package shall address instrument compliance with the Space Segment Requirements Document.

The ICDR Data Package shall address the procurement status of long lead items and Electrical, Electronic, and Electromechanical (EEE) parts.

The ICDR Data Package shall address manufacturing flow, and the status of manufacturing and assembly drawings, bill of materials, etc.

The ICDR Data Package shall address manufacturing procedures.

The ICDR Data Package shall address mission assurance product checkpoints and evaluation criteria.

The ICDR Data Package shall address standard applicable in-house processes.

The ICDR Data Package shall address special/unique tooling/fixturing.

The ICDR Data Package shall address facilities required for manufacturing.

The ICDR Data Package shall address personnel resources (time phased).

The ICDR Data Package shall address the delivery schedules for flight hardware and GSE.

The ICDR data package shall address detailed analysis from FMEA, fault tree analysis, and reliability analysis.

The ICDR Data Package shall address worst case analyses of:

(a) Electrical circuits
(b) Scanning drive system
(c) Lubrication and lubrication loss
(d) Tolerance and tolerance sensitivity analysis (including thermal and mechanical considerations)
(e) Communications link budget(s)

The ICDR Data Package shall address stress analyses using NASTRAN with hand verification

The Instrument CDR Data Package shall address thermal analysis of:

(a) Detectors/Focal Plane Array
(b) Telescope
(c) Electronics
(d) In-flight calibrators
(e) Structure
(f) Thermal control system

The ICDR Data Package shall address weight and power.

The ICDR data package shall contain a detailed report of Key Technical Parameters down to a level below the one reported in the MPSR.

The ICDR Data Package shall address test plans (including all environmental tests)

The ICDR Data Package shall address manufacturing considerations

The ICDR Data Package shall address maintainability considerations, including storage.

The ICDR Data Package shall address materials and processes lists

The ICDR Data Package shall provide a summary of deviations/waivers

The ICDR Data Package shall address contamination control and monitoring considerations

The ICDR Data Package shall address spares program

The ICDR Data Package shall address system safety hazards analyses
(a) Hazards identification matrix
(b) Single point failure summaries
(c) Risk assessment rationale

The ICDR Data Package shall delineate the status of each document as to its acceptability for use as is.

The ICDR package shall address the operations concept.

The ICDR Data Package shall present any additional test results from breadboard and brassboard testing

The ICDR Data Package shall present the test data from sub-assembly engineering development units and the status of EDU development and testing results, if any.

The ICDR Data Package shall address the development status of all GSE, including test and calibration procedures, and the software/firmware design and operation and interface aspects as evaluated since the PDR.

The ICDR Data Package shall address the status of all program risks and their mitigation

The ICDR Data Package shall address the status of all sub-contract design activity and schedule for delivery of EDU and flight hardware, as appropriate, and demonstrate that designs are complete and have been adequately reviewed. Where approval has been given by the Government Contracting Officer for ordering of long lead items, the Contractor shall address the design/delivery status of these items.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
RE-4	INSTRUMENT PRE-ENVIRONMENTAL REVIEW (IPER) DATA PACKAGE

3. Reference:

SOW 1.2.1.1
GSFC-STD-1001

4. Use:

Presents the description and results of the Instrument Pre-Environmental Test program, and demonstrates readiness for environmental testing.

5. Preparation Information:

The IPER Data Package shall contain all relevant instrument information required to satisfy paragraph 8.4 (Criteria for Successful Completion) of GSFC-STD-1001, Criteria for Project Flight Critical Milestone Reviews.

The IPER Data Package shall include status of action items generated at prior reviews

The IPER Data Package shall include analyses and reports required at the review.

The IPER Data Package shall contain the results of any analyses updated or revised since the ICDR.

The IPER Data Package shall include test and integration program descriptions and results

The IPER Data Package shall include failure report summaries including status of action and rationale for closure

The IPER Data Package shall include as-built documentation summary

The IPER Data Package shall include results of the functional and interface tests

The IPER Data Package shall include descriptions of any malfunctions and corrective actions

The IPER Data Package shall include comparison of measured performance with requirements and discussion of the effect of any variance and waivers

The IPER Data Package shall include mission operation constraints

The IPER Data Package shall include contamination avoidance requirements

The IPER Data Package shall include safety requirements

The IPER Data Package shall include list of spares for flight equipment and GSE

The IPER Data Package shall include review of flight hardware handling procedures

The IPER Data Package shall include spacecraft interface concerns, problems and solutions, including:

a. Analysis and test data that demonstrates that the "swept" or deployed volume is verified, accounting for all distortions and misalignments.

b. In electronic format, time/magnitude plots of their disturbances, for decomposition, of the sum of the instrument-induced periodic disturbance torques, in order to produce the corresponding magnitude spectrum.

The IPER Data Package shall include orbital operations plans and status of documentation and databases.

The IPER Data Package shall include end-item data packages (submit a summary of the content prior to review and have package available for inspection at review)

1. As-built configuration list
2. Hardware parts lists
3. Hardware materials and processes lists
4. Test Log Book (including total operating time and cycle records)
5. Open item lists (including reasons for being open)
6. Safety compliance data package
7. Limited life items listings and status
8. Critical parameters trend data
9. Final comprehensive performance test results
10. Failure report summaries including status of action and rationale for closure

The Instrument IPER Data Package shall discuss the compatibility of instrument with spacecraft flight support equipment, ground support equipment and operational ground equipment

The IPER Data Package shall address the availability and readiness of facilities and GSE required for environmental testing

The IPER Data Package shall address the status of all program risks and their mitigation plans.

The IPER Data Package shall address the readiness of environmental test plans and procedures

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
RE-5	INSTRUMENT PRE-SHIP REVIEW (IPSR) DATA PACKAGE

3. Reference:

SOW 1.2.1.1
GSFC-STD-1001

4. Use:

To evaluate instrument performance during qualification or acceptance testing, and evaluate readiness to ship.

5. Preparation Information:

This data package shall address, as a minimum:

The IPSR Data Package shall contain all relevant instrument information required to satisfy paragraph 10.4 (Criteria for Successful Completion) of GSFC-STD-1001, Criteria for Project Flight Critical Milestone Reviews.

The IPSR Data Package shall address responses to action items generated at prior reviews

The IPSR Data Package shall address the solutions to all problems encountered during the environmental test and validation program and the solution rationale.

The IPSR Data Package shall address any rework/replacement of hardware, regression testing, and test plan changes.

The IPSR Data Package shall address compliance with the test verification matrix

The IPSR Data Package shall address measured test margins versus requirements.

The IPSR Data Package shall address qualification/acceptance temperature margins

The IPSR Data Package shall address any data that has been trended to identify compliance with specification, indicating a change or drift to the trend.

The IPSR Data Package shall summarize and analyze the monthly trend reports (CDRL SE-4) of trended instrument data, focusing on trends that have changed or drifted anomalously (see SOW

paragraph 2.5).

The IPSR Data Package shall address total failure-free operating time of the item

The IPSR Data Package shall address the number of cycles during testing of parts with finite lifespans

The IPSR Data Package shall address the results of the final audit of any remaining drawing changes.

The IPSR Data Package shall address "could-not-duplicate failures" along with assessment of the problem and the residual risk that may be inherent in the item

The IPSR Data Package shall address project assessment of any residual risk

The IPSR Data Package shall provide an update from CDR on shipping containers, monitoring/transportation/control plans

The IPSR Data Package shall address ground support equipment status

The IPSR Data Package shall address post shipment plans

The IPSR Data Package shall address spacecraft integration plan.

The IPSR shall address the plans for storage of the instrument, if required.

The IPSR Data Package shall include documentation verifying that the instrument does not outgas at a rate greater than that specified in the Contamination Control Plan.

The IPSR Data Package shall include alignment data relative to the Instrument Boresight and the mounting surface datum(s) associated with the instrument.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
RE-6	MISSION DEFINITION REVIEW (MDR)

3. Reference:

SOW 1.2.1.3
GSFC-STD-1001

4. Use:
To evaluate the requirements, requirements flow-down, and the operational concepts and to validate the realism of the functional and performance requirements and their congruence with the system configuration selected to conduct the mission.

5. Preparation Information:

The MDR Data Package shall contain all information required to satisfy paragraph 3.4 (Criteria for Successful Completion) of GSFC-STD-1001, Criteria for Project Flight Critical Milestone Reviews.

The MDR Data Package shall discuss contractor system level requirements, rationale, and flow-down plans to lower level requirements.

The MDR Data Package shall show the allocation and traceability of requirements to major subsystems.

The MDR Data Package shall address any identified Single Point Failures.

The MDR Data Package shall cover requirements for all aspects of the mission, including the Mission Operations Element, Observatory Simulator, and the associated Ground Support Equipment, flight software, ground test software, and data processing algorithms, including Observatory Simulator data processing algorithms,

The MDR Data Package shall show how the current concept meets all government specified requirements including interface requirements.

The MDR Data Package shall discuss the preliminary operations concept of the Observatory and Mission Operations Element.

Results of Review—As a result of successful completion of the MDR, the system and its operation are well enough understood to warrant design and acquisition of the end items. Approved specifications for the system, its segments, and preliminary specifications for the design of appropriate functional elements may be released.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
RE-7	MISSION PRELIMINARY DESIGN REVIEW (PDR) DATA PACKAGE

3. Reference:

SOW 1.2.1.3
GSFC-STD-1001

4. Use:

To demonstrate the Flight Equipment and GSE design meet the documented requirements.

5. Preparation Information:

The PDR Data Package shall contain all information required to satisfy paragraph 5.4 (Criteria for Successful Completion) of GSFC-STD-1001, Criteria for Project Flight Critical Milestone Reviews.

The PDR package shall contain a matrix of the status of program compliance with GSFC-STD-1000. The PDR shall address program compliance with GSFC-STD-1000.

The PDR data package shall include Science/Technical Objectives, Requirements, General Specification.

The PDR data package shall include responses to action items from previous reviews, including subsystem PDRs.

The PDR data package shall include changes since the last review.

The PDR data package shall address performance requirements and their flow-down to the card or equivalent level.

The PDR data package shall address system performance budgets.

The PDR data package shall address error budget determination.

The PDR data package shall address mass, power, data rate, coding and format, commands, EMI/EMC.

The PDR data package shall contain a detailed report of Key Technical Parameters down to a level below the one reported in the MPSR.

The PDR data package shall address interface requirements, including the following information:

a. Preliminary analysis that will allow the Contractor to ensure that the "swept" or deployed volume is verified, accounting for all distortions and misalignments.

b. Preliminary estimates of gimbaled masses, inertia's, and to permit sizing the spacecraft control components to meet pointing and stability requirements.

c. Preliminary analysis of disturbances of the sum of any periodic disturbance torques, in order to produce the corresponding magnitude spectrum.

The PDR data package shall address mechanical/structural design, analyses, and life tests.

The PDR data package shall address electrical and thermal, optical/radiometric design and analyses.

The PDR data package shall address software requirements, design, and development environment.

The PDR data package shall address Ground Support Equipment design and work flow, and describe how each item will be fabricated, tested and certified when needed.

The PDR data package shall address design verification, test flow and calibration/test plans.

The PDR data package shall address the observatory operations concept.

The PDR data package shall address the Mission Operations Element operations concept and definition of interfaces with the Observatory.

The PDR data package shall address parts selection, and qualification.

The PDR data package shall address preliminary Failure Modes and Effects Analysis (FMEA); Fault Tree Analysis; and reliability analysis and results.

The PDR data package shall address redundancy and redundancy management.

The PDR data package shall address single point failures.

The PDR Data Package shall address the list of long lead items, and of items that may become obsolete prior to completion of all flight instruments, identify those items that must be procured prior to CDR (including a list of those that were ordered prior to PDR and MDR), and provide a plan for procuring these items and all parts.

The PDR data package shall address contamination requirements and control plan

The PDR data package shall address safety and mission success.

The PDR data package shall address safety hazards identified for flight, range, ground hardware and operations.

The PDR data package shall delineate the status of each document required at PDR as to its acceptability for use as is.

The PDR data package shall address open interface items and the status of any ICDs.

The PDR Data Package shall present all program risks and address their mitigation.

The PDR Data Package shall provide the status of all sub-contracts and discuss the preliminary design status of critical assemblies and sub-assemblies.

The PDR Data Package shall present a summary of all breadboard and brassboard testing and present the available test results.

The PDR Data Package shall present the development status of sub-assembly engineering units, and available test data.

The PDR package shall address the following Observatory Simulator items:

a. Information to cover the Observatory Simulator data processing algorithm design
b. Changes since the last review
c. Address performance requirements and their flow-down to the component level
d. Address subsystem performance budgets
e. Address error budget determination
f. Address all subsystem interface requirements
g. Address open interface items and the status of any ICDs
h. Indicate the high level functional break down of the subsystem into components and the interfaces/interactions between the components
i. Include mock-ups of key graphical user interfaces
j. Include pertinent architecture drawings such as component diagrams, data flow diagrams, interface diagrams, etc
k. Address software requirements, design, and development environment
l. Address design verification and test plans
m. Address the subsystem operations concept, as appropriate
n. Address spacecraft subsystems simulated by the Observatory Simulator
o. Address the modes of operation of the Observatory Simulator
p. Address the list of long lead items, and of items that may become obsolete prior to completion Observatory Simulator development, identify those items that must be addressed prior to, and provide a plan for development/procurement of these items.
q. Delineate the status of each document required at PDR as to its acceptability for use as is
r. Present all subsystem program risks and address their mitigation
s. Address software assurance process.

The PDR Data Package shall address the producability of the design solution.

The PDR Data Package shall address mission assurance to be imposed including parts and materials usage as well and workmanship standards imposed.

The PDR Data Package shall address software assurance process.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
RE-8	MISSION CRITICAL DESIGN REVIEW (CDR) DATA PACKAGE

3. Reference:

SOW 1.2.1.3

4. Use:

To present the Flight Equipment and GSE design and operation , S/C-to-instrument interface aspects, Observatory-to-Ground interface aspects, and to demonstrate that all related manufacturing documentation, processes and fixtures are in place before hardware manufacture begins, and to demonstrate that the design meets all performance requirements.

5. Preparation Information:

The CDR Data Package shall contain all information required to satisfy paragraph 6.4 (Criteria for Successful Completion) of GSFC-STD-1001, Criteria for Project Flight Critical Milestone Reviews.

The CDR package shall contain a matrix of the status of program compliance with GSFC-STD-1000. The CDR shall address program compliance with GSFC-STD-1000.

The CDR data package shall include responses to action items from previous reviews, including subsystem CDRs.

The CDR data package shall include changes since the last review.

The CDR Data Package shall address the procurement status of long lead items and Electrical, Electronic, and Electromechanical (EEE) parts.

The CDR Data Package shall address manufacturing flow, and the status of manufacturing and assembly drawings, bill of materials, etc.

The CDR Data Package shall address manufacturing procedures.

The CDR Data Package shall address mission assurance product checkpoints and evaluation criteria.

The CDR Data Package shall address standard applicable in-house processes.

The CDR Data Package shall address special/unique tooling/fixturing.

The CDR Data Package shall address facilities required for manufacturing.

The CDR Data Package shall address personnel resources (time phased).

The CDR Data Package shall address the delivery schedules for flight hardware, mission operations hardware, and GSE.

The CDR data package shall address detailed analysis from FMEA, fault tree analysis, and reliability analysis.

The CDR Data Package shall address worst case analyses of:

(f) Electrical circuits
(g) Scanning drive system
(h) Lubrication and lubrication loss
(i) Tolerance and tolerance sensitivity analysis (including thermal and mechanical considerations)
(j) Communications link budget(s)

The CDR Data Package shall address stress analyses using NASTRAN with hand verification

The CDR Data Package shall address weight and power.

The CDR data package shall contain a detailed report of Key Technical Parameters down to a level below the one reported in the MPSR.

The CDR Data Package shall address test plans (including all environmental tests)

The CDR Data Package shall address manufacturing considerations

The CDR Data Package shall address maintainability considerations, including storage.

The CDR Data Package shall address materials and processes lists

The CDR Data Package shall provide a summary of deviations/waivers

The CDR Data Package shall address contamination control and monitoring considerations

The CDR Data Package shall address spares program

The CDR Data Package shall address system safety hazards analyses

(d) Hazards identification matrix
(e) Single point failure summaries

(f) Risk assessment rationale

The CDR Data Package shall delineate the status of each document as to its acceptability for use as is.

The CDR data package shall address open interface items and the status of any ICDs.

The CDR package shall address the mission operations concept.

The CDR Data Package shall present any additional test results from breadboard and brassboard testing

The CDR Data Package shall present the test data from sub-assembly engineering development units and the status of EDU development and testing results, if any.

The CDR Data Package shall address the development status of all GSE, including test and calibration procedures, and the software/firmware design and operation and interface aspects as evaluated since the PDR

The CDR Data Package shall address the status of all program risks and their mitigation

The CDR Data Package shall address the status of all sub-contract design activity and schedule for delivery of flight hardware, and demonstrate that designs are complete and have been adequately reviewed, The Contractor shall address the design/delivery status of Long lead items.

The CDR package shall address the status of the Observatory Simulator, to include the following items:

a. Responses to action items from previous reviews, including system CDRs
b. Changes since the last review
c. Address the development and/or procurement status of long lead items
d. Address standard applicable in-house software processes
e. Address hardware required for development and operations
f. Address personnel resources (time phased)
g. Address the delivery schedules for the Observatory Simulator
h. Performance specification
i. Block diagrams and description of software components
j. UML software design diagrams (object models, class diagrams, sequence diagrams, etc.)
k. Description of key design classes
l. Address the extensibility of the simulator design
m. Address the modes of operation of the simulator
n. Address the spacecraft subsystems simulated by the Observatory simulator
o. Address software test plans
p. Address maintainability considerations
q. Address any COTS products and licenses involved
r. Provide a summary of deviations/waivers
s. Delineate the status of each document as to its acceptability for use as is. If updates and/or

changes are required, these shall be estimated in required man-hours

t. Address open interface items and the status of any ICDs
u. Address the simulation operations concept
v. Present results and data from any related proof of concept testing
w. Present results and data from any related prototype testing
x. Present key updated graphical user interfaces
y. Address the status of all program risks resulting from the Observatory Simulator development and their mitigation

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
RE-9	PRE-ENVIRONMENTAL REVIEW (PER) DATA PACKAGE

3. Reference:

SOW 1.2.1.3
GSFC-STD-1001

4. Use:

Presents the description and results of the Pre-Environmental Test program, and demonstrates readiness for environmental testing.

5. Preparation Information:

The PER Data Package shall contain all information required to satisfy paragraph 8.4 (Criteria for Successful Completion) of GSFC-STD-1001, Criteria for Project Flight Critical Milestone Reviews.

The PER Data Package shall include status of action items generated at prior reviews

The PER Data Package shall include analyses and reports required at the review.

The PER Data Package shall contain the results of any analyses updated or revised since the CDR. Analyses shall be provided for mission parameters such as: lifetime fuel budget, attitude determination error analysis, orbit determination error analysis, maneuver frequency estimates [drag make-up and inclination], disposal, etc.

The PER Data Package shall include test and integration program descriptions and results

The PER Data Package shall include failure report summaries including status of action and rationale for closure

The PER Data Package shall include as-built documentation summary

The PER Data Package shall include results of the functional and interface tests

The PER Data Package shall include descriptions of any malfunctions and corrective actions

The PER Data Package shall include comparison of measured performance with requirements and discussion of the effect of any variance and waivers

The PER Data Package shall include mission operation constraints

The PER Data Package shall include contamination avoidance requirements

The PER Data Package shall include safety requirements

The PER Data Package shall include list of spares for flight equipment and GSE

The PER Data Package shall include review of flight hardware handling procedures

The PER Data Package shall include orbital operations plans and status of documentation and databases.

The PER Data Package shall include end-item data packages (submit a summary of the content prior to review and have package available for inspection at review)

1. As-built configuration list
2. Hardware parts lists
3. Hardware materials and processes lists
4. Test Log Book (including total operating time and cycle records)
5. Open item lists (including reasons for being open)
6. Safety compliance data package
7. Limited life items listings and status
8. Critical parameters trend data
9. Final comprehensive performance test results
10. Failure report summaries including status of action and rationale for closure

The PER Data Package shall address the availability and readiness of facilities and GSE required for environmental testing

The PER Data Package shall address the status of all program risks and their mitigation plans.

The PER Data Package shall address the readiness of environmental test plans and procedures

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
RE-10	MISSION PRE-SHIP REVIEW (PSR) DATA PACKAGE

3. Reference:

SOW 1.2.1.3
GSFC-STD-1001

4. Use:

To evaluate system performance during qualification or acceptance testing, and evaluate readiness to ship from contractor.

5. Preparation Information:

The PSR Data Package shall contain all information required to satisfy paragraph 10.4 (Criteria for Successful Completion) of GSFC-STD-1001, Criteria for Project Flight Critical Milestone Reviews.

The PSR Data Package shall address responses to action items generated at prior reviews

The PSR Data Package shall address the solutions to all problems encountered during the environmental test and validation program and the solution rationale.

The PSR Data Package shall summarize and analyze the monthly trend reports (CDRL SE-4) of trended data, focusing on trends that have changed or drifted anomalously (see SOW paragraph 2.5).

The PSR Data Package shall address any rework/replacement of hardware, regression testing, and test plan changes.

The PSR Data Package shall address compliance with the test verification matrix

The PSR Data Package shall address measured test margins versus requirements.

The PSR Data Package shall address the Attitude Control System (ACS) nominal sensor alignment data.

The PSR Data Package shall address qualification/acceptance temperature margins

The PSR Data Package shall address any data that has been trended to identify compliance with specification, indicating a change or drift to the trend.

The PSR Data Package shall address total failure-free operating time of the item

The PSR Data Package shall address the number of cycles during testing of parts with finite lifespans (e.g. – valves in propulsion system)

The PSR Data Package shall address the results of the final audit of any remaining drawing changes.

The PSR Data Package shall address "could-not-duplicate failures" along with assessment of the problem and the residual risk that may be inherent in the item

The PSR Data Package shall address project assessment of any residual risk

The PSR Data Package shall provide an update from CDR on shipping containers, monitoring/transportation/control plans

The PSR Data Package shall address ground support equipment status

The PSR Data Package shall address post shipment plans

The PSR shall address the plans for storage of the observatory, if required

The PSR Data Package shall address launch preparation plan

The PSR Data Package shall address approval of safety status for flight, range, ground hardware and operations

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
RE-11	MISSION OPERATIONS REVIEW

3. Reference:

SOW 1.2.1.3
GSFC-STD-1001

4. Use:

Provide LDCM Space Segment information to the lead entity in support of mission level reviews. The review team will expect information required to satisfy paragraph 7.4 (Criteria for Successful Completion) of GSFC-STD-1001, Criteria for Project Flight Critical Milestone Reviews.

5. Preparation Information:

The MOR Data Package shall contain all information required to satisfy paragraph 7.4 (Criteria for Successful Completion) of GSFC-STD-1001, Criteria for Project Flight Critical Milestone Reviews.

The Mission Operations Review (MOR) data package shall address the following items at a minimum:

a. Mission Requirements/Operations Concept
b. Overall Schedule and Status including: Documentation (i.e. Space Segment operations concept, ground system requirements, flight operations and contingency plans and Interface Control Documents, handbooks and users manuals), flight operations staffing plan, and detailed mission timeline.
c. Closure of action items from previous reviews (e.g., Project-unique ground system reviews)
d. Mission, Payload Instruments and Communications Services, Spacecraft, Flight Software, and Ground System Overviews
e. Flight Software Maintenance Approach
f. Flight Operations Team build up and Training Plans
g. Pre-launch Test Plans including: RF and Project Operations Control Center (POCC) Compatibility Tests, Data Flow and End-to-End Tests, Simulations and exercises, Launch Site and Pad Tests
h. Launch and early orbit overview including deployment activities and coverage
i. In-orbit Checkout Overview
j. Project Database and Procedure Development

k. Spacecraft and Instrument Operations Constraints
l. Spacecraft Subsystem Level Activities
m. Mission Planning and Scheduling
n. On-board Data Memory Management
o. Real-time Operations including: Health and Safety Monitoring, Safe Mode Operation
p. Trend Analysis Plans including Reports and Archiving
q. Science Operations Planning, Data Processing and Analysis
r. Ground System Requirements and Development Status
s. Mission Readiness Testing
t. Preliminary List of all Launch Critical Facilities and Functions
u. Issues and Concerns
v. Specification and Drawing Trees
w. Mass Properties Report
x. Power Profile Report

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
RE-12	FLIGHT OPERATIONS REVIEW

3. Reference:

SOW 1.2.1.3
GSFC-STD-1001

4. Use:

Provide LDCM Space Segment information to the lead entity in support of mission level reviews. The review team will expect information required to satisfy paragraph 9.4 (Criteria for Successful Completion) of GSFC-STD-1001, Criteria for Project Flight Critical Milestone Reviews.

5. Preparation Information:

The FOR Data Package shall contain all information required to satisfy paragraph 9.4 (Criteria for Successful Completion) of GSFC-STD-1001, Criteria for Project Flight Critical Milestone Reviews.

The Flight Operations Review Data Package should include all of the items specified for an MOR, updated to the present stage of progress, plus the following additional items:

a. Closure of actions from the MOR
b. New requirements and changes in plans
c. Test result summaries including contractor's assessment of the criticality of open problems
d. Work remaining including tests, simulations, and closure of problems
e. Personnel location for launch and early orbit and in-orbit checkout including Project Office, Operations, and Observatory Subsystem expert personnel
f. Contingency procedures, development and verification/validation status
g. Safety and mission success

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: RE-13

2. Title: OPERATIONAL READINESS REVIEW

3. Reference:

SOW 1.2.1.3

4. Use:

To examine the actual system characteristics and the procedures used in the system or product's operation and ensure that all system and support (flight and ground) hardware, software, personnel, procedures, and user documentation accurately reflects the deployed state of the system.

5. Preparation Information:

The Operational Readiness Review shall address the following items:

1. Status of completion of all validation testing.
2. Resolution of test failures and anomalies from validation testing and incorporation of the results into all supporting and enabling operational products.
3. Status of all operational supporting and enabling products (facilities, equipment, documents, updated databases, etc) that are necessary for the nominal and contingency operations. Status of delivery/installation of these products at the site(s) necessary to support operations.
4. Status of training to the users and operators on the correct operational procedures for the system.
5. Status of operational contingency planning and all training of personnel.

Review Success Criteria:

1. The system, including any enabling products, is determined to be ready to be placed in an operational status.
2. All applicable lessons learned for organizational improvement and systems operations have been captured.
3. All waivers and anomalies have been closed.
4. Systems hardware, software, personnel, and procedures are in place to support operations.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
RE-14	FLIGHT READINESS REVIEW

3. Reference:

SOW 1.21.3

4. Use:

To examines tests, demonstrations, analyses, and audits that determine the system's readiness for a safe and successful flight/launch and for subsequent flight operations. It also ensures that all flight and ground hardware, software, personnel, and procedures are operationally ready.

5. Preparation Information:

The Flight Readiness Review shall address the following items at a minimum:

1. Certification that flight operations can safely proceed with acceptable risk.
2. Confirmation that the system and support elements are properly configured and ready for flight.
3. Confirmation that all interfaces are compatible and function as expected.
4. Confirmation that the system state supports a launch "go" decision based on go/no-go criteria.

Review Success Criteria:

Determination that:
1. The flight vehicle is ready for flight.
2. The hardware is ready for a safe flight with a high probability for achieving mission success.
3. Flight and ground software elements are ready to support flight and flight operations.
4. Interfaces are checked out and found to be functional.
5. Open items and waivers have been examined and found to be acceptable.
6. The flight and recovery environmental factors are within constraints.
7. All open safety and mission risk items have been addressed.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
RE-15	LAUNCH READINESS REVIEW (LRR)

3. Reference:

SOW 1.2.1.3

4. Use:

To update the status of the system readiness for launch.

5. Preparation Information:

The LRR is held to update the mission status, close out actions from the previously held FRR, authorize approval to proceed into launch countdown, and sign the Certification of Flight Readiness (COFR). The LRR is held at the launch site no later than 1 day before launch. The LRR is chaired by the Space Operations Assistant Associate Administrator (AAA) for Launch Services or may be delegated to the LSP Program Manager, as appropriate. The COFR is signed at the conclusion of the LRR.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
RE-16	ON-ORBIT ACCEPTANCE REVIEW

3. Reference:

SOW 1.2.1.3

4. Use:

To demonstrate that the Observatory and Mission Operations Element are ready for Government acceptance.

5. Preparation Information:

The On-Orbit Acceptance Review shall provide the following information:

1. Data review (in the form of data plots/tables) of the results of operational performance identified during Launch and Early Orbit (LOR) and bus and sensor checkout.
2. Results of application of all contractor-developed image algorithms to the image data.
3. Results of on-orbit calibration.
4. Data review (in the form of data plots/tables) of thermal signatures for key components (controls, power, thermal)
5. Data review (in the form of data plots/tables) for all anomalies and unexpected behavior encountered by the contractor during LOR and bus and sensor checkout, including:
    a. Data showing the anomalous or unexpected behavior
    b. Descriptions of any workarounds and/or fixes
    c. Data illustrating response to the workarounds and/or fixes
6. Current status of all anomalies, ground system problems, and database problems encountered by the contractor during LOR and commissioning
7. Measured on-orbit performance of the LDCM versus the requirements of the Space Segment Requirements Document and the Mission Operations Element Requirements Document.

8. **DESCRIPTION OF REQUIRED DATA**

1. CDRL No.:	2. Title:
RE-17	ENGINEERING PEER REVIEW DATA PACKAGES

3. Reference:

SOW 1.2.2
SOW 4.5.3.1

4. Use:

Engineering Peer Reviews (EPRs) focus on the design and implementation details at levels that system-level reviews cannot address. They provide a resource for Design Teams to identify potential engineering design and implementation flaws, and increase the probability of success. Applying the EPR process early and throughout the product life cycle affords the maximum advantage in terms of resource efficiency as well as design confirmation and ultimate mission success. Peer review documentation represents knowledge that may prove invaluable later.

5. Preparation Information:

Engineering Peer Review documentation shall address, as appropriate for the timeframe conducted, at a minimum:

A. Design Adequacy: Drawings, Schematics, Analyses, Parts and Materials
B. Manufacturing Adequacy: Facilities, GSE, Personnel, etc.
C. Verification Approach: Test, Analyses, and Simulation
D. Verification Results: Data Adequacy, Observed Margins, Trends, and Anomalies
E. Calibration Approach and Results
F. Claims of heritage from previous missions
G. Lessons Learned

SOFTWARE DIDS

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SW-1	SOFTWARE DEVELOPMENT AND MANAGEMENT PLAN

3. Reference:

SOW 4.4.2
NPR 7150.2

4. Use:

Defines contractor activities required to develop and manage all software

5. Preparation Information:

The Software Development and Management Plan shall describe processes and activities used in the development and testing of the various types of software being acquired, acknowledging the fact that not all software has the same criticality level or process requirements (reference the classification requirements in SOW sections 4.4.1.1.3 and 4.4.1.1.4.

Topics to be included in the Software Development and Management Plan are:

A. Purpose and Description;
B. Resources, Budgets, Schedules, and Organization; A description of how the software personnel structure is integrated into the overall LDCM development organization.
C. Acquisition Activities;
D. Development methodologies and Activities;
E. Sustaining Engineering and Operations Activities;
F. Software Assurance Plan
G. System safety;
H. Software Risk Management plan;
I. Software Configuration Management plan;
J. Delivery and Operational Transition
K. V&V and IV&V;
L. COTS, GOTS, and MOTS software.
M. Subcontractor management and monitoring
N. The plan and approach for training personnel (Contractor staff, external maintainers, Flight Operation Team) in the use of all delivered software and supporting facilities

Additionally, the Contractor shall evaluate all flight software using software metrics. The metrics collected, trended, and presented monthly. Metrics shall include at a minimum:

A. Number of flight software requirements and their change status
B. Design/Code complexity index at CSU, CSC, and CSCI levels
C. Source code production rate estimates versus actuals
D. Number of Software Change Requests/Problem Reports and their status
E. Resource margins for Utilization of memory, CPU, I/O Bandwidth and Bus traffic
F. Effort data (staffing profile) estimates versus actuals

Include an alphabetized list of definitions for abbreviations and acronyms used in this document. Include an alphabetized list of definitions for special terms used in the document, i.e., terms used in a sense that differs from or is more specific than the common usage for such terms.

Material that is too detailed or sensitive to be placed in the main body of text may be placed in an appendix or included as a reference. Include the appropriate reference in the main body of the text. Appendices may be bound separately, but are considered to be part of the document and shall be placed under configuration control as such.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SW-2	SOFTWARE REQUIREMENTS SPECIFICATION

3. Reference:

SOW 4.4.2.1

4. Use:

The Software Requirements Specification specifies in detail each Software Element's requirements for a particular computer Software Configuration Item (CSCI), including functional and performance requirements, interface requirements, testing requirements, security and safety requirements

5. Related Documents:

NASA-Software documentation Standard (NASA-STD-2100-91), Data Item Description NASA-DID-P200

6. Preparation Information:

The Software Requirements Specification shall be prepared IAW the full contents of NASA-Software documentation Standard (NASA STD-2100-91), Data Item Description NASA-DID-P200. Alternatively, the contractor may, with agreement from the government, use an alternative industry standard SRS approach such as MIL-STD-498 or IEEE standards.

In addition to the content required by NASA-DID-P200, include a bidirectional traceability matrix that maps each software requirement to a system or sub-system (high level) requirement from which it is derived. Additionally, the test method used to verify each requirement shall be identified.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SW-3	SOFTWARE DESIGN DOCUMENT/USERS GUIDE

3. Reference:

SOW 4.4.2.2

4. Use:

Describes the software design and operation for use by software maintenance team.

The Software Design Document describes in detail the architecture, structure, and organization of a particular Computer Software Configuration Item (CSCI), decomposing the top-level CSCI into Computer Software Components (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).

The Software Users Guide shall contain the information required to use the software, including detailed procedures and functionalities

5. Preparation Information:

Provide a system level design overview that contains:
(a) Design Methodology
(b) Design Overview
(c) Design Studies
(d) Design Issues
(e) Hardware Interface

Provide a system design description that contains, at a minimum
(a) Subsystem Description for each subsystem
(b) Software Description for each software component
(c) Software Interface Control Description for both software-to-software and software-to-hardware interfaces

Describe the system operations design, including:
(a) Operations Scenarios
(b) User-System Interface
(c) Operations Environment and Facilities

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SW-4	SOFTWARE TEST READINESS REVIEW (SWTRR) DATA PACKAGE

3. Reference:

SOW 4.4.3.2

4. Use:

Presents the description and results for the S/W and System Integration/Test program.

5. Preparation Information:

The SWTRR shall show that the contractor has adequately prepared for formal software acceptance testing to include, at a minimum, the check-out of test procedures, test cases, and requirements traceability.

This design review package shall address, as a minimum:

A. All documentation as called for in the Software Development and Management Plan
B. Test and Integration program descriptions and results
C. Software test results
D. Failure report summaries including status of action and rationale for closure
E. As-built documentation summary

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SW-5	SOFTWARE ACCEPTANCE REVIEW (SWAR) DATA PACKAGE

3. Reference:

SOW 4.4.3.2

4. Use:

For review of all test data and designs for compliance against specification requirements, variances, mission operations requirements, etc.

5. Preparation Information:

This data package shall address, as a minimum:

A. Results of the functional and interface tests
B. Malfunctions and corrective actions
C. Reliability predictions
D. Comparison of measured performance with requirements and discussion of the effect of any variance and waivers
E. Mission operation constraints
F. Safety requirements
G. Maintenance and operation manuals
H. Interface concerns, problems and solutions
I. Compatibility of instrument with spacecraft flight support equipment, ground support equipment and operational ground equipment

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SW-6	SOFTWARE TEST REPORTS

3. Reference:

SOW 4.4.2.3

4. Use:

Provide summary of the software acceptance testing and/or retesting activities

5. Preparation Information:

These reports shall be prepared in accordance with the MAR.

These reports shall be developed for each test described in the Software Test Plan and shall include the following, as a minimum:

A. Version number of software tested
B. Identity and number of planned tests that have been completed
C. Conformance of test results to expected results
D. Number, type, and criticality of discrepancies
E. Identification of software areas tested
F. Analysis of any performance requirements that the tested software could affect
G. Test result summary

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SW-7	FLIGHT SOFTWARE TEST PLAN

3. Reference:

SOW 4.4.2.1

4. Use:

Provide overall view of the software acceptance test program detailing test philosophy objectives and rationale for all software testing and hardware/software integration activities planned for the program.

5. Preparation Information:

This shall incorporate the requirements of the MAR.

This shall include, as a minimum:

A. Tests to be accomplished to demonstrate that the software meets requirements; the Draft STP shall contain a bidirectional traceability matrix that maps all requirements in the Software Requirements Specification to their corresponding test case4s, analyses, inspections, etc. The Final STP traceability matrix shall include the additional mapping of test cases to test procedures/scripts.
B. Test environment, simulators and tools needed
C. Required test data
D. Expected results
E. Test schedules
F. Special operating conditions (if required)
G. Any required support from other organizations

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SW-8	SOFTWARE DELIVERY PACKAGE AND OPERATIONS TRANSITION PLAN

3. Reference:

SOW 4.4.8

4. Use:

A software delivery package is required at the end of the contract period. There are three items comprising the software delivery package. The first item is the delivery letter describing what is being delivered. The second item is the software on appropriate media. The third item is accompanying documentation. The final software delivery should include the operations transition plan.

5. Related Documents:

6. Preparation Information:

A software delivery package is required at the end of the contract period. The software delivery package shall include the following information with appropriate approvals:

A. Software Delivery Letter, one page in length, which defines briefly what is being delivered, contains in its attachments the details of the delivery, and identifies a point of contact for resolution of questions/misunderstandings/problems involving the delivery. Attachments which support the delivery letter are described in items (a) through (k) below:

(a) Description of Delivery Contents – Identify the delivery in terms of subsystem, release number(s), configuration ID(s), media type(s) (tapes, diskettes, other) and number of copies.

(b) Build Instructions - Provide instructions to be used in building the delivered software, including the version number of system or vendor-supplied software required to build the system. The supplier should provide evidence that these instructions have been executed prior to delivery and that the software has been built successfully using them (As Built Configuration).

(c) Special Operating Instructions – Indicate any special instructions that test or operations personnel need to know in using the software. These may include, for example, the use of special simulators, changes to operational procedures, the addition of new files, file format changes, operating constraints/limitations, workaround resolutions to documented problems, operational software version numbers, and associated database version numbers.

(d) List of Resolved Anomaly Reports and Change Requests.

(e) List of Unresolved Anomaly Reports and Change Requests.

(f) Copy of Resolved Anomaly Reports and Change Requests.

(g) Copy of Unresolved Anomaly Reports and Change Requests.

(h) Matrix of requirements addressed by this release (may be done by reference to mapping of requirements identified in requirements specification document).

(i) Release History Summary Matrix.

(j) Inventory of the Delivered Media – Produce the inventory from the media themselves,

(k) List of Release Documentation, e.g. users guide procedures.

B. Software Delivery Media

The second of the three items of the delivery package is the delivered software, including the source code and executable code. Provide this software on the media in accordance with the contract schedule. The media can be magnetic disk, magnetic tape, optical media, paper listings, etc. Number of copies of the media is in accordance with the contract schedule.

C. Accompanying Documentation

The third and final item included in the software package is the documentation that describes the delivered software. Provide copies of the following:

(a) Users Guide.

(b) Software Description

(c) Requirement(s) Documentation or draft change pages.

(d) Design Documentation or draft change pages.

(e) Data Definitions

(f) Test Plans, Procedures and Results as appropriate.

D. An operations transition plan is required prior to the final software release for Government acceptance. It plans for the transition of all deliverable software and supporting databases from the development team to the operations and the software maintenance teams. The plan shall include delivery and transition of software, documents, and users guides to its operational state on deliverable simulators or test beds such as the Software Development and Validation Facility and Flight Software Validation

and Maintenance Facility.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SW-9	SOFTWARE REQUIREMENTS PEER REVIEW PACKAGE

3. Reference:

SOW 4.4.3.2

4. Use:

At the SRR, the development team presents the detailed requirements and specifications for the software system or subsystem to independent experts, management, customers, users and other interested parties. The purpose of the pre-SRR Peer Review is to verify that these software requirements are clear, complete, consistent, feasible, traceable, and testable. Successful completion of the SRR certifies that the requirements form a satisfactory basis for proceeding with software design.

5. Related Documents:

6. Preparation Information:

The Pre-SRR Peer Review package should include the following information, as a minimum:

Software Development Approach

- Development methodology being followed, focusing on requirements definition, requirements analysis, and high-level design
- Identification of all source documents from which software requirements were derived
- Explanation of any prototypes, simulations, or other studies of requirements feasibility

- Requirements context – Overview of system concepts and requirements from which the detailed requirements and specifications were derived

Hardware Context

- Diagrams showing the hardware environment in which the software will operate (e.g., processors, buses, sensors, communications networks)
- Major software functional elements, showing data flows between software and hardware elements

- Identification of any resource limitations or allocations associated with the hardware elements on which software depends, including processors, memory, data storage
- Identification of Interface Requirements Documents (IRDs) and Interface Control Documents (ICDs) and the organizations developing or acquiring hardware elements; IRD and ICD status and need dates for any open or TBD issues

Software Context

- Diagrams showing external software interfaces to this software system/subsystem.
- Identification of software IRDs and ICDs and the development organizations associated with relevant external software elements; IRD and ICD status and need dates for open/TBD issues
- Architectural diagrams showing any COTS, GOTS, heritage software, operating systems, and/or development languages specified in the higher-level requirements or system concept documents

Operations Context

- Diagram of operations characteristics (e.g., ground contacts, science operations)
- Operational scenarios for the major functional areas, including input mechanisms, processing, output, interfaces, and identification of users
- Software control modes and mode transition rules
- Fault detection, isolation and recovery (FDIR) strategies
- Safety hazard reduction strategies
- Security features

- Functional requirements – Address the following *for* ***each major functional area*** of the software:
  - Definition of high-level requirements for each functional area
  - Block diagram of the major software components in each functional area, their interfaces and data flows
  - Definition of relevant operational modes (e.g., nominal, critical, contingency)
  - Critical and/or controversial requirements, including open issues and areas of concern
  - Requirements needing clarification or additional information
  - Trace of each requirement to the higher-level (e.g., mission) document from which it was derived
- Performance requirements
  - Identification of performance requirements for the software (e.g., system response times, failure recovery times, output data availability)
  - Description of critical timing relationships and constraints (e.g., external hardware interface timing, command execution timing)
- Design strategy
  - Explanation of design drivers and design decisions that have been made, including software architecture, operating systems, reuse of existing software, and selection of COTS components
  - Resource goals and preliminary sizing estimates in the context of available hardware allocations; strategies for measuring and tracking resource utilization
  - Initial Build Plan
- Qualification requirements

- Discussion of overall software test strategy, including the test levels (unit, integration, build, and system-level testing), test types (interface, load/stress, regression), and test tools
- Software development and test environments, including processors, operating systems, communications equipment, simulators and their fidelity
- Traceability of requirements to build and system-level tests
- Methodology for verifying the system requirements and acceptance criteria
- Test tool requirements and development plans

- Software Management Plan

  Management approach
  - Software team(s) organization, WBS, and reporting relationships
  - Software size estimates, budgets, and staffing
  - Development schedules showing key receivables, deliverables, and dependencies
  - Management overview, including metrics to be collected
  - Risks and risk mitigation plans

  Technical approach
  - Requirements management approach and tools
  - Configuration Management, Product Assurance, and Software Safety approaches and tools
  - Software development environment(s) and tools
  - Documentation summary and schedule

- Status – Current schedule, milestone, and effort status

DESCRIPTION OF REQUIRED DATA

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1. CDRL No.: 2. Title:

SW-10 SOFTWARE PRE-PDR PEER REVIEW PACKAGE

3. Reference:

SOW 4.4.3.2

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4. Use:

This review is to determine readiness to proceed with software detailed design activities.

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5. Related Documents:

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6. Preparation Information:

The Pre-PDR Peer Review package should include the following information.

- Requirements summary – High-level review and update of the project's requirements, highlighting changes since MDR
  - Overview of requirements documents
  - Requirements for reuse of existing software
  - Unique requirements
  - Performance and/or quality requirements
  - Safety and/or security requirements
- Operational scenarios, highlighting any changes in operational concepts resulting from design activities
  - Normal operations scenarios
  - Fault detection, isolation and recovery (FDIR) strategy
  - Hazard reduction strategies
- High-level design – At a minimum, include the following:
  - System architecture, external interfaces and end-to-end data flow
  - Design drivers (e.g., performance, reliability, usability, hardware considerations)
  - Overview of software architecture, including context diagram
  - ICD status and key interface details
  - List of subsystems, tasks, or major components – e.g., user interface, database, task management.

  For each subsystem, task, or major component

- Mapping of system-level requirements to the subsystem, with any safety-critical requirements highlighted
- Derived requirements
- Design alternatives, including reuse of heritage software and/or COTS tradeoffs
- High-level design – Context diagram, functional allocations, descriptions of major modules, data flow, and internal interfaces
- Current design status and issues

- Software Management Plan – Review the following, highlighting changes since MDR:

  Management approach
  - Organization/WBS
  - Project relationship and interfaces, if applicable
  - Software size estimates, budgets, and staffing
  - Development schedule showing key receivables, deliverables, milestones, and dependencies
  - Management overview, including metrics to be collected
  - Risks and risk mitigation plan
  - Infusion of previous Lessons Learned; collection of new Lessons Learned

  Technical approach
  - Requirements management approach and tools
  - Configuration Management, Product Assurance, and Software Safety plans and tools
  - Development approach, including peer review/walkthrough plans and project standards
  - Documentation plan, including when documents are to be baselined
  - Build/release plan and contents
  - Software development and test environments and tools
  - Test strategy/plan, including test drivers/simulators, test data, and discrepancy tracking
  - Strategy or timeline for IV&V and Independent Technical Authority involvement, if applicable
  - Delivery, installation, and maintenance plan

- Status – Current schedule, milestone, ICD, and resources status

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: SW-11

2. Title: SOFTWARE PRE-CDR PEER REVIEW PACKAGE

3. Reference:

SOW 4.4.3.2

4. Use:

The purpose of this review is to determine whether the detailed design satisfies requirements and is ready to be implemented in code and tested.

5. Related Documents:

6. Preparation Information:

This design review package shall include the following items:

- **Management Overview,** highlighting changes since Software Pre-PDR Peer Review
  - Management activities, including regular management and technical meetings, status reporting
  - V&V plan, including milestone and peer reviews, walkthroughs, and external reviews
  - Status of Requests for Action (RFAs) or Review Item Dispositions (RIDs) and responses from the Software Pre-PDR Peer Review and, if applicable, the Mission PDR and/or CDR
  - Status of ICDs/IRDs and other external dependencies (documents, software, hardware, etc.)
  - Documentation plan, including each document's status and when it will be baselined
  - Product Assurance and Software Safety plans and activities
  - Independent verification and validation (IV&V) plans and status
  - Collection and analysis of software project metrics
  - Collection and reporting of Lessons Learned; infusion of Lessons Learned in earlier phases and/or projects
- **Development Process and Plans,** highlighting changes since PDR
  - Software requirements definition and management process, including documents used and produced, V&V, and baselines
  - Design process, including methodology and standards used, design documentation produced, inspections and reviews
  - Implementation process, incl. standards, review process, problem reporting, unit test, integration
  - Build plan

- Configuration Management (CM) processes, including discrepancy reporting and tracking (development and post-release)

- **Software Overview,** highlighting changes since PDR
  - Overview of functional requirements and operations concepts
  - System (software and hardware) architecture, external interfaces and end-to-end data flow
  - Software context diagram showing each subsystem or major component
  - Failure detection and correction (FDC) requirements, approach, and detailed design, if applicable
  - IT Security Requirements (Mission-specific)
  - Software Requirements Verification Matrix (mapping requirements to subsystems/components
  - Development environment (e.g., hardware diagram, operating system(s), compilers, DBMS, tools)

For each subsystem or major component,
  - **Requirements**
    - Functional and initialization requirements allocated to the subsystem/component, with any safety-critical and IT Security requirements highlighted
    - Requirements changes since PDR
  - **Detailed Design**
    - Design changes since PDR
    - Reused/heritage software or functionality from previous projects; necessary modifications
    - Subsystem/component context diagram
    - System design diagram (e.g., Level 0 data flow diagram or UML)
      For each task in the system design diagram
      - Design diagrams for the task
      - Description of functionality and operational modes
      - Resource and utilization constraints (e.g., CPU, memory); how the software will adapt to changing margin constraints; performance estimates
      - Data storage concepts and structures
    - Identification and formats of input and output data
    - Interrupts and/or exception handling, including event, FDC, and error messages
    - IT Security features
    - Current status and issues
- **Software Testing**
  - Test team roles, functions, support required, and charter
  - Documentation – titles and status of test plans, procedures, and traceability matrices
  - Test levels (e.g., unit testing, integration testing, system testing) – description, who executes, test environment, standards followed, verification methodologies
  - Testing preparation and execution activities, incl. testing of reused/heritage software if applicable
  - Build test timeline and ordered list of components and requirements to be tested in each build

- Test environments for each test level –diagram and description of tools, testbeds, facilities
- Software requirement verification recording, monitoring, and current status – databases and test reports; sample test verification matrix
- Mission Project V&V plans and status
- System and acceptance testing – operational scenarios to be tested, including stress tests and recovery testing, if applicable
- Acceptance process – reviews (e.g., Acceptance Test Readiness Review, Acceptance Test Review), approval, and signoff processes

- **Delivery, Installation, and Maintenance**
  - Disposition of source code and tools, handling of load images, installation of databases, etc.
  - Version identification and documentation
  - Maintenance plan, if applicable, including disposition of COTS components (source code, licenses, etc.)

- **Software status**
  - Detailed schedule timeline, showing phases, milestones, and current status
  - Current software size estimate; staffing and resources status

Risks – with categories, frequency of review, consequences, and risk mitigation strategies

INTEGRATION AND TEST DIDS

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
IT-1	SPACECRAFT TEST PLANS

3. Reference:

SOW 4.2.1

4. Use:

Provide information on how the spacecraft will be tested and how its performance will be verified.

5. Preparation Information:

The contractor shall provide detailed 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 tests, 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
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.
n. Data Recording Requirements

o. Data Recording Forms and Tables
p. Accept/Reject Criteria
q. Note any test phases and profiles
r. List the requirements for the test procedure and test report development
s.Description of any necessary functional operations required during the test (ie. a CPT performed at hot and cold during thermal vacuum testing)

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: IT-2

2. Title: SPACECRAFT BUS TEST REPORTS

3. Reference:

SOW 4.2.1

4. Use:

Report the results of all tests identified in the Spacecraft Test Plans, including test procedures used, test results, and configuration status of all items under test.

5. Preparation Information:

The Contractor shall provide test reports that summarize the results of verification tests on the spacecraft. The following shall be included in test reports:

a. Test identification and hardware configuration – for specific test
b. Facility description
c. Reference - applicable test plan, test procedures, and test requirements, test log including the dates of the testing, photographs of test setup, any malfunction reports written during the test
d. Test results, to include:

1. Identification of test results which confirmed the expected results as specified in the test plan / procedures or for which variations between actual and expected results were within specified tolerance. For the latter case, actual test results shall be shown.

2. Identification of test results which differ from expected results beyond expected or acceptable limits.

3. Identification of any planned test objective or requirement for which actual results were not obtained. Reasons for not meeting the objective/requirement shall be stated.

4. Identification of any false or aberrant results noted during the test or subsequent analyses. Note that any such behavior that can prevent the spacecraft from accomplishing its mission objectives can be a basis for rejection.

d. Recommendations for subsequent actions shall be stated, based on the test results, to include:

1. Redesign of a particular component to enable the spacecraft to meet a specific requirement which was not fulfilled

2. Revision of a development or the system / subsystem specification in cases where the test results disclose ambiguity or conflicting requirements

3. The conduct of additional tests to fulfill objectives for which results were not acceptable.

4. Test Plan and Procedure Changes – Any deviations from the approved test plans or procedures that were followed during the official conduct of the test shall be documented as revision pages to the affected documents and shall be appended to the report. Acceptance of the report shall also constitute acceptance of the appended changes.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
IT-3	SENSOR INTEGRATION AND TEST PLAN

3. Reference:

SOW 4.2.2

4. Use:

To provide information on the integration and testing of the Sensor(s). To describe how the sensor components are integrated and sensor performance is tested and verified.

5. Preparation Information:

The contractor shall provide a Sensor Integration and Test Plan which describes the series of activities required to integrate the various sensor components into the final flight configuration. It also includes the activities required to test this configuration to verify its readiness for integration onto the Observatory.

At a minimum, the plans shall contain the following information:

a. Deliverables to Sensor Integration and Test
b. Flow of sensor Integration and Test sequence
c. Description of each sensor activity or test including the test configuration
d. Description of sensor procedures required to support the activity or test
e. Description of sensor special handling requirements to support the activity or test
f. Description of sensor ground support equipment requirements to support the activity or test
g. Description of sensor safety requirements to support the activity or test
h. Description of sensor personnel required to support the activity or test
i. Requirement to take photographs during the integration process for reference
j. Description of the process to be used for handling anomalies as they occur during I&T
k. Requirement of log books to be maintained throughout the I&T process
l. Sensor level requirements to be verified, cross referenced to the SPVP
m. Calibration test requirements
n. Data/ simulator requirements

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
IT-4	SENSOR TEST PLANS

3. Reference:

SOW 4.2.2

4. Use:

To provide information on how the sensor(s) will be tested and how its performance will be verified

5. Preparation Information:

The contractor shall provide detailed test plans to be used during Sensor Level 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 tests, 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 sensor test operations, interfaces, and sensor performance requirements (i.e., electrical, structural and mechanical, EMC), and shall cover specialized tests such as mechanical function and deployments, environmental exposure tests (i.e., vacuum, vibration), sensor 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 sensor configuration, including any differences from flight configuration
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.
n. Data Recording Requirements
o. Data Recording Forms and Tables
p. Accept/Reject Criteria
q. Note any test phases and profiles
r. List the requirements for the test procedure and test report development
s. Description of any necessary functional operations required during the test (ie. a CPT performed at hot and cold during thermal vacuum testing)

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
IT-5	SENSOR TEST REPORTS

3. Reference:

SOW 4.2.2

4. Use:

To report the results of all tests identified in the Sensor Test Plans, including test procedures used, test results, and configuration status of all items under test.

5. Preparation Information:

The Contractor shall provide test reports that summarize the results of verification tests on the sensor. The following shall be included in test reports:

a. Test identification and hardware configuration – for specific test
b. Facility description
c. Reference - applicable test plan, test procedures, and test requirements, test log including the dates of the testing, photographs of test setup, any malfunction reports written during the test, calibration data
d. Test results, to include:

1. Identification of test results which confirmed the expected results as specified in the test plan / procedures or for which variations between actual and expected results were within specified tolerance. For the latter case, actual test results shall be shown.

2. Identification of test results which differ from expected results beyond expected or acceptable limits

3. Identification of any planned test objective or requirement for which actual results were not obtained. Reasons for not meeting the objective/requirement shall be stated.

4. Identification of any false or aberrant results noted during the test or subsequent analyses. Note that any such behavior that can prevent the sensor from accomplishing its mission objectives can be a basis for rejection.

e. Recommendations for subsequent actions shall be stated, based on the test results, to include:

1. Redesign of a particular component to enable the sensor to meet a specific requirement which was not fulfilled

2. Revision of a development or the system / subsystem specification in cases where the test results disclose ambiguity or conflicting requirements

3. The conduct of additional tests to fulfill objectives for which results were not acceptable.

4. Test Plan and Procedure Changes – Any deviations from the approved test plans or procedures that were followed during the official conduct of the test shall be documented as revision pages to the affected documents and shall be appended to the report. Acceptance of the report shall also constitute acceptance of the appended changes.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
IT-6	END-TO-END TEST DOCUMENTATION

3. Reference:

SOW 6.1

4. Use:

The test plan purpose is to coordinate planning of a photons-in-at-Space Segment through image-out-at-Ground Segment functional end-to-end test(s). Since this test involves Government assets, close coordination between the Contractor and the Government is crucial to the success of this test. The report documents the results of the test(s) and any follow-up actions required.

5. Preparation Information:

There are two deliverables in this DID: an end-to-end test plan and an end-to-end test report.

A. The Test Plan shall define the following items at a minimum:

1. Objectives/goals of the test(s)
   - Interfaces to be tested
2. Resources required: both Contractor and Government
   - Personnel
   - Hardware, Flight and Support
   - Software
   - Simulators
3. Configuration of resources
4. Required interfaces and configuration
5. Schedule and durations
6. List of required procedures
7. Any simulated inputs or interfaces and rational for using simulated data or inputs
8. Input to be transmitted (i.e., what is the sensor(s) taking an image of?)
9. Expected output at the Ground System

B. The Test Report shall contain the following at a minimum:

1. Results of the test
2. Corrective actions to be made as a result of the test(s)

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: IT-7

2. Title: OBSERVATORY INTEGRATION AND TEST PLAN

3. Reference:

SOW 4.2.3.

4. Use:

To provide information on the integration and testing of the Observatory. The Observatory I&T plan addresses integration of the Sensor(s) and Observatory subsystems onto the Spacecraft and the subsequent testing of the integrated Observatory.

5. Preparation Information:

The contractor shall provide an Observatory Integration and Test Plan which describes the series of activities required to integrate the various Observatory subsystems and Sensor(s) into the final flight configuration. It also includes the activities required to test this configuration to verify its readiness for flight and mission operations.

At a minimum, the plans shall contain the following information:

a. Deliverables to Observatory Integration and Test
b. Flow of Observatory Integration and Test sequence, including calibration
c. Observatory level requirements to be verified, cross referenced to the Observatory portion of the System Performance Verification Plan
d. Description of each Observatory activity or test including the test configuration
e. Description of Observatory procedures required to support the activity or test
f. Description of Observatory special handling requirements to support the activity or test
g. Description of Observatory ground support equipment requirements to support the activity or test
h. Description of Observatory safety requirements to support the activity or test
i. Description of Observatory personnel required to support the activity or test
j. Requirement to take photographs during the integration process for reference
k. Description of the process to be used for handling anomalies as they occur during I&T
l. Requirement of log books to be maintained throughout the I&T process
m. Description and flow of Observatory activities performed during the launch campaign

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
IT-8	OBSERVATORY TEST PLANS

3. Reference:

SOW 4.2.3.

4. Use:

To provide information on how the observatory will be tested and how its performance will be verified.

5. Preparation Information:

The contractor shall provide detailed test plans to be used during Observatory Level 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 tests, 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 Observatory test operations, interfaces, and Observatory performance requirements (i.e., electrical, structural and mechanical, EMC), and shall cover specialized tests such as mechanical function and deployments, environmental exposure tests (i.e., vacuum, vibration), Observatory 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 Observatory Configuration, including any differences from flight configuration
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.

n. Data Recording Requirements
o. Data Recording Forms and Tables
p. Accept/Reject Criteria
q. Note any test phases and profiles
r. List the requirements for the test procedure and test report development
s. Description of any necessary functional operations required during the test (ie. a CPT performed at hot and cold during thermal vacuum testing)

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: 2. Title:

IT-9 OBSERVATORY TEST REPORTS

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3. Reference:

SOW 4.2.3

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4. Use:

To provide Observatory test results of the tests called out in the Observatory Test Plan, including test procedures, test results and test configuration.

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5. Preparation Information:

The Contractor shall provide test reports that summarize the results of verification tests on the Observatory. The following shall be included in test reports:

a. Test identification and hardware configuration – for specific test
b. Facility description
c. Reference - applicable test plan, test procedures, and test requirements, test log including the dates of the testing, photographs of test setup, any malfunction reports written during the test
d. Test results, to include:

1. Identification of test results which confirmed the expected results as specified in the test plan / procedures or for which variations between actual and expected results were within specified tolerance. For the latter case, actual test results shall be shown.

2. Identification of test results which differ from expected results beyond expected or acceptable limits

3. Identification of any planned test objective or requirement for which actual results were not obtained. Reasons for not meeting the objective/requirement shall be stated.

4. Identification of any false or aberrant results noted during the test or subsequent analyses. Note that any such behavior that can prevent the Observatory from accomplishing its mission objectives can be a basis for rejection.

e. Recommendations for subsequent actions shall be stated, based on the test results, to include:

1. Redesign of a particular component to enable the Observatory to meet a specific requirement which was not fulfilled

2. Revision of a development or the system / subsystem specification in cases where the test results disclose ambiguity or conflicting requirements

3. The conduct of additional tests to fulfill objectives for which results were not acceptable.

4. Test Plan and Procedure Changes – Any deviations from the approved test plans or procedures that were followed during the official conduct of the test shall be documented as revision pages to the affected documents and shall be appended to the report. Acceptance of the report shall also constitute acceptance of the appended changes.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
IT-10	PACKAGING, HANDLING, STORAGE, AND TRANSPORTATION (PHS&T) PLAN AND PROCEDURES

3. Reference:

SOW 4.3
MAR

4. Use:

Provide the instructions and procedures for safe and effective packaging, handling, storage, and transporting of flight hardware, spares, and associated GSE throughout the mission contract.

5. Preparation Information:

This documentation shall discuss the plan and all of the step-by-step procedures for the packaging, handling, storage, and transporting of the instrument, the spacecraft, spares, and GSE. The PHS&T Plan and Procedures shall contain separate sections for spacecraft and instrument subsystems and assemblies that require special handling, such as batteries and solar panels. This plan shall be prepared in accordance with the MAR.

The documentation shall include:

For Transporting:

A. Nomenclature of all supportive equipment
B. Calibration and load-tested data
C. Identification of special environmental conditions, such as cleanliness, temperature, humidity, etc., and the controls to be implemented to maintain those conditions
D. Format for recording QA stamp, deviations and approval columns
E. Requirements for special personnel, tools, equipment, special handling fixture and containers, including:
    a. Specific procedures for use of instrument protective covers.
F. Method of transportation and carrier
G. Cargo manifest including aircraft layout diagrams, if applicable

H. Ground and/or air shipment cargo loading and unloading procedures.

I. Staging area plans and diagrams.

J. Trip planning schedule of events, required support, route, contingency plans, permits.

K. Procedures to comply with local, state and federal safety requirements

L. Procedures for maintaining contact with the transported item.

For Storage:

The contractor shall provide a detailed plan for ground storage of the LDCM Observatory. The plan shall describe the following:

a. Preparation for storage.

b. Ground storage facilities.

c. Environmental control.

d. Monitoring of critical functions during storage.

e. GSE and testing requirements during storage.

f. Impact of prolonged storage on observatory operational lifetime including expendables.

g. Removal from storage, including retesting requirements.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: IT-11

2. Title: AS-RUN TEST PROCEDURES

3. Reference:

SOW 4.2

4. Use:

As an archive of test procedures used during system development to aid in on-orbit anomaly resolution.

5. Preparation Information:

As-Run Test Procedures shall be a collection of all as-run, red-lined, contractor-format test procedures used during LDCM development, integration, and test. The test procedures shall be grouped into Sensor, Spacecraft, Observatory, Mission Operations Element, and On-Orbit procedures and placed on compact discs for delivery to the Government Contracting Officer.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
IT-12	OBSERVATORY SIMULATOR INTEGRATION AND TEST PLAN

3. Reference:

SOW 4.7.1

4. Use:

The Observatory Simulator Integration and Test Plan describes integration activities planned for the Observatory Simulator Subsystem.

5. Preparation Information:

The Observatory Simulator Integration and Test Plan shall describe the integration test activities associated with the Observatory Simulator 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.

The Observatory Simulator Integration and Test Plan lists and describes the utilities and tools needed or recommended to setup the environment, load the database, convert output data into readable reports, generate test data, etc.

The Observatory Simulator Integration and Test Plan shall list the test cases to be run on each executable in the subsystem.

The Observatory Simulator Integration and Test Plan shall 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.

The Observatory Simulator Integration Test Plan shall indicate the name and location of output files used to verify the outcome of each test case.

The Observatory Simulator Integration and Test Plan shall indicate any and all errors/defects found in the course of running each test case.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
IT-13	OBSERVATORY SIMULATOR SOFTWARE TEST REPORTS

3. Reference:

SOW 4.7.1

4. Use:

Provide summary of the software acceptance testing and/or retesting activities

5. Preparation Information:

These reports shall be developed for each test described in the Software Test Plan and shall include the following, as a minimum:

1. Version number of software tested
2. Identity and number of planned tests that have been completed
3. Conformance of test results to expected results
4. Number, type, and criticality of discrepancies
5. Identification of software areas tested
6. Analysis of any performance requirements that the tested software could affect
7. Test result summary

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
IT-14	RF COMPATIBILITY TEST DOCUMENTATION

3. Reference:

SOW 6.2

4. Use:

The test plan purpose is to coordinate planning of the RF compatibility of the LDCM Observatory and the Landsat Ground Network and the Space Network. Since this test involves Government assets, close coordination between the Contractor and the Government is crucial to the success of this test. The report documents the results of the test(s) and any follow-up actions required.

5. Preparation Information:

There are two deliverables in this DID: an end-to-end test plan and an end-to-end test report.

A. The Test Plan shall define the following items at a minimum:

1. Objectives/goals of the test(s)
   - Interfaces to be tested
2. Resources required: both Contractor and Government
   - Personnel
   - Hardware, Flight and Support
   - Software
   - Simulators
3. Configuration of resources
4. Required interfaces and configuration
5. Schedule and durations
6. List of required procedures
7. Any simulated inputs or interfaces and rational for using simulated data or inputs
8. Transmitter/Receiver Configurations

B. The Test Report shall contain the following at a minimum:

1. Results of the test
2. Corrective actions to be made as a result of the test(s)

CALIBRATION/VALIDATION DIDS

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: CV-1

2. Title: CALIBRATION/VALIDATION PLAN

3. Reference:

SOW 2.3
SOW 4.2.2.1

4. Use:

Controlling document for definition of calibration methods and equipment.

5. Preparation Information:

The Contractor shall provide a Calibration/Validation Plan that describes the approach for characterizing the spectral, spatial, radiometric, geometric, and attitude control performance of the LDCM Observatory, ensuring that the LDCM Observatory and LDCM data satisfy the LDCM Space Segment Requirements Document. The Calibration/Validation Plan shall include the requirements of the Special Calibration Test Requirements (SCTR) document.

The Calibration/Validation Plan shall incorporate the following information at a minimum:

A. A description of planned tests and analyses including:
   (a) what is being tested or analyzed and how it relates to instrument and/or Observatory performance
   (b) the expected test or analysis results
   (c) integration level for test or analysis model, i.e. part, subassembly, assembly, instrument, spacecraft
   (d) environmental conditions for test, e.g. ambient, thermal-vacuum, on-orbit
   (e) sampling methods and their statistical validity
   (f) operational phase of testing, i.e. pre-launch, or commissioning
   (g) theoretical basis for the test or analysis (how the test is performed, how the data are reduced and why it is done this way-equations and physics)
   (h) the resolution, precision and accuracy of the results and relation to the expected results
   (i) test equipment, test equipment calibration, and test setup
   (j) description of test or analysis results usage, i.e. processing algorithms that use test or analysis results or calibration parameters generated by the test or analysis
B. A test and analysis schedule and flow chart

C. How test/analysis results are made available
D. Government access and participation in pre-launch testing including a Government-owned transfer radiometer/Earth Observing System (EOS) radiometric scale realization activities and any government diffuser BRDF characterization activities
E. Description of COTS and custom analysis tools
F. A description of the On-Orbit Calibration capabilities of the LDCM sensors (including attitude sensors), their design, how they are characterized, and how they are used
G. Reference Standards and their calibration traceability
H. Support data requirements, e.g. GCP, DEM, reference images

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: CV-2

2. Title: CALIBRATION/VALIDATION PROCEDURES

3. Reference:

SOW 4.2.2.1

4. Use: To verify that the planned procedures meet the goals of the Calibration/Validation Plan.

5. Preparation Information:

1. For each test in the Calibration/Validation Plan, a Calibration/Validation procedure for each test shall include:

a. Test Objectives
b. Test Methods
c. Assumptions
d. Applicable Documents and Software
e. Associated algorithms
f. Required Sensor Configuration, including any differences from flight configuration
g. Mechanical and Electrical 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
h. Test Equipment Identification
i. Test Instrumentation
j. Calibration reference requirements
k. Safety Provisions and Cautions, including Identification of hazardous and potentially hazardous situations and operations and abort conditions
l. Environmental and/or other conditions to be maintained, including contamination controls
m. Responsibilities and chain-of-command for test performance
n. Expected results in telemetry and associated caution and warning levels.
o. Program Quality Requirements
p. Stimuli and stimuli levels
q. Durations
r. Configurations
s. Sequence of events
t. Trending of performance characteristics during verification testing
u. Step-by-step instructions
v. Data Recording/Output Format Requirements

w. Data Recording Forms and Tables
x. Analysis techniques
y. Expected results
z. Pass/Fail Criteria
aa. Test Termination Procedure

2. For each Analysis in the Calibration/Validation Plan, the procedure for each Analysis shall include:

a. Analysis Objectives i.e the short description of the item or items being validated by this analysis.
b. Analysis Methods including the analysis level of depth (i.e. 1st order, 2nd order, etc…)
c. Assumptions
d. Applicable Documents and Software
e. Associated algorithms and software tools.
f. Required analysis mode/model configuration(s).
g. List of input data that will be used and related tests ID that were used to acquire the data.
h. List of external reference sources input data/model used in analysis (e.g. DEM, SOLAR spectral radiance model)
i. List of fixed analysis parameters and set points.
j. List of adjustable analysis parameters and set points that may vary between runs.
k. Equipment requirement
l. Program Quality Requirements
m. Sequence of events
n. Step-by-step description of the data analysis procedure/algorithm
o. Description of any statistical sampling method being used
p. Data Recording/Output Format Requirements
q. Data Recording Forms and Tables
r. Expected results
s. Pass/Fail Criteria

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: CV-3

2. Title: CALIBRATION/VALIDATION REPORT

3. Reference:

SOW 4.2.2.1

4. Use: To provide results of calibration/validation tests and analyses for Government review.

5. Preparation Information:

The Contractor shall provide a Calibration/Validation Report for each calibration or validation test or analysis. All supporting data shall be provided in electronic format, where applicable.

The Calibration/Validation Reports shall include at a minimum:

A. Identification of article or component tested or being validated with date of test or related analysis and the relevant Test/Analysis ID and run number
B. Performance trends during and between each planned test
C. List of uncertainty levels for each input data in analysis or test measurements
D. If a given test or analysis have more than one configuration state the test or analysis configuration selected
E. Problems or failures with tests, procedures, or analyses
F. Anomalies and deviations from plans or procedures and their resolution/status
G. Test or analysis results, including:
   a. any calibration parameters to be used for on-orbit processing
   b. comparison of results with expectations and requirements
   c. interpretation of the results

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
CV-4	CALIBRATION/VALIDATION SUMMARY REPORT

3. Reference:

SOW 4.2.2.1

4. Use: These reports shall be designed to serve as instrument calibration references for current and future users of the LDCM data set.

5. Preparation Information:

The Contractor shall provide a Calibration/Validation Summary Report in two phases. The Pre-Ship report shall describe the pre-ship calibration process and results. The Post-Launch Report shall describe the calibration process and results from the commissioning phase. Each shall document the state of the instrument calibration relative to the Space Segment Requirements Document. The reports shall include details of any anomalies affecting the data, descriptions of the instrument calibration and characterization tests, references to previous test reports and analyses, and long term trending results. The Post-Launch Report shall include any changes made to the calibration parameters and algorithms during the Commissioning period and the justification for these changes.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
CV-5	RADIOMETRIC MATH MODEL

3. Reference:

SOW 4.1.1.2

4. Use:

For evaluating the end-to-end radiometric performance of the instrument; for allocation of error budget, etc.

5. Preparation Information:

A. The Radiometric Math Model shall be used to: evaluate the end-to-end radiometric performance of the Sensor (Photons to Calibrated at-sensor-radiance); conduct sensitivity analyses; determine absolute and relative calibration accuracies; identify error contributors which can be eliminated or mitigated during the design phase; identify impact of error budget trades; assess instrument performance in terms of Signal to Noise Ratio (SNR), Noise Equivalent Radiance (NEΔL), stability in orbit, etc.

B. The model shall incorporate actual test and calibration data; the model shall be updated and refined during the course of the Sensor development program until it simulates instrument performance within the accuracy required by the specifications. Detector performance predictions/margins shall be modeled at the detector/FPA level and compared against detector performance during detector/FPA development.

C. Also to be included in the model are on-board and preflight ground laboratory calibration algorithms and a data book that contains all pertinent estimated measured data required by the calibration algorithms. The estimated data shall be replaced with measured data when it is available. The on-board calibration algorithms are used along with ground calibration data to demonstrate that the absolute and relative radiometric accuracies are being met. The calibration data shall also be provided in a mutually agreed upon electronic format.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
CV-6	OPTICAL ANALYTICAL MODEL

3. Reference:

SOW 4.1.1.4

4. Use:

For evaluating the end-to-end geometric and spatial performance of the instrument, allocation of error budgets, and to provide a framework for thermal and mechanical sensitivity analyses.

5. Preparation Information:

1) Component Models
   a) Focal Plane Model

      Describe the size, shape, and placement of the detectors on the focal plane, including how the detectors are grouped by band and, if applicable, sensor chip assembly. Describe how detector focal plane location can be determined as a function of detector number, chip number, and band number. Show how the detector layout and sampling combine to provide complete coverage of the ground target area. Present a model of detector spatial response (ground sampling footprint) that includes the effects of detector size, shape, detector spatial responsivity, and integration time.

   b) Optical Model

      Describe the key parameters of the optical system such as Cardinal Points, FOV, and 5th order aberrations modeling, in a static nominal setting. Define the optical axes of the system and present a geometrical model of the optics that shows how locations in the instrument focal plane are mapped to directions relative to the optical axes. Present a model of the spatial response of the optical system (i.e., MTF). Provide a tolerance analysis that quantifies the effects of physical shifts of any static or dynamic components in the optical system, and physical differences in fabricated components from design requirements (i.e. radius of curve, index, coating quality, centeration, polished surface finish) on the geometrical and spatial models.

   c) Mechanism Models

      Geometrically characterize and model any dynamically moving part/s in the optical system such as a scanning/pointing mechanism, and/or a yaw steering table/mirror showing how any telemetry characterizing the operation of each mechanism is used to determine its effect upon the imaging geometry. Include an analysis of the effects of mechanical jitter documented in the Jitter Analysis Report (CV-X) on the instrument line of sight including a description of any methods used to compensate for jitter using

vibration sensors and ground processing.

2) Dynamic Models

a) Thermal Sensitivity Model

Use the results of the instrument thermal model to analyze the expected variations in the component models with temperature.

b) Vibration Sensitivity Model

Analyze the sensitivity of the component models to vibration and use the results of the instrument structural model to predict the expected variations in the component models in the operational vibration environment.

3) Performance Models

a) Spatial Performance

Combine the component and dynamic models to construct an integrated model of end-to-end spatial response that can be used to analyze and predict instrument edge response performance. Include the effects of jitter and orbital and seasonal thermal variations in the results of the model.

b) Geometric Performance

Combine the component and dynamic models to construct an integrated instrument geometrical line of sight model that can be used to analyze and predict line of sight knowledge and stability performance. Include the effects of jitter and orbital and seasonal thermal variations in the results of the model.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
CV-7	CALIBRATION ALGORITHMS AND PARAMETERS

3. Reference:

SOW 4.1.1.1

4. Use:

Algorithms for determination of instrument calibration from pre-launch and on-board calibration devices and pre-launch calibration parameters are required for image processing

5. Preparation Information:

Required algorithms:

A. For processing of solar diffuser data to absolute calibration coefficients
B. For determination of each detectors dark response during earth image acquisition based on the dark pixels and dark data acquired before and after the earth acquisition.
C. For determination of detector response based on the internal lamp system
D. For determination of radiometric stability through launch using the transfer to orbit on-board calibration devices
E. For usage of any other calibration devices
F. For computing a line of sight relative to the instrument optical axes for each detector on the focal plane.
G. For transforming detector lines of sight relative to the instrument optical axes to lines of sight relative to an absolute Earth-referenced coordinate system, using data from Observatory attitude sensors, and/or jitter sensors, as required.
H. Algorithm for characterization of the instrument response linearity on-orbit with the related on-board calibration device(s).

This algorithm delivery set shall consist of

a. An overview of each algorithm including the objective or purpose of the algorithm
b. A description of each algorithm inputs and outputs
c. A mathematical description of each algorithm
d. The algorithm executable source code and identification of the Operating System that the source code was built on.
e. A description of the methods used to validate each algorithm and the validation results

f. A list of the instrument data components used by each algorithm

Required Calibration parameters:

A. Pre-ship detector by detector absolute gains that meet the detector to detector uniformity and absolute accuracy requirements
B. Pre-ship detector-by-detector dark responses (biases)
C. Coefficients characterizing detector gain and bias sensitivity to temperature
D. List of dead, inoperable and out-of-spec detectors (Detector Operability Status list)
E. Line of sight angles and/or apparent (i.e., including the effects of optical distortion) detector locations relative to the optical axes for each detector on the focal plane.
F. Orientation/alignment matrix relating Observatory attitude and/or jitter sensors to the optical axes.
G. Scaling coefficients that convert jitter sensor counts to angular displacement.
H. Transfer functions describing the sensitivity of the jitter sensors to vibration as a function of frequency.
I. Scaling coefficients and/or alignment matrices that describe the orientation of the instrument optical axes relative to the instrument mounting surface.
J. For calibrating the output of any attitude and/or jitter sensors.
K. Any additional calibration parameters required to run the formulated radiometry calibration algorithms not captured in this original list.

Delivery of Calibration parameters shall include a description of the parameter being delivered and any information necessary to interpret the delivery.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
CV-8	DATA PROCESSING ALGORITHMS

3. Reference:

SOW 4.1.1.3
SOW 4.1.1.8

4. Use:

The Data Processing algorithms will be used to estimate and correct systematic errors in the LDCM data and to correct residual errors in the LDCM data so that the resulting corrected LDCM data meet the imagery requirements of Space Segment Requirements Document sections 6 and 7.

5. Preparation Information:

A separate delivery shall be provided for each of the algorithms described in the Space Segment Requirements Document. The algorithms to be provided are:

1. Radiometric correction Algorithms
    a. Detector Bias Determination
    b. Conversion to Radiance
    c. Conversion to Reflectance
    d. Inoperable Pixel Replacement
2. Geometric Correction Algorithms:
    a. Ancillary Data Preprocessing
    b. Line-of-Sight (LOS) Model Creation
    c. Line-of-Sight Projection
    d. Line-of-Sight Model Correction
3. Image Resampling Algorithm

Algorithm restrictions provided in the Space Segment Requirements Document shall be adhered to.

Each delivery shall consist of

a. An overview of the algorithm including the objective or purpose of the algorithm
b. The rationale for the algorithms and the specifications it supports

c. A description of any external ancillary data (i.e. from the spacecraft) used by the algorithm
d. A description of the algorithm outputs
e. A mathematical description of the algorithm
f. The algorithm executable source code and identification of the Operating System that the source code was built on.
g. An error analysis showing the expected accuracy of the algorithm results
h. A description of the methods used to validate the algorithm and the validation results
i. A list of the instrument data components used by the algorithm
j. A list of the calibration parameters used by the algorithm
k. A list of references

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
CV-9	RELATIVE SPECTRAL RESPONSE (RSR) COMPONENT MEASUREMENTS AND SYSTEM RSR ANALYSIS

3. Reference:

SOW 4.2.2.1

4. Use: To provide the measurements of relative spectral response of sensor components and the estimated system RSR.

5. Preparation Information:
The Contractor shall provide the relative spectral response (RSR) measurements used to estimate sensor relative spectral response. The provided component RSR measurements shall include:

a. the telescope optical elements
b. all spectral filters
c. a sample of detectors in each band
d. any other optical elements that contribute to the sensor RSR

The provided component data shall include:

a. The description of method used to obtain data including any sampling scheme used in obtaining the calibration data (the method description should include a statement about the traceability of the data to a standard reference or standard laboratory calibration results)
b. The calibration data of the instrument(s) used to measure the RSR or a statement of the status of the calibration of the instrument(s) used to measure the RSR.
c. The wavelength sampling used to obtain the data.
d. The environmental conditions such as temperature/humidity, the optical/geometrical set up such as the incidence angle, and f/# (the ratio of focal length to entrance pupil diameter) at which the RSR of spectral filter data, and any other related transmissive elements in the system optical path, at which the data was measured and how the data was adjusted (if applicable) to account for operational temperatures, incident angle, and f/#.
e. A description of any other adjustments to the data.
f. An estimate of the accuracy of the measured data, including added RSR variations due to the method used for collecting the response data; for example, short circuit currents vs. DN obtained directly from FPA electronics.

The system RSR estimate shall include:

a. The methodology used to convolve the component measurements to estimate the system RSR.
b. A spreadsheet of the estimated RSR of each spectral band which contains the convolution of the component-level RSRs and any adjustments made to the data.
c. An accuracy estimate of the RSR in each band and the basis of the estimate, which shall include a discussion of the entire range of expected on-orbit operations conditions including the variation the in total power levels illuminating the detectors.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
CV-10	SENSOR DATA SETS

3. Reference:

SOW 4.2.2

4. Use: To provide LDCM sensor data sets for use in LDCM Ground Segment testing.

5. Preparation Information:

During Sensor Thermal Vacuum Testing, data sets shall be generated and recorded for use by the Government. These data sets shall consist of:

(TBD)

These data sets shall be in the following format/media:

(TBD)

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: CV-11

2. Title: JITTER ANALYSIS REPORT

3. Reference:

SOW 4.1.3

4. Use:

To show that the potential sources of mechanical disturbances from the spacecraft and sensor have been properly assessed and measured and that the resulting effects on the sensor line-of-sight stability have been analyzed to ensure that high frequency jitter will not unacceptably degrade spatial or geometric performance. This report will document the expected vibration environment used to predict system performance in the Optical Analytical Model (CV-6).

5. Preparation Information:

1) Jitter Sources
   a) Spacecraft Jitter Sources
      Identify the spacecraft mechanisms that are potential sources of jitter. This includes the solar array drive, reaction wheels, pointable antennae (if any), and other moving parts. Show the expected angular jitter and linear acceleration imparted at the sensor/spacecraft interface generated by each mechanism as a function of frequency, based on either component specifications or direct measurements, and mechanical analysis. Show the combined effects of all spacecraft jitter sources as integrated angular jitter and linear acceleration inputs in each axis at the spacecraft/sensor interface.
   b) Sensor Jitter
      Show the expected angular jitter and linear acceleration disturbances created by any sensor mechanisms or moving parts as a function of frequency, based on either component specifications or direct measurements, and mechanical analysis.
2) Line-of-Sight Jitter
   a) Line-of-Sight Sensitivity
      Provide an analysis of the combined effects of mechanical jitter from all spacecraft and sensor sources on the instrument line of sight. Include the effects of any jitter suppressing mounting fixtures.

SYSTEMS ENGINEERING DIDS

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: 2. Title:

SE-1 ECPS, DEVIATIONS, AND WAIVERS

3. Reference:

SOW 1.9
MAR

4. Use:

To facilitate the orderly processing of change requests to appropriate level of approval authority for disposition.

5. Preparation Information:

Consistent with the Contractor's Configuration Management Plan (CMP), the contractor shall prepare and submit Class I Engineering Change Proposals (ECPs). In addition to the change description, the ECP shall contain sufficient information in the form of attachments, drawings, test results, etc., to allow the Government to evaluate the total impact of the proposed change. The Government Contracting Officer may direct the contractor to prepare ECPs under the "Changes" clause of the contract. The contractor shall also submit Class II changes for Government review.

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

a. Affects any Government Contract specification or interface requirement.

b. Affects schedules of end item deliverables to the Government.

c. Impacts Government Furnished Equipment.

d. Affects configuration to the extent that changes would be required to prior deliverables in order to maintain specified performance.

A change may be classified Class II when it does not fall within the definition of a Class I change as given above. Examples of Class II changes are:

a. A change in documentation only (for example, correction of errors, addition or clarifying

notes or views).

b. A minor change in hardware (for example, substitution with an approved alternative material) which does not affect any item listed under Class I changes.

c. Drawing changes that do not affect a baseline, interface, etc.

Class II changes normally do not require Government CCB approval unless they are written against Government CM-controlled documents.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-2	CONTRACTOR - GENERATED INTERNAL TECHNICAL INFORMATION

3. Reference:

- SOW 1.5

4. Use:

To document technical information and decisions related to the LDCM program.

5. Preparation Information:

These memoranda shall preferably be in electronic format. Hand-drawn sketches may be used if they preserve timeliness.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-3	OBSERVATORY SIMULATOR USERS GUIDE

3. Reference:

SOW 4.7.

4. Use:

The Observatory Simulator User's Guide describes the operation of the Observatory Simulator for use by operators and the software maintenance team.

5. Preparation Information:

The Observatory Simulator User's Guide shall contain the information required to use the software, including detailed procedures and functionalities. It shall show a screen-shot of all Observatory Simulator Graphical User Interfaces (GUIs) and detail the usage of each GUI. It shall give detailed descriptions of major functionality provided by the Observatory Simulator, then give step-by-step instructions (with the use of the screen-shots) on how to use the Observatory Simulator to achieve these functionalities. The Observatory Simulator 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 role.

The Observatory Simulator User's Guide shall give a list of all alerts or notifications produced by the Observatory Simulator along with their meanings.

The Observatory Simulator User's Guide shall indicate how to start the simulator, including cold and warm starts if applicable.

The Observatory Simulator User's Guide shall indicate recovery methods in cases of irrevocable errors or faults.

The Observatory Simulator User's Guide shall indicate data types expected within each field of each GUI.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-4	TREND ANALYSIS AND OPERATIONS LOG

3. Reference:

SOW 2.5

4. Use:

Provides a list of critical engineering and performance parameters for the LDCM Space Segment and Mission Operations Element. Provides a log of Observatory subsystem operating hours. Starting at component acceptance testing and continuing during the system integration and test phases through the on-orbit commissioning phase, trend parameters are to be monitored for trends leading toward degradation of performance or reliability of the LDCM.

5. Preparation Information:

Trend List:
The list of parameters to be trended shall be subdivided by Observatory assembly or subassembly, including the imaging sensor(s) and the MOE. A brief rationale for including the parameter shall be included. The list shall be coordinated with the Government prior to implementation.

Trend Reports:
The trend data shall be graphed with clearly marked axes. The scale of the graphs shall be set such that trends can be clearly identified. The scale of each graph shall be tailored for each parameter for the best clarity. The scale of the graphs shall be readjusted with the range of the data in order to continue identification of trends.

Operations Log:
A log shall be maintained of the accumulated operating time of all Observatory subsystems. The log shall include the following information, as a minimum:

A. Identification of hardware item
B. Serial number
C. Total operating time since assembly as a unit
D. Total operating time since last failure
E. Total additional operating time projected for the unit prior to launch
F. Identification of key parameters being monitored
G. Upper/lower spec tolerance limit for each parameter being monitored
H. Observed value (in sequence) for the reporting interval

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: SE-5

2. Title: INTERFACE CONTROL DOCUMENTS

3. Reference:

SOW 2.2

4. Use:

Provides definition of interfaces between the Space Segment and all interfaces, and the Mission Operations Element and all interfaces. Permits coordination and definition of interfaces between Contractor –developed assets and Government assets.

5. Preparation Information:

TBD

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: SE-6

2. Title: THERMAL MATH MODEL

3. Reference:

SOW 4.1.1.7

4. Use:

To design and evaluate the thermal performance of the instrument, define the thermal control system requirements (heater power, thermometry, etc.) and to define the thermal loads at the instrument/spacecraft interface.

5. Preparation Information:

The model shall be composed of at least 250 nodes. The Thermal Math Model shall have sufficient detail of all subsystems and critical interfaces to accurately predict absolute interfaces. These models shall be verified and refined after comparison with thermal test data.

The Contractor shall also develop reduced thermal models in accordance with (TBD).

SINDA+TSS compatible or Thermal Desktop-compatible and TRASYS-compatible reduced node versions of the full instrument thermal math model, appropriately documented, are required for analytical integration with the spacecraft. A user's guide shall be provided for deliverable math models. The thermal model table of delivery shall be included in the user's guide.

A thermal model between the science instrument(s) and the attitude control system hardware shall also be provided.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-7	WIRING DIAGRAMS

3. Reference:

SOW 2.3

4. Use:

For definition of all wire flows of the Observatory (including both the bus and the Sensor(s) electronics.

5. Preparation Information:

These wiring diagrams shall cover the system, subsystem, component electronics and GSE. It shall identify each wire by its classification:

- Ground
- Signal
- Power
- Wire type
- Connector

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

Preliminary wiring diagrams are due prior to harness fabrication.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-8	ENGINEERING DRAWINGS AND CHANGE NOTICES

3. Reference:

SOW 1.9

4. Use:

To provide layouts and engineering drawings to serve as the basis for technical discussions, evaluations, operations and maintenance.

5. 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 spacecraft and sensor 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.

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 in the contractor's format.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: SE-9

2. Title: SYSTEM PERFORMANCE VERIFICATION PLAN

3. Reference:

SOW 2.3
SOW 4.2

4. Use:

Provides the overall approach for accomplishing the verification program. Defines the specific tests, analyses, calibrations, alignments, hardware models, etc. that will demonstrate that the flight hardware complies with the mission requirements.

5. Preparation Information:

The System Performance Verification Plan (SPVP) shall:

A. Provide an overview of the entire LDCM verification program, including spacecraft, sensors, the Observatory, the subsystems of the Mission Operations Element (MOE), the integrated MOE and the entire LDCM system.
B. Flow requirements for environmental testing into all levels of assembly and describe the verification method for these tests. Include the following environmental test information:

1. Standard conditions for all test areas (temp., humidity, cleanliness)
2. Qualification and acceptance test temperatures (incl. uncertainties)
3. Shock test requirements
4. Radiation levels
5. Acoustic excitation levels
6. Qualification and acceptance vibration test levels
7. Electromagnetic test levels
8. Thermal and thermal vacuum test profiles for all components.

C. Flow performance requirements to all levels of assembly and describe the verification method for these tests.

The SPVP describes the approach (test, analysis, etc.) that will be utilized to verify that the hardware/software complies with mission requirements. If verification relies on tests or analyses at other levels of assembly, describe the relationships. The System Performance Verification Plan will include a section describing the environmental verification program and details the specific

environmental parameters used in each test or analysis. Payload peculiarities and interactions with the launch vehicle will be considered when defining quantitative environmental parameters under which the hardware elements must meet their performance requirements.

This Plan includes level of assembly, configuration of item, objectives, facilities, instrumentation, safety considerations, contamination control, test phases and profiles, appropriate functional operations, personnel responsibilities, and requirements for procedures and reports. For each analysis activity, include objectives, a description of the mathematical model, assumptions on which the model will be based, required output, criteria for assessing the acceptability of the results, interaction with related test activity, and requirements for reports.

The Plan describes an operational methodology for controlling, documenting, and approving activities not part of an approved procedure. It also includes controls that prevent accidents that could damage or contaminate hardware or facilities, or cause personal injury. Include a test matrix that summarizes all tests to be performed on each component, each subsystem, the integrated sensor, the integrated spacecraft bus, the integrated Observatory, and the Real-Time Operations System. Include tests on the Structural Thermal Model and Engineering Demonstration Unit performed to satisfy qualification requirements. Include tests and checkouts to be conducted at the observatory level, the launch base, and on-orbit. On-orbit tests shall be cross-referenced to the On-Orbit Commissioning Plan.

The SPVP shall incorporate the requirements of the MAR.

The Final SPVP due 15 days prior to PER shall incorporate all review comments.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: SE-10

2. Title: VERIFICATION REPORTS

3. Reference:

MAR
SOW 4.2

4. Use:

Provide summary of each integration and test result, conformance, non-conformance, and trend data. A Verification Report for all verification types indicated in the System Performance Verification Plan (Test, Analysis, Inspection, Demonstration) shall be generated.

5. Preparation Information:

Verification reports are required for all integration and test and environmental test activities commencing at component level testing through testing at the integrated Observatory level. Contents of these reports shall include, as a minimum:

A. Summary of the test results of each activity and an assessment of the quality and acceptability of the item tested, including pass/fail criteria and performance against the criteria.

B. Summary of non-conformances occurring during the test and their resolution and corrective actions taken

C. Trends in the performance of critical components

D. Actual sequence of these operations including dates and times

E. For thermal testing, tabulation of test target temperatures and actual test temperatures for all equipment and components

F. For thermal balance testing, a tabulation of test prediction and actual temperatures and a tabulation of other pertinent targeted parameters vs. their actual test values, such as heater powers, heater place temperatures, solar intensity, etc.

G. Across-reference to the test procedure number(s) or analysis used in the verification.

Contractor format may be used for these reports as long as the required information is included.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: SE-11

2. Title: CONFIGURATION ITEM IDENTIFICATION LIST

3. Reference:

SOW 1.9

4. Use:

To establish a structure for controlling the configuration of the LDCM Observatory and ground segment by identifying all Configuration Items (CIs) and Computer Software Configuration Items (CSCIs) used on the program and correlating those CIs/CSCIs to their Specification and test requirements documents.

5. Preparation Information:

The Configuration Item Identification List (CIIL) identifies all CIs and CSCIs. This CIIL shall conform to the following:

a. The CIIL shall be organized and broken down as follows:
   1) All system level CIs and CSCIs.
   2) All subsystem level CIs and all CIs/CSCIs within each subsystem.

b. For each CI listed, the following information shall be provided:
   1) Assigned CI Number.
   2) The CI top drawing number.
   3) The CI nomenclature.
   4) The applicable specification number. For those CIs not governed by a specification, the word "NONE" shall be entered in this column.
   5) Acceptance test procedure number and, if qualification tested, the qualification test procedure number. If the CI is neither acceptance nor qualification tested, the functional test procedure number should be entered in this column.

c. For each CSCI listed the following information shall be provided:
   1) Assigned CI Number.
   2) The CI nomenclature.
   3) The applicable specification number. For those CIs not governed by a specification, the word "NONE" shall be entered in this column.
   4) Acceptance test procedure number and, if qualification tested, the qualification test procedure number. If the CI is neither acceptance nor qualification tested, the functional test procedure number should be entered in this column.

d. This list shall be prepared in the contractor's format.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-12	SPACE SEGMENT DESIGN SPECIFICATION

3. Reference:

SOW 4.1
SOW 9.1

4. Use:

In order to assure that the contractor is performing in accordance with the LDCM Space Segment Requirements Document, the contractor shall provide a Space Segment design specification that will be used by the contractor to direct the development of the entire Space Segment.

5. Preparation Information:

The Space Segment Design Specification shall delineate the design for the LDCM Space Segment. It shall establish the top-level design and interface specification(s) placed on the Space Segment in response to the LDCM Space Segment Requirements Document and the Interface Requirements Document.

The lower level System and Subsystem level specifications shall be directed and controlled by the Space Segment Design Specification. This specification shall divide and allocate the design responsibilities and interfaces between all of the elements of the Space Segment.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-13	SPACECRAFT DESIGN SPECIFICATION

3. Reference:

SOW 4.1

4. Use:

To ensure that the spacecraft design requirements flow correctly from the Space Segment Design Specification.

5. Preparation Information:

The Spacecraft Design Specification shall delineate the design for the LDCM Spacecraft. It shall establish the top-level design and interface specification(s) placed on the spacecraft that flows from the Space Segment Design Specification.

The lower level spacecraft subsystem level specifications shall be directed and controlled by the Spacecraft Specification. This specification shall divide and allocate the design responsibilities and interfaces between all of the elements of the spacecraft.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-14	SENSOR DESIGN SPECIFICATION

3. Reference:

SOW 4.1
SOW 9.1

4. Use:

To ensure that the sensor design requirements flow correctly from the Space Segment Design Specification.

5. Preparation Information:

The Sensor Design Specification shall delineate the design for the LDCM Sensor. It shall establish the top-level design and interface specification(s) placed on the sensor that flows from the Space Segment Design Specification.

The lower level sensor subsystem level specifications shall be directed and controlled by the Sensor Specification. This specification shall divide and allocate the design responsibilities and interfaces between all of the elements of the sensor.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-15	FOCAL PLANE ARRAY PLANNING DOCUMENTATION

3. Reference:

SOW 4.2.2

4. Use:

To provide insight into the focal plane array (FPA) design and development.

5. Preparation Information:

Delivered FPA documentation shall consist of:

1. FPA delivery schedule
   - at a minimum, include start times and durations of design effort, manufacturing effort, Engineering Model effort, qualification, and testing
2. Manufacturing plan
   - at a minimum, include processes to be used and their heritage, parts to be manufactured or purchased, number of lots to be processed, parts assembly plan and procedure
3. Qualification plan
   - at a minimum, include criteria for screening candidate chip assemblies, number of qualification test units, environmental testing criteria, pull test criteria, electrical test criteria, and accept/reject criteria for all qualification tests
4. Test plan
   a. What is to be tested, what tests are to be run, at what stage, and to what level.
   b. Test objectives
   c. Test Methods
   d. Required configuration for each test
   e. Test Equipment
   f. Test Instrumentation
   g. Environmental and/or other conditions to be maintained, including contamination controls
   h. Expected results
   i. Test analysis method(s)
   j. Accept/Reject Criteria
   k. Test Termination Procedure
   l. data archival location

5. Qualification procedures
   - At a minimum, include nature of qualification units, qual tests, qual levels, and pass/fail criteria.
6. Test procedures
   - At a minimum include test set-up and validation, test sequence, test data format, test criteria, pass/fail criteria, raw data storage

7. FPA acceptance test results
   - At a minimum, include FPA performance requirements versus recorded FPA performance prior to acceptance of each FPA deliverable from the FPA vendor.

8. FPA design specification

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-16	LAUNCH-TO-ORBIT MISSION ANALYSIS

3. Reference:

SOW 2.1

4. Use:

Provide all mission parameters to assure that the Observatory will be placed in the required orbit, with acceptable launch constraints.

5. Preparation Information:

This document shall provide the analyses performed to ensure that the required orbit parameters are achieved. This shall include satellite mass properties, propellant load, and propellant margins for orbit insertion and station keeping. The orbital elements and accuracy needed to achieve the required orbit shall be discussed.

These analyses shall include all flight constraints, constellation phasing requirements, collision avoidance considerations during launch and final mission orbit trims, and time to achieve mission orbit vs. launch days. Time constraints caused by ground station coverage shall be defined. Ground station support requirements are to be detailed.

Pre-launch and launch environment constraints are to be presented.

These analyses shall include all flight constraints, pre-launch and launch environment constraints including:

- o Pre-launch environmental controls at the launch site
- o Launch constraints including windows
- o Launch vehicle environment restrictions
- o Launch vehicle performance through separation
- o Spacecraft propulsion requirements
- o All TT&C or other monitoring required from launch to orbital injection
- o Observatory thermal requirements/constraints

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-17	SPECIFICATION TREE

3. Reference:

SOW 2.3

4. Use:

To provide a reference for contractor's specification breakout.

5. Preparation Information:

The specification tree shall document the breakout of the contractor's specifications starting at the top-level LDCM Space Segment Design Specification and the Mission Operations Element Design Specification, showing all lower-level specifications to the sub-assembly (box/board) level, and indicating the relationships and interfaces between the documents.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-18	LDCM SPACE SEGMENT TO INTERNATIONAL COOPERATORS INTERFACE CONTROL DOCUMENT

3. Reference:

SOW 4.1.3

4. Use:

To establish interface requirements between the LDCM Space Segment and International Cooperators' ground assets.

5. Preparation Information:

This document shall provide detailed information regarding the interface of the LDCM Space Segment to International Cooperators. The interface control document shall include, but not be limited to, the following information:

a. Communications protocols, data rates.
b. Data format, to include: detailed bit definitions, command, meta and ancillary data definitions for all telemetry and command data, detailed data format and content of the specific sensor data and ancillary data files as stored on the flight data recorder and specific detailed data formats and outputs of the flight data recorder for sensor and ancillary data transferred via the sensor real-time downlink interfaces.
c. Compression algorithms, error detection and correction schemes.
d. Antenna patterns, EIRP, G/T, beam width, uplink/downlink, frequencies, polarizations and modulations for each channel.
e. Telemetry formats.
f. Satellite contact scenarios for data transmission, operations, and maintenance.
g. Link analysis for available ground station antennas.
h. Interface requirements for RF compatibility test.
i. Interface requirements for End-to-End test.
i. Description of Observatory operating modes and command events.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: 2. Title:

SE-19 LDCM SPACE SEGMENT TO GOVERNMENT ASSETS INTERFACE CONTROL DOCUMENT

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3. Reference:

SOW 4.1.3

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4. Use:

To establish interface requirements between the LDCM Space Segment and Mission Operations Element and Government-provided ground assets.

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5. Preparation Information:

This document shall provide detailed information regarding the interface of the LDCM Space Segment and the LDCM Mission Operations Element to all external interfaces. The Government will provide input, and will provide requirements for, the interfaces to Government systems. The interface control document shall include, but not be limited to, the following information:

a. Communications protocols, data rates.
b. Data format, to include: detailed bit definitions, command, meta and ancillary data definitions for all telemetry and command data (command and telemetry list), detailed data format and content of the specific sensor data and ancillary data files as stored on the flight data recorder and specific detailed data formats and outputs of the flight data recorder for sensor and ancillary data transferred via the sensor mission data downlink interfaces.
c. Compression algorithms, error detection and correction schemes.
d. Antenna patterns, EIRP, G/T, beam width, uplink/downlink, frequencies, polarizations and modulations for each channel.
e. Telemetry and command formats.
f. Satellite contact scenarios for data transmission, operations, and maintenance.
g. Link analysis for available ground station antennas.
h. Interface requirements for RF compatibility test.
i. Interface requirements for End-to-End test.
j. Description of command and data time tagging.
k. Description of Observatory operating modes and command events.
l. Communications approach for maneuver planning and execution.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-20	OBSERVATORY DATABASE

3. Reference:

SOW 7.3.1

4. Use:

To provide data required for operations of the LDCM Observatory.

5. 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:

a. Database pre-launch parameters such as Observatory mass, fuel mass, pertinent pressures, gyro drift characteristics, etc.

b. Alignments, especially those included in error budgets for open-loop pointing and yaw attitude determination.

c. Any spacecraft calibration data necessary to satisfy mission requirements, e.g., Earth Sensor, fine Sun Sensor and/or star trackers, magnetometers, and gyros calibrations sufficiently accurate to enable attitude determination, smoothing coefficients, antenna gimbal limits, deadbeat intervals, calibration biases, torquer/magnetometer coupling matrix, phase shifter calibration data, and the location of the multiple access elements in body-fixed Cartesian coordinates.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-21	SPACE SEGMENT OPERATIONS CONCEPT DOCUMENT

3. Reference:

SOW 2.1

4. Use:

To provide information on the LDCM Concept of Operations derived from unique aspects of the Contractor's design.

5. Preparation Information:

The LDCM Space Segment Operations Concepts Document shall describe the methodology required to operate the Observatory using the Mission Operations Element. Relative to the contractors design (including any and all unique features) the operations concepts shall address:

a) LDCM Observatory operational environment

b) Over and above existing M&O requirements to accommodate uniqueness factors

c) MOC staffing and organization required by the contractor's design

d) Internal and external interfaces resulting from LDCM requirements

e) Unique ground segment logistics, hardware and software maintenance and sustaining engineering

f) LDCM unique ground C&DH operations

g) User support operations

h) Contingency and emergency operations in the event of LDCM ground system modifications potential problems, problems, or failures

i) LDCM unique Operational scenarios

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: SE-22

2. Title: SYSTEM PERFORMANCE VERIFICATION MATRIX

3. Reference:

SOW 2.3

4. Use:

To verify that all system performance, mission assurance, and calibration/validation requirements are demonstrated and to provide a summary of the verification results.

5. Preparation Information:

The System Performance Verification Matrix (SPVM) will summarize the flow-down of system specification, Mission Assurance, and calibration/validation requirements verification. The SPVM will stipulate how each requirement will be verified, and summarizes current status of compliance/non-compliance with requirements. The SPVM will list a summary description of each requirement, and a summary of the measured/analyzed/demonstrated performance of the system against each requirement. It will show each Space Segment Requirements Document, Mission Operations Element Requirements Document, MAR, and Calibration/Validation Plan requirement reference source (to the specific paragraph or line item), the method of compliance, applicable procedure references, report reference numbers, etc. It will show the flow-down of requirements verification through the sub-system (box/board) level.

The SPVM will trace requirements backwards to the next level above, i.e., a level 4 requirement will be traced back to its level 3 parent, etc.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-23	MASS PROPERTIES REPORT

3. Reference:

SOW 2.1

4. Use:

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).

5. Preparation Information:

This document shall provide a mass properties database for the observatory. Mass properties shall include mass, center of gravity, moments of inertia and products of inertia. 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.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-24	STRUCTURAL AND MECHANICAL SUBSYSTEM PERFORMANCE ANALYSIS REPORT

3. Reference:

SOW 4.1.3

4. Use:

To document the analyses and data which demonstrate that all structural and mechanical subsystem performance requirements are satisfied.

5. Preparation Information:

This data item shall contain the following:

Design limit loads: This data item shall define the observatory design limit loads. The philosophy used in the derivation of the design limit loads shall be described in detail. Factors of safety and uncertainty factors applied to or utilized in the development of the design limits loads shall also be addressed.

Flight loads analyses: This data item shall provide observatory flight loads analysis data and results, for each flight loads analysis performed either by the observatory contractor or by the launch vehicle contractor.

Observatory alignment and stiffness: This data item shall document the analyses, tests and test data required to verify all observatory alignment and stiff requirements. The document shall also address observatory mechanical design verification with respect to dynamic interactions with the launch vehicle.

Observatory clearances: This data item shall document all observatory critical clearances and loss of clearances, with the associated analyses. This shall include dynamic loss of clearance between the observatory and the launch vehicle, and between various observatory elements. Clearance loss shall be determined for critical clearances throughout all mission phases, including launch, on-orbit deployments and on-orbit operations. Components contributing to each clearance loss, such as manufacturing and assembly tolerances, clearance loss due to observatory dynamics and thermal gradients, as well as observatory insulation, harnesses and grounding provisions, shall be quantified. Analytical and measured data used for clearance verification shall be provided.

Mechanical performance. This data item shall fully document the tests and analyses performed to verify the performance of the observatory mechanisms and deployment devices. Analyses and test data used to verify the observatory structural performance and workmanship shall also be provided. This document shall also address any methods utilized during fabrication and assembly which verify workmanship of the observatory structure and mechanical components.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-25	STRUCTURAL AND DYNAMIC MODELS AND MODEL VERIFICATION PLAN

3. Reference:

SOW 4.1.1.6

4. Use:

To provide test verified mathematical models that represent the static and dynamic structural characteristics of the observatory and can be utilized with other data to predict structural accelerations, deflections and internal loads. Also, to provide the dynamic model for use by the launch vehicle contractor in the performance of the flight loads analyses for the LDCM mission.

5. Preparation Information:

A. STRUCTURAL AND DYNAMIC MATHEMATICAL MODELS AND DOCUMENTATION

The contractor shall develop and document test-verified mathematical structural models of the LDCM observatory in the launch configuration. These shall include a structural finite element model and a dynamic model in Craig-Bampton form, developed, verified, and documented as described below. The finite element model shall represent the structural and dynamic characteristics of the observatory. Interface degrees of freedom shall be compatible with corresponding attachment degrees of freedom on the model of the launch vehicle. The dynamics model shall be based on the finite element structural model using standard reduction techniques such as Guyan reduction.

The structural finite element models and dynamic models shall be provided on electronic medium in a format acceptable to the launch vehicle contractor. Individual component models used to develop the observatory model shall also be delivered. The dynamic model shall be delivered for use by the launch vehicle contractor for the performance of the design flight loads analyses for the LDCM mission, and shall be accompanied by documentation necessary for the launch vehicle contractor to use the model. The test verified dynamic model shall also be delivered for use by the launch vehicle contractor for the performance of the verification loads cycle analyses.

The dynamic models shall:

a. Include the overall system (observatory)),

b. Be in Craig-Bampton form with modes that represent the dynamic characteristics of the observatory to at least 200 Hz, with all modes through 50 Hz test verified by dynamic modal survey testing,
c. Define dynamic degrees of freedom to allow calculation of acceleration levels and relative deflections at critical points, and
d. Include Load Transformation Matrices (LTM) described in the next section.

The finite element model documentation shall include the following:

a. A listing of the input data for the model,
b. Model definition plots, coordinate system definition, definition of stiffness properties, nodal mass distribution, and any other pertinent model definition information, along with documentation of the correlation between the modeled properties and the observatory design.
c. Mode shapes, frequencies, modal damping, modal participation factors, modal effective weights, orthogonality and cross orthogonality between analytical and test modes, and all data required to demonstrate test-verification of the models, and
d. Characterization of all significant frequencies and mode shapes for the observatory constrained at the launch vehicle boundary points, in addition to the constraint modes, one for each boundary degree of freedom.

B. LOAD TRANSFORMATION MATRICES (LTMs)

The Load Transformation Matrices shall be fully documented and provided on electronic medium in a format acceptable to the launch vehicle contractor. The LTMs shall:

a. Consist of influence coefficients relating selected output variables to the associated dynamics model response variable,
b. Include launch vehicle interface reaction forces, component/observatory interface reaction forces, and reaction force at support locations for deployables,
c. Include force, shear, and moment coefficients for determining internal loads in critical structural members, and
d. Include coefficients for determining absolute and relative deflections of observatory internal elements.

The LTM documentation shall provide:

a. A description of the model(s) from which the LTMs were generated,
b. A description of each row of the LTM,
c. Instructions for use of the LTM, including discussion of the equations used for computing internal transient loads, and
d. Results of standard analyses performed for verification of the LTM (e.g., response to 1g accelerations and unit displacements at the interface).

C. STRUCTURAL MODEL VERIFICATION PLAN

In support of the development of the test-verified structural models, the contractor shall develop a verification plan which includes:

a. Identification of the modeling techniques and analysis programs to be utilized,

b. Analytical and testing techniques to be used to verify the analytical models and, where required, plans for revising models and repeating analyses based on verification results,
c. A description of analyses to be performed, along with the objective, scope, and output of each analyses, and description of testing which will be used for model verification accompanied by associated schedules

d. A compilation of required loads interface data (e.g., loads to components or deployables, or loads from launch vehicle(s), etc.), and a schedule of need dates.

SPECIAL PREPARATION INSTRUCTIONS

All models, simulations, and/or databases required by this DID shall be delivered on magnetic media compatible with the hardware platform on which it is to execute and include everything necessary to provide a fully functioning computer model whose execution requires only commercially available hardware and software.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-26	STRESS ANALYSIS

3. Reference:

SOW 4.1.3

4. Use:

To provide a detailed stress analysis and margins of safety calculations for all structural components in the observatory.

5. Preparation Information:

The contractor shall provide a detailed "hand" stress analysis and margins of safety calculations for all components of the observatory. Margins of Safety shall be summarized in tabular form, providing a description of each structural element, its critical loading condition, including thermal and mechanical loadings, failure mode, margin of safety, and reference to the detailed analysis. Primary load-paths shall be identified and all simplifying assumptions clearly stated. If separate finite element models are developed for use in analyzing structural components, these models shall also be documented and included in the final stress report. The documentation shall also include any parametric studies and analyses directed toward minimizing component loads and stresses.

All important structural requirements shall be assembled and provided in conjunction with the stress analysis report. It shall serve as the source for design loads, stresses, deformations, margins of safety and information which defines the structural materials such as alloy type, strength, heat treatment, hardness, chemical treatment, finish, and other physical properties that have an influence on structural analysis. It shall also address the structural requirements of the launch vehicle that are related to the observatory.

Stress Report Updates

The stress analyses shall be provided to verify margins of safety using the design coupled flight loads analysis results. The stress analyses shall be updated and provided using the verification coupled flight loads analysis results, to verify that modifications to the structural models to achieve correlation with modal test data and hardware modifications encountered during observatory manufacturing and integration maintain positive margins of safety.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-27	PROPULSION SUBSYSTEM PERFORMANCE ANALYSES

3. Reference:

SOW 4.1.3

4. Use:

To document and verify that the Propulsion Subsystem design will satisfy the required performance criteria and will meet overall mission objectives.

5. Preparation Information:

The Propulsion Subsystem Analyses Report shall include, but not be limited to, the following analyses:

a. Propulsion performance for the following mission functions:

1. Placing LDCM Observatory in correct operational orbit
2. Constellation phasing requirements and collision avoidance
3. Required on-orbit repositioning maneuvers
4. Injection into end-of-life orbit.

For each function address the following:

- o Maximum and minimum firing duration
- o Maximum and minimum thrust level
- o Thrust vector misalignment tolerance
- o Number of engine starts
- o Total impulse required
- o Thruster calibration requirements/repeatability/steady state, etc.
- o Thruster duty cycles

b. Propulsion performance for attitude control including the following:

- o Effects of thrust vector misalignment tolerance and CG shift on ACS limit cycle.
- o Maximum and minimum firing durations
- o Maximum and minimum thrust levels
- o Total impulse required for attitude control
- o Thruster duty cycles

c. Propulsion performance for any failure mode in the propulsion subsystem or other observatory subsystem which has an impact on propellant consumption or thruster usage. The analysis should include propellant usage and operational scenarios and constraints.

d. Detailed propellant requirements budget for each mission function including all system inefficiencies, system pressure drop, and thrust decay over mission life.

e. The propulsion subsystem report shall include, but not be limited to, the following analyses:

- o Stress/loads
- o Power
- o Thermal
- o Containment/Plume Impingement
- o Slosh
- o Pressure Surge
- o TLM and CMD Interfaces

f. Subsystem operational scenario and timeline to include system utilization during launch to orbit phase.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-28	ATTITUDE CONTROL SYSTEM PERFORMANCE ANALYSIS REPORT

3. Reference:

SOW 4.1.3

4. Use:

To verify that the LDCM Observatory Attitude Control Subsystem design satisfies all functional and performance requirements and will successfully support LDCM mission objectives.

5. Preparation Information:

This document shall consist of the analyses necessary to validate and verify successful mission performance of the LDCM Observatory attitude control, solar array and antenna pointing, and attitude determination functions. As a minimum, but not limited to, the following shall be addressed:

a. All ACS control modes which have been analyzed, modeled, and simulated, to provide verification of all LDCM Observatory ACS control performance requirements and ACS interfaces. Included shall be mode transitions, control mode stability, flexible Observatory dynamics, and a description of ACS modes of operation.

b. The LDCM Observatory ACS attitude determination functions which have been analyzed, modeled, and simulated to verify LDCM Observatory ACS attitude determination performance requirements.

c. All antenna and solar array pointing and control functions which have been analyzed, modeled, and simulated.

d. An overall LDCM Observatory pointing error budget shall be provided for each antenna type and shall assign allocation of the overall error budget to related subsystems. Supporting data shall be included to verify compliance with overall LDCM Observatory mission pointing requirements and objectives.

e. All tasks to be accomplished at the Mission Operations Control Center and/or other ground facility in support of LDCM Observatory ACS shall be identified and described.

f. All ACS components shall be identified and described.

g. All ACS command and telemetry functions shall be identified, including all input and output ACS electronics, formats, rates, and valid ranges or states.

h. An ACS requirements compliance matrix shall be provided.

i. ACS reliability analysis shall be provided, including identification of failure modes.

j. ACS block diagrams shall be provided, including ACS subsystem and ACS electrical schematic and data flow diagrams.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-29	RF COMMUNICATIONS PERFORMANCE ANALYSES/TEST REPORTS

3. Reference:

SOW 4.1.3

4. Use:

The analyses or test (at various levels of I&T) shall verify the compatibility of the subsystem with TDRSS and the Landsat Ground Network

5. Preparation Information:

Link Analyses and Calculations

Provide link analysis and calculations for all observatory modes of operation and for nominal and worst case observatory attitudes for each RF system configuration including, but not limited to, the following:

a. The narrowband communications link in nominal Mission Mode and in non-nominal operational modes
b. The Wideband communications system in nominal Mission Mode and Safe-Hold Mode

Wideband Transmitters

Review of transponder data packages to verify that the TT&C transponder and wideband transmitters meet the specification and requirements, specifically in the following areas: Command Channel Performance, Telemetry Channel Performance, and Ranging Channel Performance.

Provide a report on the measurement of the filter characteristics, including insertion loss and eye pattern distortion, and a report on the measurement of the filtered and transmitted spectrum at the output of the power amplifier.

Passive Devices

Review of diplexer (or similar devices) packages to verify that the devices meet LDCM Observatory requirements and specifications, specifically in at least the following areas: frequency range, VSWR, impedance, insertion loss, and power handling requirements.

Antenna

Review of antenna data packages to verify that the antennas will meet requirements and specifications.

Narrowband Operation

Provide a complete analysis of the Narrowband Communications System including, but not limited to, the following:

a. Normal operations
b. Antenna or receiver selection method
c. Possible problem areas
d. Operations with loss of Observatory attitude control
e. All possible transponder cross strap configurations and any impacts on system performance.
f. An analysis of antenna patterns in all configurations (i.e., deployed, not deployed)

Wideband Operation

Provide a complete analysis of the Wideband Communications System including, but not limited to, the following:

a. Normal operations
b. Antenna or receiver selection method
c. Possible problem areas
d. Operations with loss of Observatory attitude control
e. All possible transponder cross strap configurations and any impacts on system performance.
f. An analysis of antenna patterns in all configurations (i.e., deployed, not deployed)

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-30	THERMAL ANALYSIS REPORT

3. Reference:

SOW 4.1.1.7

4. Use:

To document the thermal analyses used in the design of the LDCM Observatory. Several analysis reports are required as noted in the table of CDRL deliverable models and reports.

5. Preparation Information:

This document shall describe in detail the various analysis cases (e.g., launch, transfer orbit, on-orbit, on-orbit hot and cold cases, etc.). This description shall include:

a. List of all parameters and assumptions used

b. Interrelationships between various models and how boundary conditions are obtained

c. Detailed calculations and descriptions of computer models and analyses

d. Results of final analyses including predicted thermal performance over worst case extremes and design margins

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-31	POWER SUBSYSTEM PERFORMANCE ANALYSES REPORT

3. Reference:

SOW 4.1.3

4. Use:

Provides analyses of the power subsystem implementation to show the design fulfills the mission requirements.

5. Preparation Information:

Power subsystem analyses shall be documented in a power subsystem analysis technical report. The power subsystem analysis technical report shall include, but not be limited to, the following:

a. Solar array performance analysis.

b. Battery performance analysis.

c. Power distribution and regulation analysis for all steady state and transient load conditions.

d. Overload/fault suppression requirements, and the methods used to meet the requirements.

e. Analysis of power subsystem interaction with external sources, such as GSE and launch vehicle, for steady state and transient conditions.

f. Energy Balance computational analysis for all anticipated modes of operation.

g. Component EMI/EMC requirements, and analysis of methods used to meet requirements for each component.

h. All power subsystem Telemetry and Command interfaces.

i. Block diagrams.

j. Description of components.

k. Reliability assessment.

l. A requirements verification matrix.

m. Description of on-orbit operational considerations.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-32	COMMAND AND DATA HANDLING SYSTEM PERFORMANCE ANALYSIS REPORT

3. Reference:

SOW 4.1.3

4. Use:

To verify that the LDCM Observatory Command and Data Handling System design satisfies all functional and performance requirements and will successfully support LDCM mission objectives.

5. Preparation Information:

This document shall consist of the analyses necessary to validate and verify successful mission performance of the LDCM Observatory Command and Data Handling subsystem functions. As a minimum, but not limited to, the following shall be addressed:

a. The C&DH can support all functional and performance requirements of the LDCM.

b. A data flow, data processing and timing analysis showing that the C&DH subsystem design will support LDCM data flow and processing requirements.

c. A data coding analysis to determine which coding techniques (ie convolutional coding, bit interleaving, Reed-Solomon coding, EDAC, etc) recommended to guarantee that the LDCM can meet all data requirements. The analysis will include all data paths and data storage devices including the forward and return links, on-board memory devices. The analysis will recommend techniques to recover data in the event of radiation effects causing up-sets and parts failures.

d. Redundancy and cross-strapping implementations.

e. All C&DH components shall be identified and described.

f. All C&DH command and telemetry functions shall be identified, including all input and output C&DH electronics, formats, rates, and valid ranges or states.

g. An C&DH requirements compliance matrix shall be provided.

h. C&DH reliability analysis shall be provided, including identification of failure modes.

i. A C&DH block diagram shall be provided, showing all components of the C&DH subsystem, interfaces between component, and data within and interfacing to the C&DH.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-33	OBSERVATORY SIMULATOR SUBSYSTEM REQUIREMENTS DOCUMENT (SRD)

3. Reference:

SOW 4.7.1

4. Use:

The Observatory Simulator Subsystem Requirements Document (SRD) establishes the functionality required of the Observatory Simulator.

5. Preparation Information:

The Observatory Simulator Requirements Document shall contain at a minimum the following items:

a. The Observatory Simulator Subsystem level 5 requirements
b. All requirements relating to the Observatory Simulator external interfaces
c. All requirements relating to the Observatory Simulator internal interfaces
d. All requirements necessary to define the functionality required of the Observatory Simulator
e. All requirements relating to the performance of the Observatory Simulator
f. All requirements related to fault detection and handling
g. All requirements related to check-pointing and logging of Observatory Simulator data
h. All requirements related to persistent storage of Observatory Simulator data
i. All requirements related to modes of operation of the Observatory Simulator
j. All requirements related to Observatory Simulator displays
k. All requirements related to allowable data types and data conversions
l. All requirements related to Observatory Simulator alerts and warnings
m. All requirements related to access control requirements.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-34	OBSERVATORY SIMULATOR ARCHITECTURE DOCUMENT

3. Reference:

SOW 4.7.1

4. Use:

The Observatory Simulator Architecture Document describes the high-level software design and operation for use by software maintenance team.

The Observatory Simulator Architecture Document describes in detail the architecture, structure, and organization of the Observatory Simulator Subsystem, decomposing the Simulator into software components and lower levels of units as appropriate. The Architecture Document describes each software component in terms of its interfaces (input/output), data architectures, data flows, and high-level functionality. The architecture document also defines the hardware platform, programming language, database of choice, use cases, and key GUI mock-ups.

5. Preparation Information:

Provide a subsystem level design overview that contains:

(f) Design Methodology
(g) Design Overview
(h) Design Studies
(i) Design Issues
(j) Hardware Interface

Provide a subsystem design description that contains, at a minimum

(d) Subsystem Description
(e) Software Description for each software component
(f) Software Interface Control Description for both software-to-software and software-to-hardware interfaces

Describe the subsystem operations design, including:

(d) Operations Scenarios
(e) User-Subsystem Interface
(f) Operations Environment and Facilities

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: SE-35

2. Title: SPARE PARTS PLAN AND LIST

3. Reference:

SOW 4.6

4. Use:

To review contractor's spares plan and list.

5. Preparation Information:

The Spares Parts Plan shall define and justify the contractor's position for the spares proposed for the spacecraft bus and the sensor(s). This plan shall also present the schedule and method for obtaining the spares. The Plan shall provide a listing of Spare Parts. For the purposes of this CDRL, the contractor should concentrate on parts that are not commonly available, or may cause schedule problems if out of stock.

Further, this plan shall address all of the requirements of SOW paragraph 4.6.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
SE-36	ACCEPTANCE DATA PACKAGE

3. Reference:

SOW 7.3.2

4. Use:

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

5. Preparation Information:

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

A. Contract End Item Specification
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. Open item lists (including reasons for being open)
G. Safety compliance data package
H. Limited life items listings and status
I. Environmental tests results
J. Subsystem tests results
K. Calibration tests results
L. Critical parameters trend data
M. Final comprehensive performance test results
N. Anomaly reports and FRB disposition information

Item A above, the Contract End Item Specification, establishes the architecture, configuration, function, and performance of the LDCM, and shall address design compliance with and traceability to the LDCM Space Segment, Mission Operations Element Requirements Document, and other applicable requirements documents.

The updated delivery shall include on-orbit commissioning test results and updates to the previously delivered package.

A copy of this package shall accompany each end item, in addition to the delivery requirements in Table 3-1.

SYSTEMS ASSURANCE DIDS

DID SA-1: Quality Manual

Title: Quality Manual/Systems Assurance Plan	**CDRL Number:** SA-1
Reference: MAR Sections 2.1, 5.1	
Use: Documents the developer's QMS.	
Related Documents: ANSI/ISO/ASQC Q9001:1994, ANSI/ISO/ASQC Q9001:2000, SAE AS9100 and ISO 10013.	
Place/Time/Purpose of Delivery: Provide with the proposal for GSFC review. Provide the Quality Manual updates to the GSFC Project Office for review prior to implementation, or Provide with the proposal for information, along with evidence of third party certification/registration of the developer's QMS by an accredited registrar. The developer is required to provide a Systems Assurance Plan (or their version of a safety and mission assurance plan) in draft form for GSFC approval at the developers PDR. A final GSFC approved version is due 45 days prior to the developers CDR. The plan must address all the requirements listed in the MAR.	
Preparation Information: Prepare a Quality Manual addressing all applicable requirements of relevant quality standard (see above related documents). Refer to ISO 10013 for further guidelines on the preparation of a quality manual. The Quality Manual shall contain: a. The title, approval page, scope and the field of application. b. A table of contents. c. Introductory pages about the organization concerned and the manual itself. d. The quality policy and objectives of the organization. e. The description of the organization, responsibilities, and authorities, including the organization responsible for the EEE parts, materials, reliability, safety, and test requirements implementation. f. A description of the elements of the quality system, developer policy regarding each element and developer implementation procedure for each clause or reference(s) to approved quality system procedures. System level procedures shall address the implementation of all requirements cited in this document. g. A definitions section, if appropriate. h. An appendix for supportive data, if appropriate. Quality Manual distribution and changes shall be implemented by a controlled process. The Quality Manual shall be maintained/updated by the developer throughout the life of the contract. The Systems Assurance Plan must define how each of the MAR requirements will be met. The developer is encouraged to make use of in house procedures to the maximum extent provided they are approved by GSFC.	

DID SA-2: Problem Failure Reports

Title: Problem Failure Reports (PFRs)	**CDRL Number:** SA-2
Reference: MAR Section 2.2.3	
Use: To report failures promptly to the FRB for determination of cause and corrective action.	
Related Documents: N/A	
Place/Time/Purpose of Delivery: Provide information to the GSFC Project Office within 24 hours of each occurrence; Provide to GSFC Project Office for approval immediately after developer closure.	
Preparation Information: Reporting of failures shall begin with the first power application at the start of end item acceptance testing of the major component, subsystem, or instrument level (as applicable to the hardware level for which the developer is responsible) or the first operation of a mechanical item. It shall continue through formal acceptance by the GSFC Project Office and the post-launch operations, commensurate with developer presence and responsibility at GSFC and launch site operations. All failures shall be documented on existing developer PFR form, which shall identify all relevant failure information. PFRs and updated information shall be submitted to GSFC by hard copy or in electronic format. PFRs submitted to the GSFC for closure include a copy of all referenced data and shall have had all corrective actions accomplished and verified.	

DID SA-3: System Safety Program Plan

Title: System Safety Program Plan	**CDRL Number:** SA-3
Reference: MAR Section 3.3	

Use:

The approved plan provides a formal basis of understanding between the GSFC Code 302 and the developer on how the System Safety Program will be conducted to meet the applicable launch range safety requirements (ELV launch). The approved plan shall account for all contractually required tasks and responsibilities on an item-by-item basis.

Related Documents:

KNPR 8715.3, "KSC Safety Practices Procedural Requirements"
AFSCM 91-710, "Range Safety User Requirements Manual"

Place/Time/Purpose of Delivery:

The developer will submit the SSPP to GSFC Code 302 for review and approval at the SRR or the first program review.

Preparation Information:

The SSPP shall describe in detail tasks and activities of system safety management and system safety engineering required to identify, evaluate, and eliminate and control hazards, or reduce the associated risk to an acceptable level throughout the system life cycle.

Provide a detailed SSPP to describe how the project will implement a safety program in compliance with launch range requirements. Integration of system/facility safety provisions into the SSPP is vital to the early implementation and ultimate success of the safety effort. The SSPP shall:

a. Define the required safety documentation, applicable documents, associated schedules for completion, roles and responsibilities on the project, methodologies for the conduct of any required safety analyses, reviews, and safety package.
b. Provide for the early identification and control of hazards to personnel, facilities, support equipment, and the flight system during all stages of project development including design, fabrication, test, transportation and ground activities.
c. Ensure the program undergoes a safety review process that meets the requirements of NASA-STD-8719.8, "Expendable Launch Vehicle Payloads Safety Review Process Standard." Address compliance with the system safety requirements of range requirements.
d. Address compliance with the baseline industrial safety requirements of the institution, range safety, applicable Industry Standards to the extent practical to meet NASA and OSHA design and operational needs (i.e. NASA STD 8719.9, "Std. for Lifting Devices and Equipment"), and any special contractually imposed mission unique obligations (including applicable safety requirements).
e. Address the software safety effort to identify and mitigate safety-critical software products in compliance with NASA-STD-8719.13 "NASA Software Safety Standard."

DID SA-4: Preliminary Hazard Analysis

Title: Preliminary Hazard Analysis	**CDRL Number:** SA-4

Reference: MAR Section 3.3.1

Use:

The developer shall perform and document a Preliminary Hazard Analysis (PHA) to identify safety critical areas, to provide an initial assessment of hazards, and to identify requisite hazard controls and follow-on actions. Safety provisions and alternatives needed to eliminate hazards or reduce their associated risk to a level acceptable to Office of Systems Safety and Mission Assurance (OSSMA) GSFC.

Related Documents:

AFSCM 91-710, "Range Safety User Requirements"
NPR 8715.3, "NASA Safety Manual"
MIL-STD-882, "System Safety Program Requirements" (provides guidance)

Place/Time/Purpose of Delivery:

The developer with input from the instrument developers shall submit the PHAs 30 days post PDR for review.

Deliver the PHA as a component of the SAR or MSPSP.

a. Deliver the PHA for instruments with the SAR at PDR + 30 days.
b. Deliver the PHA for the spacecraft with the MSPSP at PDR + 30 days.

Preparation Information:

Perform and document a PHA, based on the hazard assessment criteria provided in Chapter 3 of NPR 8715.3, and AFSCM 91-710, "Range Safety User Requirements" to obtain an initial risk assessment of the system. Based on the best available data, including mishap data (if assessable) from similar systems and other lessons learned, hazards associated with the proposed design or function shall be evaluated for hazard severity, hazard probability, and operational constraint. Safety provisions and alternatives needed to eliminate hazards or reduce their associated risk to an acceptable level shall be included. The PHA shall consider the following for identification and evaluation of hazards at a minimum:

a. Hazardous components.
b. Environmental constraints including the operating environments.
c. Operating, test, maintenance, built-in-tests, diagnostics, and emergency procedures.
d. Facilities, real property installed equipment, support equipment.
e. Safety related equipment, safeguards, and possible alternate approaches.
f. Safety related interface considerations among various elements of the system. This shall include consideration of the potential contribution by software to subsystem/system mishaps. Safety design criteria to control safety-critical software commands and responses shall be identified and appropriate action taken to incorporate them in the software (and related hardware) specifications.
g. Malfunctions to the system, subsystems, or software. Each malfunction shall be specified, the causing and resulting sequence of events determined, the degree of hazard determined, and appropriate specification and/or design changes developed.

Additionally, the PHA shall include a system description and a description of the methodology used to develop the analysis.

DID SA-5 Operations Hazard Analysis

Title: Operations Hazard Analysis	**CDRL Number:** SA-5

Reference: MAR Section 3.3.2

Use:

The operations hazard analysis (OHA) shall consider safety requirements for personnel, procedures, and equipment used during testing, transportation, storage, and integration operations in the 7/10/15/29 complex at GSFC. An engineering design analysis shall be accomplished for review and for developing recommendations concerning system integration and test operations.

Related Documents:

540-PG-8715.1.1, "Mechanical Systems Division Safety Manual – Volume I"
540-PG-8715.1.2, "Mechanical Systems Division Safety Manual – Volume II"

NPR 8715.3, "NASA Safety Manual"

Place/Time/Purpose of Delivery:

The developer with input from instrument developers shall provide a preliminary OHA 45 days prior to use. A final version must be submitted 15 days prior to initiating any I&T activities. The GSFC Systems Safety And Reliability Office shall review the OHAs. During I&T activities, a Hazard Tracking Log (HTL) shall be used to track and close all remaining items.

Note: Closure methodology for the HTL is the same as for the VTL in DID SA-9.

Preparation Information:

The OHA shall include the following information:

1.0 Introduction
- a. Provide an abstract summarizing the major findings of the analysis and the proposed corrective or follow-up actions.
- b. Define any special terms, acronyms, and/or abbreviations used.

2.0 System Description
- a. Provide a description of the system hardware and configuration. List components of subsystems.
- b. The most recent schedules for integration and testing of the instrument/SC.
- c. Photographs, diagrams, and sketches should be included to support the test.

3.0 Analysis of System Hazards
- a. The analysis shall identify all real or potential hazards presented to personnel, equipment, and property during I&T processing.
- b. A listing of all identified hazards shall be provided in a tabulated format. Each hazard shall be numbered and shall include the following information:
  - (1) System Component/Phase. The particular phase/component that the analysis is concerned with. This could be a system, subsystem, component, operating/maintenance procedure or environmental condition.
  - (2) System Description and Hazard Identification, Indication.
    - (a) A description of what is normally expected to occur as the result of operating the component/subsystem or performing the operating/maintenance action.
    - (b) A complete description of the actual or potential hazard resulting from normal actions or equipment failures. Indicate whether hazard will cause personnel injury and/or equipment damage.
    - (c) A description of crew indications which include all means of identifying the hazard to operating or maintenance personnel.
    - (d) A complete description of the safety hazards of software controlling hardware systems where the hardware effects are safety critical.
  - (3) Effect on System. The detrimental results an uncontrolled hazard could inflict on the whole system.
  - (4) Risk Assessment. A risk assessment for each hazard as defined in paragraph shall be provided.
  - (5) Caution and Warning Notes. A complete list of specific warnings, cautions, procedures required in operating and maintenance manuals, training courses, and test plans.
  - (6) Status/Remarks.
    - (a) The status of actions to implement the recommended, or other, hazard controls.
    - (b) Any information relating to the hazard, not covered in the other blocks, for example, applicable

documents, previous failure data in similar systems, or administrative directions.

4.0 References. List all pertinent references such as test reports, preliminary operating and maintenance manuals, and other hazard analysis.

5.0 Appendices. The appendix will contain charts, graphs, or data which are too cumbersome for inclusion in the previous sections, or are applicable to more than one section. It may also contain detailed formulation or analysis which is more conveniently placed in an appendix.

DID SA-6: Safety Requirements Compliance Checklist

Title: Safety Requirements Compliance Checklist	**CDRL Number:** SA-6

Reference: MAR Section 3.4

Use:

The checklist shall indicate for each requirement if the proposed design is compliant, non-compliant but meets intent, non-compliant (waiver required) or non-applicable.

Related Documents:

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

Place/Time/Purpose of Delivery:

The developer with input from the instrument developers shall provide Safety Requirements Checklists with each submittal of the SAR and MSPSP for review.

Preparation Information:

A compliance checklist of all design, test, analysis, and data submittal requirements shall be provided.

The following items are included with a compliance checklist.

1. Criteria/requirement.
2. System.
3. Compliance
4. Noncompliance.
5. Not applicable.
6. Equivalent Level of Safety (ELS)
7. Resolution.
8. Reference.
9. Copies of all Range Safety approved non-compliances, including waivers and equivalent levels of safety certifications.

DID SA-7 Missile System Pre-Launch Safety Package

Title: Missile System Pre-Launch Safety Package	**CDRL Number:** SA-7

Reference: MAR Section 3.5

Use:

Provide a detailed description of the payload design, sufficient to support hazard analysis results, hazard analysis method, and other applicable safety related information. The developer shall include analyses identifying the ground operations hazards associated with the flight system, GSE, and their interfaces. The developer shall take measures to control and/or minimize each identified significant hazard.

Related Documents:

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

Note: Other launch vehicle and/or contractor or commercial facility requirements may apply.

Place/Time/Purpose of Delivery:

Provide preliminary MSPSP 30 days after PDR package, an updated MSPSP 30 days after CDR, and final 60 days prior to PSR for review and approval by GSFC Code 302. (See applicable launch range and launch vehicle requirements for details.)

Preparation Information:

MSPSP shall follow the guidance in AFSCM 91-710, and include the following information:

1. Introduction. State, in narrative form, the purpose of the MSPSP.
2. System Description. This section may be developed by referencing other program documentation such as technical manuals, System Program Plan, System Specifications, etc.
3. System Operations. A description of:
   a. Or reference to the procedures for operating, testing, and maintaining the system. Discuss the safety design features and controls incorporated into the system as they relate to the operating procedures.
   b. Any special safety procedures needed to assure safe operations, test, and maintenance, including emergency procedures.
   c. Anticipated operating environments and any specific skills required for safe operation, test, maintenance, transportation, or disposal.
   d. Any special facility requirements or personal equipment to support the system.
4. Systems Safety Engineering Assessment. This section shall include:
   a. A summary or reference of the safety criteria and methodology used to classify and rank hazardous conditions.
   b. A description of, or reference to, the analyses and tests performed to identify hazardous conditions inherent in the system.
   c. A list of all hazards by subsystem or major component level that have been identified and considered from program inception.
   d. A discussion of the hazards and the actions taken to eliminate or control these items.
   e. A discussion of the effects of these controls on the probability of occurrence and severity level of the potential mishaps.
   f. A discussion of the residual risks that remain after the controls are applied or for which no controls could be applied.
   g. A discussion of, or reference to, the results of tests conducted to validate safety criteria requirements and analyses. These items shall be tracked and closed-out via a VTL.
5. Conclusions and Recommendations. This section shall include:
   a. A short assessment of the results of the safety program efforts. A list of all significant hazards, including specific safety recommendations or precautions required to ensure the safety of personnel and property.
   b. For all hazardous materials generated by or used in the system, the following information shall be included.
      (1) Material identification as to type, quantity, and potential hazards.
      (2) Safety precautions and procedures necessary during use, storage, transportation, and disposal.
      (3) A copy of the Material Safety Data Sheet (OSHA Form 20 or DD Form 1813) as required.
   c. Reference material, to include a list of all pertinent references, such as test reports, preliminary operating

manuals, and maintenance manuals.

d. A statement signed by the Contractor System Safety Manager and the Program Manager, certifying that all identified hazards have been eliminated or controlled, and that the system is ready to test, operate, or proceed to the next acquisition phase. In addition, include recommendations applicable to the safe interface of this system with other systems.

DID SA-7 Missile System Pre-Launch Safety Package (continued)

DID SA-8 Safety Assessment Report

Title: Safety Assessment Report	**CDRL Number:** SA-8
Reference: MAR Section 3.5	

Use:

The Safety Assessment Report (SAR) is used to document a comprehensive evaluation of the mishap risk being assumed prior to the testing or operation of an instrument or subsystem not being developed by the SC contractor. The SAR will be provided to the SC contractor as an input to their preparation of the MSPSP, which is one of the media through which missile system prelaunch safety is obtained.

Related Documents:

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

Place/Time/Purpose of Delivery:

SAR delivery shall support the GSFC PROJECT OFFICE MSPSP submittal schedule. The preliminary MSPSP is due 30 days post PDR, with updates 30 days post CDR, and final 60 days prior to PSR. For adequate support of the MSPSP development, the preliminary SAR shall be delivered 30 days after instrument PDR and shall be updated 30 days pre instrument CDR, and the final SAR shall be delivered 30 days prior to instrument delivery.

Preparation Information:

The SAR will identify all safety features of the hardware, software, and system design as well as procedural, hardware, and software related hazards that may be present in the system being acquired. This includes specific procedural controls and precautions that shall be followed. The safety assessment will summarize the following information:

1. The safety criteria and methodology used to classify and rank hazards and any assumptions upon which they were based or derived, including the definitions of acceptable risk (as specified by Range Safety).
2. The results of those analyses and tests performed to identify hazards inherent in the system, including:
   a. Those hazards that still have a residual risk and the actions taken to reduce the associated risk to a level contractually specified as acceptable
   b. Results of tests conducted to validate safety criteria, requirements, and analyses
3. Hazard reports documenting the results of the safety program efforts, including a list of all significant hazards, including specific safety recommendations or precautions required to ensure safety of personnel, property, or the environment. NOTE: List categorization shall denote whether the risks may be expected under normal or abnormal operating conditions.
4. Any hazardous materials generated by or used in the system.
5. The conclusion, with signed statement, that all identified hazards have been eliminated or their associated risk has been controlled to acceptable levels, and the system is ready to test, operate, or proceed to the next phase.
6. In order to aid the SC developer/observatory integrator in completing an orbital debris assessment, it is necessary to identify any stored energy sources (e.g., pressure vessels, batteries, etc.) that can be passivated at end of life.
7. Recommendations applicable to hazards at the interface of Range User systems with other systems.

DID SA-9: Verification Tracking Log

Title: Verification Tracking Log	**CDRL Number:** SA-9

Reference: MAR Section 3.5.1

Use:

To provide a Hazard Control and Verification Tracking process, or "closed-loop system," to assure safety compliance has been satisfied in accordance to applicable launch range safety requirements.

Related Documents:

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

Place/Time/Purpose of Delivery:

Provide hazard control verification and tracking system in accordance with AFSCM 91-710 and applicable launch site range safety requirements. Documented methods of hazard controls shall be submitted with the preliminary MSPSP and updated with each consecutive submittal. All open hazard control verification items must be closed in accordance with applicable launch site range safety requirements before launch, and individual items shall be closed with appropriate documentation verifying that the stated hazard control has been implemented, and shall be completed prior to first operational use. Closures shall be reviewed and approved by Range and KSC Safety.

Preparation Information:

Provide documentation that demonstrates the process of verifying the control of all hazards by test, analysis, inspection, similarity to previously qualified hardware, or any combination thereof. All verifications listed on the hazard reports shall reference the tests/analyses/inspections. Results of these tests/analyses/inspections shall be available for review and submitted in accordance with the contract schedule and applicable launch site range safety requirements.

The VTL shall contain the following information in tabular format:

a. Log
b. Hazard report number
c. Safety verification number
d. Description (Identify procedures/analyses by number and title)
e. Constraints on Launch Site Operations
f. Independent Verification Required (i.e., mandatory inspection points)? Yes/No
g. Scheduled completion date
h. Completion date
i. Method of Closure

DID SA-10: Ground Operations Procedures

Title: Ground Operations Procedures	**CDRL Number:** SA-10
Reference: MAR Section 3.5.2	
Use: All hazardous ground operations procedures to be used at developer facilities, other integration facilities, or the launch site shall be submitted to the GSFC Project Safety Manager for review.	
Related Documents: AFSCM 91-710, "Range Safety User Requirements Manual" KNPR 8715.3, "KSC Safety Practices Procedural Requirements" NPR 8715.3, "NASA Safety Manual" Note: Other launch vehicle and/or contractor or commercial facility requirements may apply.	
Place/Time/Purpose of Delivery: Provide 60 days prior to PDR, final 60 days before PSR.	
Preparation Information: All hazardous operations, as well as the procedures to control them, shall be identified and highlighted. All launch site procedures shall comply with the applicable launch site safety regulations.	

DID SA-11 Safety Variances

Title: Safety Variances	**CDRL Number:** SA-11

Reference: MAR Section 3.5.3

Use:

The hardware developer shall submit to GSFC Code 302 an associated safety noncompliance request that identifies the hazard and shows the rationale for approval of noncompliance when a specific safety requirement cannot be met, as defined in the applicable launch site safety regulation. Range Safety concurrence may be required for the noncompliance request to be approved.

Related Documents:

AFSCM 91-710, "Range Safety User Requirements Manual"
KNPR 8715.3, "KSC Safety Practices Procedural Requirements"
NASA Problem Reporting/Problem Failure Reporting Module Web-based Online System

Place/Time/Purpose of Delivery:

As identified to the GSFC Project Safety Manager. GSFC Code 302, Range and KSC Safety shall review and approve. all safety non-compliances.

Preparation Information:

The noncompliance request shall include the following information resulting from a review of each waiver or deviation request.

a. A statement of the specific safety requirement and its associated source document name and paragraph number, as applicable, for which a waiver or deviation is being requested.
b. A detailed technical justification for the exception.
c. Analyses to show the mishap potential of the proposed alternate requirement, method, or process, as compared to the specified requirement.
d. A narrative assessment of the risk involved in accepting the waiver or deviation. When it is determined that there are no hazards, the basis for such determination shall be provided.
e. A narrative on possible ways of reducing hazard severity and provability, and existing compliance activities (if any).
f. Starting and expiration date for waiver/deviation.

DID SA-12: Orbital Debris Assessment

Title: Orbital Debris Assessment	**CDRL Number:** SA-12
Reference: MAR Section 3.8	

Use:

Ensure NASA requirements for post mission orbital debris control are met.

Related Documents:

NPD 8710.3, "NASA Policy for Limiting Orbital Debris Generation"
NSS 1740.14, "Guidelines and Assessment Procedures for Limiting Orbital Debris"

Place/Time/Purpose of Delivery:

Provide preliminary assessment prior to PDR, and final 45 days prior to CDR. Deliveries should be made jointly to GSFC Code 302, NASA HQ OSSMA, NASA HQ Enterprise Associate Administrator, and the Johnson Space Center (JSC) Orbital Debris Office. Additional info may be required after review of the report, and should be provided as soon as possible to complete the assessment.

Preparation Information:

The assessment shall be done in accordance with NSS 1740.14. The preliminary debris assessment shall be conducted to identify areas where the program or project might contribute debris, and to assess this contribution relative to the guidelines in so far as feasible. Prior to CDR another debris assessment shall be completed. This report shall comment on changes made since the preliminary report. The level of detail shall be consistent with available information of design and operations. When design changes are made after CDR that impact the potential for orbital debris generation, the updated of the debris assessment report shall be prepared, approved, and coordinated with the Office of System Safety and Mission Assurance.

Orbital Debris Assessment Software is available for download from JSC at:
http://sn-callisto.jsc.nasa.gov/mitigate/das/das.html

DID SA-13: Probabilistic Risk Assessment

Title: Probabilistic Risk Assessment	**CDRL Number:** SA-13

Reference: MAR Section 4.2

Use:

Probabilistic Risk Assessments (PRAs) provide a structured, disciplined approach to analyzing system risk to enable management decisions that ensure mission success, improve safety in design, operation maintenance and upgrade, improve performance, and reduce design, operation, and maintenance costs.

Related Documents:

NPR 8705.4, "Risk Classification for NASA Payloads"
NPR 8705.5, "Probabilistic Risk Assessment Procedures for NASA Programs and Projects"

Place/Time/Purpose of Delivery:

Preliminary PRA due 30 days before PDR for review.
Final PRA due 30 days after CDR for approval.
Updates due as changes are made and between CDR and delivery, for approval.

Preparation Information:

The PRA prepared shall identify what types of analyses are to be performed for each scenario and what modeling tools and techniques are to be used (e.g., Master Logic Diagrams [MLD], FMEAs, FTAs, Event Tree Analyses [ETA], and Event Sequence Diagrams).

The PRA shall include:

a. A definition of the objective and scope of the PRA, and development of end-states-of-interest to the decision maker.
b. Definition of the mission phases and success criteria.
c. Initiating event categories.
d. Top level scenarios.
e. Initiating and pivotal event models (e.g., fault trees and phenomenological event models).
f. Data development for probability calculations.
g. An integrated model and quantification to obtain risk estimates.
h. An assessment of uncertainties.
i. A summary of results and conclusions, including a ranking of the lead contributors to risk.

DID SA-14: Failure Mode and Effects Analysis

Title: Failure Mode and Effects Analysis	**CDRL Number:** SA-14
Reference: MAR Section 4.3.1	

Use:

The Failure Mode and Effects Analysis (FMEA) is a reliability analysis to evaluate design relative to requirements, to identify single point failures, and to identify hazards to guide preventative design actions.

Related Documents:

FAP P-302-720, "Performing a Failure Mode and Effects Analysis"
MIL-STD-1629, "Procedures for Performing an FMECA"

Place/Time/Purpose of Delivery:

Preliminary 30 days before PDR for GSFC review.
Final 30 days before CDR for GSFC review.
Updates as required, including changes, for GSFC review.

Preparation Information:

The FMEA report shall document the reliability analysis including approach, methodologies, results, conclusions, and recommendations. The report shall include objectives, level of the analysis, ground rules, functional description, functional block diagrams, reliability block diagrams, bounds of equipment analyzed, reference to data sources used, identification of problem areas, single-point failures, recommended corrective action, and work sheets as appropriate for the specific analysis being performed.

DID SA-15: Critical Items List

Title: Critical Items List	**CDRL Number:** SA-15
Reference: MAR Section 4.3.1	
Use: The Critical Items List (CIL) provides a list of critical items, which require the highest level of attention in design, fabrication, verification, and problem correction during the development, handling, and mission use of the system.	
Related Documents: FAP P-302-720, "Performing a Failure Mode and Effects Analysis" MIL-STD-1629, "Procedures for Performing an FMECA"	
Place/Time/Purpose of Delivery: Preliminary 30 days before PDR for GSFC review. Final 30 days before CDR for GSFC review. Updates as required, including changes, for GSFC review.	
Preparation Information: The CIL shall include item identification, cross-reference to FMEA line items, and retention rationale. Appropriate retention rationale may include design features, historical performance, acceptance testing, manufacturing product assurance, elimination of undesirable failure modes, and failure detection methods.	

DID SA-16: Fault Tree Analysis

Title: Fault Tree Analysis	**CDRL Number:** SA-16
Reference: MAR Section 4.3.2	

Use:

A fault tree is an analytical technique, whereby an undesired state of the system is specified, and the system is then analyzed in context of its environment and operation to find all credible ways in which the undesired event can occur. The analysis provides a methodical approach to understanding they system, its operation, and the environment it will operate in. Through this understanding, informed decisions regarding system design and operation can be made.

Related Documents:

NPR 8705.5, "Probabilistic Risk Assessment Procedures for NASA Programs and Projects"

Place/Time/Purpose of Delivery:

Preliminary 30 days before PDR for GSFC review.
Final 30 days before CDR for GSFC review
Updates as required, including changes, for GSFC review.

Preparation Information:

The Fault Tree Analysis (FTA) Report shall contain:

a. Ground rules for the analysis, including definitions of the undesirable end states analyzed.
b. References to documents and data used.
c. The fault tree diagrams.
d. Statement of the results and conclusions.

DID SA-17: Contamination Control Plan

Title: Contamination Control Plan	**CDRL Number:** SA-17
Reference: MAR Section 6.1	
Use: To establish contamination allowances and methods for controlling contamination.	
Related Documents: N/A	
Place/Time/Purpose of Delivery: 30 days before PDR for GSFC review, 30 days before CDR for GSFC approval.	
Preparation Information: Data on material properties, design features, test data, system tolerance of degraded performance, and methods to prevent degradation shall be provided to permit independent evaluation of contamination hazards. The following items should be included in the plan: 1. Materials a. Outgassing as a function of temperature and time. b. Nature of outgassing chemistry. c. Areas, weight, location, and view factors of critical surfaces. 2. Venting: size, location, and relation to external surfaces. 3. Thermal vacuum test contamination monitoring plan, including vacuum test data, QCM location and temperature, pressure data, system temperature profile and shroud temperature. 4. On-orbit SC and instrument performance as affected by contamination deposits. a. Contamination effect monitor. b. Methods to prevent and recover from contamination in orbit. c. How to evaluate on-orbit degradation. d. Photopolymerization of outgassing products on critical surfaces. e. Space debris risks and protection. f. Atomic oxygen erosion and re-deposition. 5. Analysis of contamination impact on the satellite on-orbit performance. 6. On-orbit contamination impact from other sources, such as STS, space station, and adjacent instruments.	

DID SA-18: Printed Wiring Board Test Coupons

Title: Printed Wiring Board Test Coupons	**CDRL Number:** SA-18
Reference: MAR Section 10.3	

Use:
Validates printed wiring boards (PWBs) procured for space flight and mission critical ground use are fabricated in accordance with applicable workmanship standards.

Related Documents:
IPC-6011, "Generic Performance Specifications for Printed Boards"
IPC-6012B, "Qualification and Performance Specification for Rigid Printed Boards" product to meet requirements of the Performance Specification Sheet for Space and Military Avionics
IPC-6013, "Qualification and Performance Specification for Flexible Printed Boards"
IPC-6018, "Microwave End Product Board Inspection and Test"
IPC A-600, "Guidelines for Acceptability of Printed Boards"

* IPC-6011, IPC-6012, IPC-6013 must use Class 3 Requirements

Place/Time/Purpose of Delivery:
Prior to population of flight PWBs. Applies individually to each procured lot of boards.

Preparation Information:
Prior to population of PWBs:

- Contact GSFC Materials Engineering Branch (MEB), Code 541.
- Submit test coupons for destructive physical analysis (DPA) per Code 541 procedures.
- Do not release PWBs for population until notification by MEB that test coupons passed DPA.

DID SA-19 Parts Control Plan (PCP)

Title: Parts Control Plan	**CDRL Number:** SA-19
Reference: MAR Section 11.1	
Use: Description of developer's approach and methodology for implementation of the Parts Control Program.	
Related Documents: Parts Identification List (PIL)	
Place/Time/Purpose of Delivery: Developed and delivered with, or incorporated into, the developer's Systems Assurance Plan for GSFC approval. Subsequent revisions will be delivered for GSFC approval.	
Preparation Information: The PCP will address all EEE parts program requirements. The PCP will contain, at a minimum, detailed discussions of the following: a. The developer's plan or approach for conforming to the EEE parts requirements. b. The developer's parts control organization, identifying key individuals and specific responsibilities. c. Detailed PCB procedures, to include membership, designation of Chairperson, responsibilities, review and approval procedures, meeting schedules and notification method, meeting minutes, etc. d. Parts tracking methods and approach, including tools to be used such as databases, reports, PIL, etc. Description of the system for identifying and tracking parts approval status. e. Parts procurement, processing and testing methodology and strategies. Identify internal operating procedures to be used for incoming inspections, screening, qualification testing, derating, testing of parts pulled form stores, DPA, radiation assessments, etc.	

DID SA-20 Parts Identification List (PIL)

Title: Parts Identification List/ADPL/ABPL	**CDRL Number:** SA-20

Reference: MAR Sections 11.7, 11.7.1, 11.7.2, 11.7.3, 11.7.4

Use:
Listing of all EEE parts intended for use in spaceflight hardware.

Related Documents:
Parts Control Plan

Place/Time/Purpose of Delivery:
Parts Identification List 30 days before PDR for GSFC approval. Subsequent revisions, with changes clearly noted, for GSFC review.
As Designed Parts List 30 (ADPL) days before CDR for GSFC review.
The As-Built Parts List (ABPL) will be developed from this document/database, and will be submitted to GSFC for review 60 days prior to delivery of the end item.

Preparation Information:
The PIL/ADPL will be prepared and maintained throughout the life of the project. They will be compiled by the developer and will include the following information at a minimum:

a. Part name
b. Part number
c. Manufacturer
d. Manufacturer's generic part number
e. Procurement specification
f. GIDEP Alert status

Any format may be used, provided the required information is included. All submissions to GSFC will be provided in an electronic spreadsheet format, with changes from the last revision shall be clearly noted (identified with date and revision level).
Note: The ABPL will include the following information in addition to the above list:

a. Lot date code
b. Quantities
c. Parts use location to the sub-assembly level or reference designator

DID SA-21: Materials and Processes Control Program Plan

Title: Materials and Processes Control Program Plan	**CDRL Number:** SA-21
Reference: MAR Section 12.2	
Use: Description of developers approach and methodology for implementing MPCP, including flow-down of applicable MPCP requirements to sub-developers.	
Related Documents: N/A	
Place/Time/Purpose of Delivery: The MPCP shall be developed and delivered at PDR for GSFC Project Office Review A final version is due to GSFC for approval 30 days prior to CDR.	
Preparation Information: The MPCP shall address all M&P program requirements. The MPCP shall contain, at a minimum, detailed discussions of the following: a. The developer's plan or approach for conforming to M&P requirements. b. The developer's M&P control organization, identifying key individuals and specific responsibilities. c. M&P tracking methods and approach, including tools to be used such as databases, reports, etc. Describe system for identifying and tracking M&P approval status. d. M&P procurement, processing and testing methodology and strategies. Identify internal operating procedures to be used for incoming inspections, screening, qualification testing, derating, testing of M&P pulled from stores, DPA, radiation assessments, etc. e. M&P vendor surveillance and audit plan. f. Electrostatic Control Plan g. Flow-down of MPCP requirements to sub-developers. h. May be part of the developer/contractor Assurance Implementation Plan	

DID SA-22: As-Designed Materials and Processes List

Title: As-Designed Materials and Processes List	**CDRL Number:** SA-22
Reference: MAR Section 12.4	
Use: Listing of Materials and Processes intended for use in space flight hardware.	
Related Documents: N/A	
Place/Time/Purpose of Delivery: Submission to GSFC Project Office 30 days prior to PDR for review and CDR for approval. Updates as required, including changes.	
Preparation Information: The As-Designed Materials and Processes List (ADMPL) shall be compiled by instrument, instrument component, or SC component, and shall include the following information at a minimum: a. Materials and Processes name b. Materials and Processes number c. Manufacturer d. Manufacturer's generic Materials and Processes number e. Procurement specification Any format may be used, provided the required information is included. All submissions to GSFC Project Office will include a paper copy and a computer readable form.	

DID SA-23: Parts Stress Analysis

Title: Parts Stress Analysis	**CDRL Number:** SA-23
Reference: MAR Section 4.3.3	

Use:

Provides EEE parts stress analyses for evaluating circuit design and conformance with derating guidelines. Demonstrates that environmental operational stresses on parts comply with project derating requirements.

Related Documents:

NASA Parts Selection List

Place/Time/Purpose of Delivery:

Final 45 days before CDR for GSFC approval
Updates to include changes as required for GSFC approval

Preparation Information:

The stress analysis report shall contain:

a. Ground rules for the analysis.
b. References to documents and data used.
c. Statement of the results and conclusions.
d. Analysis worksheets, which shall include (at a minimum):
   - Part identification (traceable to circuit diagrams)
   - Environmental conditions assumed (consider all expected environments)
   - Rated stress
   - Applied stress (consider all significant operating parameter stresses at the extremes of anticipated environments)
   - Ratio of applied-to-rated stress

DID SA-24: Worst Case Analysis

Title: Worst Case Analysis	**CDRL Number:** SA-24
Reference: MAR Section 4.3.4	
Use: To demonstrate the adequacy of margin in the design of electronic and electrical circuits, optics, and electromechanical and mechanical items.	
Related Documents: NPD 8720.1, "NASA Reliability and Maintainability (R&M) Program Policy" NASA-STD-8729.1, "Planning, Developing and Managing an Effective R&M Program"	
Place/Time/Purpose of Delivery: Available 30 days prior to pre-CDR subsystem peer reviews to GSFC for approval. Updates with design changes.	
Preparation Information: These analyses shall address the worst case conditions for the analysis performed on each component. Each analysis shall cover the mission life and consider the critical parameters set at maximum and minimum limits, including the effect of environmental stresses on the operational parameters being evaluated.	

DID SA-25: Limited-Life Items List

Title: Limited Life Items List	**CDRL Number:** SA-25
Reference: MAR Section 4.4	
Use: Defines and tracks the selection, use and wear of limited-life items, and the impact on mission operations.	
Related Documents: N/A	
Place/Time/Purpose of Delivery: Preliminary 30 days before PDR for GSFC Project Office review. Final 30 days before CDR for approval. Updates as changes are made, and between CDR and Delivery, for approval.	
Preparation Information: List limited-life items and their impact on mission parameters. Define expected life, required life, duty cycles, and basis for selecting and using the items. Include selected structures, thermal control surfaces, solar arrays, and electromechanical devices. Atomic oxygen, solar radiation, shelf-life, extreme temperatures, thermal cycling, wear and fatigue are used to identify limited-life control surfaces and structural items. When aging, wear, fatigue, and lubricant degradation limit their life, include batteries, compressors, seals, bearings, valves, tape recorders, momentum wheels, hinge assemblies, drive assemblies, gyros, actuators, and scan devices.	

LAUNCH SUPPORT DIDS

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
LS-1	INPUTS TO LAUNCH VEHICLE INTERFACE REQUIRMENTS DOCUMENT (IRD)

3. Reference:

SOW 7.1.1

4. Use:

This is the first Launch Support document and is designed to provide the initial definition of Observatory requirements, interface details, launch site facilities, and preliminary safety data to the launch service provider.

5. Preparation Information:

The Contractor will receive a questionnaire to complete. The questionnaire contains a set of questions whose answers define the requirements and interfaces as they are known at the time of preparation.

A definitive response to some questions may not be possible because many items are defined at a later date. Normally this document would not be kept current; it will be used to create the initial version of the ICD (CDRL LS-3) and in support of the launch service provider's launch permit (Federal Aviation Administration).

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: LS-2

2. Title: OBSERVATORY MATHEMATICAL MODEL FOR DYNAMIC ANALYSIS

3. Reference:

SOW 7.1.2

4. Use:

An Observatory mathematical model is required for use in a coupled loads analysis (CLA) done by the launch services provider.

5. Preparation Information:

Acceptable forms include (1) a discrete math model with associated mass and stiffness matrices or (2) a constrained normal mode model with modal mass and stiffness and the appropriate transformation matrices to recover internal responses. Required model information such as specific format, degree-of-freedom requirements, and other necessary information will be supplied by the launch services provider. This information is required at three times:

1) Initial input at L-24 months - this is needed so CLA can be provided as input to the dynamic clearance analysis and provides the initial maximum lateral load factors for lift/off transonic

2) Update at L-18 months for second CLA - input to second clearance analysis;

3) Verified/validated at L-38 Weeks for VLC (Verified Load Cycle- model verified by Observatory environmental testing)

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: 2. Title:

LS-3 INPUTS TO LAUNCH VEHICLE INTERFACE CONTROL DOCUMENT

3. Reference:

SOW 7.1.2

4. Use:

This is the launch vehicle/Observatory interface control document prepared by the launch services provider based on Observatory contractor inputs. It contains the Observatory description, Observatory-to-blockhouse wiring diagram, compatibility drawing, targeting criteria, special Observatory requirements affecting the standard launch vehicle, description of special ground equipment and facilities the launch services provider is required to furnish.

5. Preparation Information:

The initial issue is based on data provided in the interface requirements document. Subsequent issues are published as requirements and data become available. The mission-specific requirements documented in the mission specification along with the standard interfaces issued by the launch services provider define the Observatory-to-launch vehicle interface.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: LS-4

2. Title: OBSERVATORY ENVIRONMENTAL TEST DOCUMENTS

3. Reference:

SOW 7.1.5

4. Use:
This CDRL consists of the Environmental Test Plan and the Environmental Test Reports. The environmental test plan documents the contractor's approach for qualification and acceptance tests. The Environmental Test Reports summarize the tests performed.

5. Preparation Information:

The Environmental Test Plan is intended to provide the general test philosophy and an overview of the systems-level environmental testing to be performed to demonstrate the adequacy of the Observatory for flight (e.g., RF, static loads, vibration, acoustics, shock). The test plan should include test objectives, test specimen configuration, general test methods, and a schedule. It should not include detailed test procedures.

The Environmental Test Reports summarize the results of the system-level structural loads and dynamic environment testing. These reports shall summarize the testing performed to verify the adequacy of the Observatory structure for the flight loads. For any structural systems not verified by test, a structural loads analysis report documenting the analysis performed and the resulting margins of safety should be provided.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
LS-5	ELECTRICAL WIRING REQUIREMENTS

3. Reference:

SOW 7.1.2

4. Use:

The Electrical Requirements Wiring document defines the hardware interface from the Observatory to the blockhouse for control and monitoring of Observatory functions after Observatory installation in the launch vehicle.

5. Preparation Information:

The wiring requirements for the Observatory to the blockhouse are needed as early as possible. The launch services provider will prepare an Observatory-to-blockhouse wiring diagram based on the Observatory requirements. Any requirements for the payload processing facilities are to be furnished with the blockhouse information.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: LS-6

2. Title: FAIRING REQUIREMENTS

3. Reference:

SOW 7.1.2

4. Use:

This document provides the final Observatory requirements used to define the mission-specific fairing modifications made during production.

5. Preparation Information:

Early Observatory fairing requirements should be addressed in the IRD (LS-1) and updated in the ICD (LS-3). Any in-flight requirements, ground requirements, critical Observatory surfaces, surface sensitivities, mechanical attachments, RF transparent windows, and internal temperatures on the ground and in flight must be provided.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: LS-7

2. Title: RADIATION USE REQUEST/AUTHORIZATON

3. Reference:

- SOW 7.1.4

4. Use:

To obtain use of RF spectrum during ground processing and launch.

5. Preparation Information:

The Observatory agency is required to specify the RF transmitted by the Observatory during ground processing and launch. An RF data sheet specifying individual frequencies and names and qualifications of Observatory user personnel who will operate the system will be provided. Transmission frequency bandwidths, frequencies, radiated durations, power, etc., will be provided. The launch services provider will forward these data to the appropriate range/government agencies for approval. . The data will also be used for the L/V performed RF compatibility analysis.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
LS-8	INPUTS TO PERFORMANCE AND GUIDANCE ACCURACY ANALYSIS (PGAA)

3. Reference:

SOW 7.1.6

4. Use:

These analyses are done by the launch services provider. They are intended to uncover and resolve any unusual problems inherent in accomplishing the mission objectives. Information pertaining to vehicle environment, performance capability, sequencing, and orbit dispersion is presented. Parametric performance and accuracy data are provided to assist the Observatory contractor in selection of the final mission-orbit requirements. The orbit dispersion data are presented in the form of variations of the critical orbit parameters as functions of probability level.

5. Preparation Information:

TFA (Trajectory Feasibility Analysis) at L-94 weeks:
PMA (Preliminary Mission Analysis) at L-66 weeks;
DTO (Detailed Test Objective) at L-38 weeks;
BET (Best Estimate Trajectory) at L-4 weeks

This analysis is done in several stages by the launch services provider using inputs provided by the Observatory contractor. This CDRL describes the data the Observatory contractor is to provide the launch services provider. The template for the DTO is very similar to the information needed for the TFA and PMA. The general information in the DTO template is:

- Observatory inputs to Launch Vehicle description (payload attach fitting)
- Observatory Requirements
  - Mission Objectives
  - Observatory Coordinate System
  - Observatory Mass Properties
  - Nutation time constants
- Mission Requirements
  - Launch window
  - Injection orbit characteristics
  - Orbit dispersions
  - Probability of commanded shutdown

Observatory separation attitude/tip-off requirements
Sun angle constraints
Telemetry requirements/constraints
Thermal attitude constraints
Contamination constraints

- Analysis Requirements (including, but not limited to, the following):
  - Trajectory simulation to update mass performance based on the specified mission requirements/constraints and targets.
  - Observatory propagation
  - Sun-angle data
  - Expected orbit dispersion at Observatory separation
  - Telemetry ground stations [and required mobile assets] elevation and azimuth angles along with respective acquisition/loss of signal times.
  - Sequence of flight events from lift-off through end of mission.

For the BET delivery, data already supplied by the Observatory contractor may be sufficient. The guided simulation is based on targeting defined in the DTO trajectory, which can be adjusted slightly based on final Observatory contractor inputs. The final Observatory weight is needed as an input. The Observatory is usually weighed by the launch services provider.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: 2. Title:

LS-9 MISSION OPERATIONAL AND SUPPORT REQUIREMENTS

3. Reference:

SOW 7.1.3

4. Use:

To obtain unique range and network support.

5. Preparation Information:

The Observatory contractor must define any range or network requirements (operational configuration, communications, tracking, data flow) appropriate to the mission and submit them to the launch services provider.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
LS-10	INPUTS TO PROGRAM REQUIREMENTS DOCUMENT (PRD)

3. Reference:

SOW 7.1.3

4. Use:

To obtain range and network support an Observatory PRD must be prepared

5. Preparation Information:

This CDRL consists of a set of pre-printed standard forms (with associated instructions) that must be completed and submitted to the launch services provider. The launch services provider will compile, review, provide comments, and, upon comment resolution, forward the Observatory PRD to the appropriate support agency for formal acceptance.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: 2. Title:

LS-11 PAYLOAD PROCESSING REQUIREMENTS DOCUMENT

3. Reference:

SOW 7.1.4

4. Use:

The PPRD is prepared if commercial facilities are to be used for Observatory processing. The Observatory contractor is required to provide data on all Observatory activities to be performed at the commercial facility.

<NOTE: This CDRL is needed only if commercial processing facilities are to be used - launch services are GFE so that will be a NASA decision. DID will be included or not accordingly>

5. Preparation Information:

Data required includes detailed information of all facilities, services, and support requested by the launch service contractor to be provided by the commercial facility. Observatory hazardous systems descriptions shall include drawings, schematics, summary test data, and any other available data that will aid in appraising the respective hazardous system. The commercial facility will accept Observatory ground operations plans and/or MSPSP data as input to the PPRD.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
LS-12	LAUNCH WINDOW

3. Reference:

SOW 7.1.4

4. Use:

The Observatory contractor is required to specify the maximum launch window for any given day.

5. Preparation Information:

The window opening time (preferably to the nearest minute) and the window closing time (nearest minute) are to be specified. The final window data should extend for at least 2 weeks beyond the scheduled launch date. Liftoff is targeted to the specified window opening unless otherwise instructed by the Observatory contractor

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DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
LS-13	OBSERVATORY DRAWINGS

3. Reference:

SOW 7.1.2

4. Use:

The launch services provider prepares the Observatory compatibility drawing that will become part of the ICD. The launch services provider uses the Observatory drawings submitted under this CDRL as input to the process of preparing the compatibility drawings. This is a working drawing that identifies Observatory-to-launch vehicle interfaces. It defines electrical interfaces; mechanical interfaces, including Observatory-to-PAF separation plane, separation springs and spring seats, and separation switch pads; definition of stay out envelope, both internal and external to the PAF; definition of stay-out envelopes within the fairing; and location and mechanical activation of spring seats. The Observatory contractor reviews the drawing and provides comments, and upon comment resolution and incorporation of the final Observatory drawings, the compatibility drawing is formally accepted as a controlled interface between the launch vehicle contractor and the Observatory contractor. The data is also used to perform a static clearance check.

5. Preparation Information:

Observatory configuration drawings are required as early as possible. The drawings should show nominal and worst-case (maximum tolerance) dimensions to the launch vehicle contractor-prepared compatibility drawing, fairing compatibility, and other interface details.

Also required are the build drawings for the PAF ring, the S/C electrical umbilical cables and any other mission unique hardware that interfaces with LV that the Observatory contractor is building (i.e., if a T-O purge is requested, the drawings of that interface). These are used as verification of the interface.

Preliminary drawings are desired with the Input to Launch Vehicle IRD (LS-1) but no later than 78 weeks prior to launch. Observatory drawings should be submitted to the launch vehicle services contractor in both 20.20 scale hardcopy and electronic formats. STEP is preferred. Suggested electronic submittal is CD or 8mm digital audio tape (DAT) of Observatory model in IGES format.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
LS-14	OBSERVATORY LAUNCH SITE TEST PLAN

3. Reference:

SOW 7.1.4

4. Use:

To provide all agencies with a detailed understanding of the launch site activities and operations planned for a particular mission, the Observatory contractor is required to prepare a launch site test plan.

5. Preparation Information:

The plan is intended to describe all aspects of the program awhile at the launch site.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
LS-15	OBSERVATORY LAUNCH SITE TEST PROCEDURES

3. Reference:

SOW 7.1.4

4. Use:

Operating procedures must be prepared for all operations that are accomplished at the launch site.

5. Preparation Information:

For those operations that are hazardous in nature (either to equipment or personnel), special instructions must be followed in preparing the procedures.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
LS-16	INPUTS TO OBSERVATORY INTEGRATED OPERATIONS

3. Reference:

SOW 7.1.4

4. Use:

For each mission, the launch services provider prepares launch site procedures for various operations that involve the Observatory after it is mated with the launch vehicle upper stage.Included are the reuirements for operations such as Observatory weighing, Observatory installation to the second stage and into the handling can, Observatory transportation to the launch complex, Observatory hoisting into the white room, handling can removal, Observatory mating to the launch vehicle. Fairing installation, flight program verification test, and launch countdown.

5. Preparation Information:

The launch services provider needs inputs to these procedures in the form of handling constraints, environmental constraints, personnel requirements, equipment requirements, etc.Of particular interest are Observatory tasks/requirements during the final week before launch.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
LS-17	OBSERVATORY MASS PROPERTIES STATEMENT

3. Reference:

SOW 7.1.6

4. Use:

The data from the Observatory Mass Report are used in orbit error control, performance and separation analyses.

5. Preparation Information:

The mass report represents the current estimate of final mass properties. These data should include any changes in mass properties while the Observatory is attached to the launch vehicle. Values quoted should include nominal and 3-sigma uncertainties for mass, centers of gravity, moments of inertia, products of inertia, and principal axis misalignment.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: LS-18

2. Title: INPUT TO OBSERVATORY/LAUNCH VEHICLE SEPARATION MEMORANDUM

3. Reference:

SOW 7.1.6

4. Use:

An analysis is performed to verify that there is adequate clearance and separation distance between the Observatory and expended payload attach fitting (PAF). For two-stage missions this analysis verifies adequate clearance exists between the Observatory and second stage during separation and second stage post-separation maneuvers.

5. Preparation Information:

If LDCM is a three-stage mission, NTC analysis values are to be provided. The other required input is mass properties.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
LS-19	POST-LAUNCH ORBIT CONFIRMATION DATA

3. Reference:

SOW 7.1.6

4. Use:

To reconstruct launch vehicle performance, orbit data at burnout are required from the Observatory contractor.

5. Preparation Information

The Observatory contractor should provide orbit conditions at the burnout epoch based on Observatory tracking data prior to any orbit-correction maneuvers. A complete set of orbital elements and associated estimates of 3-sigma accuracy are required.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: LS-20

2. Title: RADIO FREQUENCY APPLICATOIN

3. Reference:

SOW 7.1.4

4. Use:

If the Observatory contractor plans to radiate at the launch site, an FCC license should be obtained by the Observatory contractor. This will assure the Observatory contractor that the Observatory frequency will not be interfered with during use.

5. Preparation Information:

The launch services provider will assist the Observatory contractor in this process.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
LS-21	INPUT TO OBSERVATORY VENTING ANALYSIS

3. Reference:

SOW 7.1.2

4. Use:

The launch services provider conducts venting analysis using Observatory vented and unvented volumes as defined by the Observatory contractor.

5. Preparation Information:

These data would normally be obtained through analysis of the Observatory and instrument CAD 3-D models, released drawings, and the Observatory mass report (CDRL LS-17)

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: 2. Title:

LS-22 OBSERVATORY THERMAL MODEL

3. Reference:

SOW 7.1.2

4. Use:

This launch services provider analysis uses the thermal model to predict temperature profiles within the fairing.

5. Preparation Information:

The thermal model must be in TRASYS and SINDA85/Fluient with a negotiable limit of up to 500 nodes.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: 2. Title:

LS-23 OBSERVATORY SLOSH MODEL

3. Reference:

SOW 7.1.2

4. Use:

Used by the launch services provider in the dynamic analysis of the integrated Launch vehicle and Observatory.

5. Preparation Information:

Model to be provided in the same format as the Observatory mass model (CDRL LS-2)

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
LS-24	LAUNCH COMMIT CRITERIA

3. Reference:

SOW 7.2.1

4. Use:

To provide a list of conditions which must be met to proceed with launch.

5. Preparation Information:

This deliverable documents the launch commit criteria and the criteria to be used to commit the LDCM Observatory for launch. The document shall address the LDCM Observatory, the Observatory launch control center(s), and associated activities prior to liftoff.

Each telemetry parameter shall be tabulated with its acceptable values, tolerances, and out-of-limits conditions which would require a resolution prior to launch.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
LS-25	LAUNCH AND EARLY ORBIT PROCEDURE

3. Reference:

SOW 7.2.1

4. Use:

The Launch-to-Orbit Procedure is required to coordinate the launch operation between the launch vehicle organization, the LDCM Project, and the Mission Operations Control Center (MOCC).

5. Preparation Information:

The LDCM Launch-to-Orbit Procedure contains the LDCM Observatory sequences required for the MOCC to support the LDCM operational events during the launch phase of the mission. These procedures are applicable from launch vehicle-Observatory separation until the LDCM Observatory is configured for on-orbit operation prior to the start of the on-orbit system test activities.

The procedure shall include a detailed flight time line and script of each communications stations' required action and response. This will include all positions, call signs, and responsibilities of each primary person of the launch team, including LDCM Project and contractor representatives at the launch site and the MOCC.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: LS-26

2. Title: LAUNCH TELEMETRY DATA

3. Reference:

SOW 7.2.1

4. Use:

To provide the Government data on the functional performance of the LDCM Observatory during the pre-launch, launch, deployment and on-orbit test phases of the mission.

5. Preparation Information:

This deliverable consists of LDCM Observatory telemetry from 24 hours preceding launch until on-orbit Observatory acceptance by the Government. This deliverable includes a timeline of planned events during this period.

This data shall be provided real time at the GSFC.

This telemetry shall be in a format compatible with the RTMS.

MISSION OPERATIONS ELEMENT DIDS

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
MO-1	MISSION OPERATIONS ELEMENT PRE-GROUND SYSTEM REQUIREMENTS REVIEW (GSRR) PEER REVIEW PACKAGE

3. Reference:

SOW 1.2.1.2

4. Use:

To evaluate the Mission Operations Element System requirements, requirements flow-down, and the operational concepts and to validate the realism of the functional and performance requirements and their congruence with the system configuration selected to conduct the mission. The MOE SRR is part of the LDCM Ground System SRR and therefore the MOE SRR Package will be combined with the LDCM Ground System SRR Package to be presented together.

5. Preparation Information:

The MOE GSRR Peer Review Package shall discuss contractor subsystem level requirements and rationale.

The MOE GSRR Peer Review Package shall show the allocation and traceability of requirements to major subsystem components.

The MOE GSRR Peer Review Package shall cover requirements for the MOE System data processing algorithms, all MOE subsystems, performance, data types and conversions, internal interfaces and external interfaces.

The MOE GSRR Peer Review Package shall show how the current concept meets all government specified MOE requirements including interface requirements.

The MOE GSRR Peer Review Package shall show that all system and performance requirements and interfaces, derived from the MOERD, are understood and compatible with LDCM Observatory specifications, design, and implementation.

The MOE GSRR Peer Review shall present the results of the MOE Software and Hardware Trade Studies.

The MOE GSRR Peer Review shall present evaluation of any performance or schedule risks that may affect the LDCM Observatory Development.

Results of Review—As a result of successful completion of the MOE GSRR Peer Review, the subsystem and its operation are well enough understood to proceed to design and acquisition of the end items. Approved specifications for the subsystem and its components may be released. For long lead items that are required to be ordered prior to SRR to meet development schedules, the Contractor shall obtain approval from the Government Contracting Officer prior to ordering these items.

The GSRR Peer Review presentation shall also be used to present the MOE Operations Concept to the customer**.** The MOE Operations Concept Review Package shall be a Power Point presentation which will be presented by the Contractor to the Government customer. This Review Package shall include key operational concepts, work flow process – including day-in-the-life operations scenarios and use cases for operating the LDCM, and a candidate operations staffing profile based on the Contractor's proposed MOE systems design approach.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
MO-2	MOE PRE-GPDR PEER REVIEW PACKAGE

3. Reference:

SOW 1.2.1.2

4. Use:

To demonstrate MOE System high-level design meets the documented functional and performance requirements. Also, the MOE PDR will be used to present any hardware or software trade studies pertinent to the selection of MOE hardware and MOE COTS software. The MOE PDR is part of the LDCM Ground System PDR and therefore the MOE SRR Package will be combined with the LDCM Ground System PDR Package to be presented together.

5. Preparation Information:

The MOE Pre-GPDR Peer Review shall address the proposed high level design of the MOE System and Subsystems. This design review shall trace down to the subsystem component level. The MOE Pre-GPDR Peer Review at a minimum shall include the following:

a. The MOE Key Requirements and General Specification
b. The Mission Operations Center (MOC) Concept of Operations.
c. The MOE requirements and design changes since the SRR.
d. Address the MOE functional and performance requirements and their flow-down to the component level.
e. The MOE subsystem performance budgets.
f. The MOE error budget determination.
g. All MOE subsystem interface requirements.
h. Open MOE interface items and the status of any MOE related IRDs including compatibility with the LDCM Observatory system design and implementation.
i. The high-level functional break down of the MOE System into subsystems and the interfaces/interactions between the subsystems.
j. The high-level functional break down of each MOE subsystem into components and the interfaces/interactions between the components.
k. All pertinent architecture drawings such as interface diagrams, data flow diagrams, component diagrams, activity diagrams, etc.
l. Lights-Out Automation.

m. Anomaly resolution and response.
n. Mock-ups of subsystem key graphical user interfaces (GUIs).
o. Address software requirements, design, and development environment.
p. Address design verification and test plans.
q. Address the MOE subsystems operations concepts, as appropriate.
r. Modes of operation of the MOE System and Subsystems.
s. Long-lead items and items that may become obsolete prior to completion of MOE development
t. Delineate the status of each document required at PDR as to its acceptability for use as is.
u. Present all MOE System and Subsystem program risks and address their mitigation plans.
v. MOE System and Subsystem Development schedules
w. Address the MOE software assurance process.
x. Address physical and IT security

Contractor MOE COTS Software Trade Studies performed shall also be presented at the pre-PDR Peer Review. The MOE COTS Software Trade Study Review Package shall be a Power Point presentation which will be presented by the Contractor to the Government customer. This Review Package shall include information and findings from the MOE COTS Software Trade Study Report reformatted as Power Point slides. The MOE COTS Software Trade Study Review Package shall review the recommended COTS products along with which functional and performance requirements are fulfilled by each product. The MOE COTS Software Trade Study Review Package shall include a discussion of any performance and schedule risks along with a risk mitigation plan.

Contractor performed MOE Hardware Trade Studies shall also be presented at the pre-PDR Peer Review**.** The MOE COTS Software Trade Study Review Package shall be a Power Point presentation which will be presented by the Contractor to the Government customer. This Review Package shall include information and findings from the MOE COTS Software Trade Study Report reformatted as Power Point slides. The MOE COTS Software Trade Study Review Package shall review the recommended COTS products along with which functional and performance requirements are fulfilled by each product. The MOE COTS Software Trade Study Review Package shall include a discussion of any performance and schedule risks along with a risk mitigation plan.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
MO-3	MOE PRE-CDR PEER REVIEW PACKAGE

3. Reference:

SOW 1.2.1.2

4. Use:

The MOE Pre-CDR Peer Review package is used to present the MOE System and Subsystems low-level design, to demonstrate that the design meets all performance and otherwise critical functional requirements and demonstrate that all needed design documentation is in place and approved before proceeding with implementation.

5. Preparation Information:

The MOE Pre-CDR Peer Review shall address the proposed low level design of the MOE System and Subsystems. This design review shall go down to the software class level. The MOE CDR shall address software and hardware design issues. The MOE Pre-CDR Peer Review at a minimum shall include the following:

a. Responses to action items from previous reviews, including system CDRs and the MOE PDR.
b. Design and requirements changes since the last review and the plan for disposition.
c. Address the development and/or procurement status of long lead items.
d. Address mission assurance product checkpoints and evaluation criteria.
e. Address standard applicable in-house software processes.
f. Address hardware and network equipment required for development and operations.
g. Address personnel resources (time phased) for development.
h. Address the MOE System and Subsystems development and delivery schedules.
i. Performance specification
j. Final calculations of system performance
k. Block diagrams and description of software components within each subsystem
l. Decomposition of the subsystem software components into executables and classes
m. UML software design diagrams (object models, class diagrams, sequence diagrams, etc.)
n. Description of key design classes
o. Address the extensibility of the subsystem designs.
p. Address the modes of operation of the subsystems.

q. Address MOE subsystem test plans.
r. Address subsystem maintainability considerations.
s. Address any COTS products and licenses involved for the implementation of the MOE subsystems.
t. Provide a summary of deviations/waivers.
u. Address single point failure summaries.
v. Address subsystem failover design.
w. Address subsystem redundancy and strings.
x. Delineate the status of each document as to its acceptability for use as is. If updates and/or changes are required, these shall be estimated in required man-hours.
y. Address open interface items and the status of any IRDs.
z. Address the simulation operations concept.
aa. Present results and data from any related proof of concept testing.
bb. Present results and data from any related prototype testing.
cc. Present key updated graphical user interfaces.
dd. Address the status of all program risks resulting from the MOE System and Subsystem development and their mitigation plans
ee. Address the role of the MOE/MOC in system wide testing.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: 2. Title:

MO-4 MOE CONCEPT OF OPERATIONS DOCUMENT

3. Reference:

SOW 5.1.1.1

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4. Use:

The purpose of this document is to define conceptually how the LDCM MOE will be operated and maintained as part of the LDCM Mission.

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5. Preparation Information:

The MOE Concept of Operations Document shall describe the methodology required to operate and maintain the Mission Operations Element. Relative to the contractors design (including any and all MOE hardware, software and personnel) the operations concept shall address:

a. MOE operational environment

b. MOE Operational Scenarios and Use Cases

c. Element to Segment Traceability

d. Subsystem to Element Traceability

e. MOE System Overview

f. MOE Modes of Operation

g. MOC Operations staffing required by the contractor's design

h. Non-MOC operations staffing required by the contractor's design

i. MOE Hardware and Network

j. MOE COTS Products and Licenses

k. High Level Architecture and Functional Flow Diagrams

l. Overview of Internal and External Interfaces

m. Unique MOE logistics, hardware and software maintenance and sustaining engineering

n. Overview of Command and Control Operations

o. Overview of Planning and Scheduling Operations including discussions of external scheduling interfaces and LTAP

p. Overview of Command Load Generation

q. Overview of Trending and Analysis Operations

r. Overview of Flight Dynamics Operations

s. Overview of Simulation Operations

t. Overview of Flight Software Maintenance Operations

u. Overview of Anomaly Resolution and Support

v. Overview of Lights Out Automation Capabilities

w. User Support Operations

x. Discussion of Functionality, Software, Hardware in the Primary and Backup MOEs

y. MOE System Fail Over Concept

z. MOE functional data transfer and interface to the BMOC MOE System suite

aa. Redundancy

bb. No Single Point of Failure Concept

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
MO-5	MISSION OPERATIONS ELEMENT INTERFACE CONTROL DOCUMENTS

3. Reference:

SOW 2.2
SOW 5.1.1

4. Use:

The MOE Interface Control Documents will specify each of the external interfaces with the MOE including type of interface and data exchanged. There will be one MOE ICD for each of the MOE external interfaces. There will be a government provided IRD for each of the MOE external interfaces and it is the contractor's responsibility to write the corresponding ICD. The first version of the MOE ICDs shall be presented at PDR and the final version presented at CDR.

5. Preparation Information:

For each of the Mission Operations Element external interfaces there shall be a contractor provided Interface Control Document provided which will detail each interface. Details shall include the type of interface (API, telephone, etc), type of data exchanged and format of the data. The ICDs shall also make clear who owns the interface and has control of the interface format.

The MOE Interface Control Documents that shall be provided by the contractor are as follows:

A. MOE to MOC ICD

B. MOE to Collection Activity Planning (CAP) ICD

C. MOE to Space Network (SN) ICD

D. MOE to Landsat Ground Network (LGN) ICD

E. MOE to International Collaborators (ICs) ICD

F. MOE to Data Processing and Archive Segment (DPAS) ICD

G. MOE to Flight Dynamics Facility (FDF) ICD

H. MOE to Launch Segment ICD

I. MOE to Flight Software Maintenance ICD

J. MOE to BMOC MOE System Suite

The Interface Control Documents shall contain at a minimum:

a. Data and media formats
b. Data rates
c. Duty cycles
d. Protocols
e. Physical interfaces
f. Error conditions
g. Timing
h. Security

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
MO-6	MISSION OPERATIONS ELEMENT SYSTEM LOWER-LEVEL REQUIREMENTS DOCUMENT

3. Reference:

SOW 5.1.1

4. Use:

Stipulates functionality required of each of the Mission Operations Element Subsystems derived from the Mission Operations Element Requirements Document (MOERD) (NASA GSFC 427-XXX) (TBD) and other Government provided requirements reference documentation.

5. Preparation Information:

A separate subsystem requirements document shall be written for each of the MOE subsystems.

The Mission Operations Element System Lower-Level Requirements Documents shall at a minimum contain the following items:

a. Mission Operations Element Level 4 and MOE Subsystem level 5 requirements
b. All requirements relating to the MOE external interfaces
c. All requirements relating to the MOE internal interfaces
d. All requirements necessary to define the functionality required of the each Mission Operations Element
e. All requirements relating to the performance of the Mission Operations Element
f. All requirements related to fault detection and handling within the Mission Operations Element
g. All requirements related to check-pointing and logging of operational data
h. All requirements related to persistent storage of operations data
i. All requirements related to modes of operation of the Mission Operations Element
j. All requirements related to MOE System displays
k. All requirements related to allowable data types and data conversions
l. All requirements related to Mission Operations Element alerts and warnings
m. All requirements related to access control requirements
n. Provide traceability to parent requirements documentation.

The Mission Operations Element System Lower-Level Requirements Documents shall provide meta data for each requirement including the following:

a. Requirement number

b. Subsystem
c. Test method
d. Author
e. Date written
f. Authorization

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
MO-7	MOE GROUND SYSTEM PRELIMINARY DESIGN REVIEW (GPDR) PACKAGE

3. Reference:

SOW 1.2.1.2

4. Use:

To demonstrate MOE System high-level design meets the documented functional and performance requirements. Also, the MOE PDR will be used to present any hardware or software trade studies pertinent to the selection of MOE hardware and MOE COTS software. The MOE PDR is part of the LDCM Ground System PDR and therefore the MOE GPDR Package will be combined with the LDCM Ground System PDR Package to be presented together.

5. Preparation Information:

The MOE Ground System Preliminary Design Review Package shall address the proposed high level design of the MOE System and Subsystems. This design review is a higher-level summary of the MOE Pre-PDR Peer Review. The MOE GPDR Package at a minimum shall include a summary of the following items that were presented at the Pre-GPDR Peer Review:

a. The MOE Key Requirements and General Specification
b. The Mission Operations Center (MOC) Concept of Operations.
c. The MOE requirements and design changes since the SRR.
d. Address the MOE functional and performance requirements
e. The MOE subsystem performance budgets.
f. The MOE error budget determination.
g. Open MOE interface items and the status of any MOE related IRDs including compatibility with the LDCM Observatory system design and implementation.
h. The high-level functional break down of each MOE subsystem into components and the interfaces/interactions between the components.
i. All pertinent architecture drawings such as interface diagrams, data flow diagrams, component diagrams, activity diagrams, etc.
j. Lights-Out Automation.
k. Anomaly resolution and response.
l. Address software requirements, design, and development environment.
m. Address design verification and test plans.

n. Modes of operation of the MOE System and Subsystems.
o. Long-lead items and items that may become obsolete prior to completion of MOE development
p. Delineate the status of each document required at PDR as to its acceptability for use as is.
q. Present all MOE System and Subsystem program risks and address their mitigation plans.
r. MOE System and Subsystem Development schedules

The MOE COTS Software Trade Studies results presented at the Pre-PDR Peer Review shall be summarized and presented at the PDR.

The MOE Hardware Trade Studies results presented at the Pre-PDR Peer Review shall be summarized and presented at the PDR**.**

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
MO-8	MOE GROUND SYSTEM CRITICAL DESIGN REVIEW (GCDR) PACKAGE

3. Reference:

SOW 1.2.1.2

4. Use:

The MOE CDR-package is used to present the MOE System and Subsystems low-level design, to demonstrate that the design meets all performance and otherwise critical functional requirements and demonstrate that all needed design documentation is in place and approved before proceeding with implementation. The MOE CDR is part of the LDCM Ground System CDR and therefore the MOE GCDR Package will be combined with the LDCM Ground System CDR Package and presented together.

5. Preparation Information:

The MOE Ground System Critical Design Review shall address the proposed low level design of the MOE System and Subsystems. This design review summarize the information presented at the MOE Pre-CDR Peer Review. The MOE GCDR Package at a minimum shall include the following:

1. Responses to action items from previous reviews, including the MOE PDR.
2. Design and requirements changes since the last review and the plan for disposition.
3. Address the development and/or procurement status of long lead items.
4. Address mission assurance product checkpoints and evaluation criteria.
5. Address standard applicable in-house software processes.
6. Address hardware and network equipment required for development and operations.
7. Address personnel resources (time phased) for development.
8. Address the MOE System and Subsystems development and delivery schedules.
9. Performance specification
10. Final calculations of system performance
11. Address the modes of operation of the subsystems.
12. Address MOE subsystem test plans.
13. Address subsystem maintainability considerations.

14. Provide a summary of deviations/waivers.
15. Address single point failure summaries.
16. Address subsystem failover design.
17. Address subsystem redundancy and strings.
18. Delineate the status of each document as to its acceptability for use as is. If updates and/or changes are required, these shall be estimated in required man-hours.
19. Address open interface items and the status of any IRDs.
20. Address the simulation operations concept.
21. Present summary results from any related proof of concept testing.
22. Present summary results from any related prototype testing.
23. Address the status of all program risks resulting from the MOE System and Subsystem development and their mitigation plans
24. Address the role of the MOE/MOC in system wide testing.

a.

DESCRIPTION OF REQUIRED DATA

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1. CDRL No.: 2. Title:

MO-9 MOE SUBSYSTEM INTEGRATION TEST PLANS

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3. Reference:

SOW 5.1.1

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4. Use:

The MOE Subsystem Integration Test Plans describe integration activities planned for the contractor designed MOE Subsystems. A separate integration test plan will be written for each of the contractor's subsystems using the preparation information listed below.

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5. Preparation Information:

The MOE Subsystem Integration Test Plans shall describe in detail the integration test activities associated with each MOE Subsystem along with expected outcomes and results.

Each Subsystem Integration Test Plan shall contain the following items:

a. List 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
b. 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
c. List the test cases to be run on each executable in the subsystem
d. 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
e. Indicate the name and location of output files used to verify the outcome of each test case

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
MO-10	MOE SUBSYSTEM VERIFICATION TEST PLANS

3. Reference:

SOW 5.1.1

4. Use:

The MOE Subsystem Verification Test Plans describe test activities planned for the MOE Subsystems in order to verify requirements allocated to each subsystem within the MOE. A separate test plan will be written for each of the contractor's subsystems using the preparation information listed below.

5. Preparation Information:

The MOE Subsystem Verification Test Plans shall describe in detail the test activities associated with each MOE Subsystem along with expected outcomes and results.

The MOE Subsystem Verification Test Plans shall include the following items:

a. List 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
b. 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
c. List the test cases to be run on each executable in the specific subsystem
d. 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
e. Indicate the name and location of output files used to verify the outcome of each test case
f. List the requirements allocated to the test plan
g. Include the evaluation criteria for each requirement allocated to the test plan
h. Include the evaluation results for each requirement allocated to the test plan
i. Indicate the test case(s) that fully or partially verify each requirement allocated to the test plan
j. Indicate key individuals associated with the test plan, such as tester(s), software development support, test lead, chief engineer and verification engineer

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
MO-11	MISSION OPERATIONS ELEMENT INTERNAL END-TO-END TEST PLAN

3. Reference:

SOW 5.1.1

4. Use:

The MOE Operations Internal End-to-End Test Plan is used to describe the end-to-end tests to be performed on the Mission Operations Element in order to verify subsystem interface requirements and interoperability of the subsystem software.

5. Preparation Information:

The Mission Operations Element Internal End-to-End Test Plan shall describe in detail the test activities associated with the Mission Operations Element along with expected outcomes and results.

The Mission Operations Element Internal End-to-End Test Plan shall contain the following items:

a. Description of the subsystems and executables under test, description of the test environment in detail (so that tests may be duplicated) and the specific version of the executables under test
b. Lists and descriptions of the utilities and tools needed or recommended to setup the environment, load the database, convert output data into readable reports, generate test data, etc
c. List of the test cases to be run and the subsystems and subsystem executables involved with each test case
d. Indication of 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
e. Indication of the name and location of output files used to verify the outcome of each test case
f. List of the interface and interoperability requirements being verified by the test plan along with the subsystem to which each requirement is allocated
g. Evaluation criteria for each requirement allocated to the test plan
h. Evaluation results for each requirement allocated to the test plan
i. Indication of the test case(s) that fully or partially verify each requirement allocated to the test plan

j. Indication of key individuals associated with the test plan, such as tester(s), software development support, test lead, chief engineer and verification engineer

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: MO-12

2. Title: MISSION OPERATIONS ELEMENT SOFTWARE TEST REPORTS

3. Reference:

SOW 5.1.1

4. Use:

The Mission Operations Element Software Test Reports provide a summary of the findings from each test. A separate Mission Operations Element Test Report shall be written for each Mission Operations Element Test.

5. Preparation Information:

The Mission Operations Element Test Reports shall be prepared in accordance with the MAR.

The Mission Operations Element Test Reports shall be developed for each test described in the Software Test Plan and shall include the following, as a minimum:

H. Version number of software tested
I. Identity and number of planned tests that have been completed
J. Conformance of test results to expected results
K. Number, type, and criticality of discrepancies and defects
L. Identification of software areas tested
M. Analysis of any performance requirements that the tested software could affect
N. Test result summary

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
MO-13	MOE OPERATIONS SYSTEM SOFTWARE TEST PROCEDURES DOCUMENTS

3. Reference:

SOW 5.1.1

4. Use:

The Mission Operations Element Test Procedures Documents are used too define the software test procedures followed for each test case in the test plan. A separate test procedures document is written for each test plan.

5. Preparation Information:

The MOE Operations Test Procedures Document shall be prepared to implement software testing as required in accordance with the MAR.

The MOE Operations Test Procedures Document shall provide the following items:

a. A description of the overall test plan and expected results
b. A description of the environment setup
c. A description of each test case along with the purpose of the test case and expected results
d. The full set of steps and actions needed to execute each test case
e. Procedures for environment setup, test execution, and data capture
f. Procedures that define the objectives, test requirements, test limits, pass/fail criteria, test fixtures and instrumentation, handling procedures, environment, and test recording requirements

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
MO-14	MOE OPERATIONS HANDBOOK

3. Reference:

SOW 5.1.1

4. Use:

The MOE Operations Handbook describes the functional capabilities and use of the MOE Subsystems. The MOE Operations Handbook is used by system operators to learn what the MOE System capabilities are and how to perform each capability, and it is used by the software maintenance team to understand the methodology and design of the MOE System which helps with software maintenance support.

5. Preparation Information:

The MOE Operations Handbook shall contain the following required information needed to understand and use the MOE Subsystem software, including detailed procedures and functionalities:

a. Screen-shots of all critical MOE Subsystem User Interfaces (GUIs) and detail the usage of each GUI. It shall give detailed descriptions of major functionality provided by each MOE Subsystems, then give step-by-step instructions (with the use of the screen-shots) on how to use the MOE Subsystem software and user interfaces to achieve these functionalities
b. Indicate how to bring up each MOE Subsystem, including cold and warm starts if applicable
c. 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 role
d. Provide a list of all alerts or notifications produced by each MOE Subsystem along with their meanings
e. Provide a list and description of all Observatory activities that are available to be planned and processed by the MOE System
f. Provide a list and description of all Observatory nominal and contingency command procedures available to be processed by the MOE System
g. Provide details on anomaly resolution within the MOE, including scenarios, personnel and turn-around times
h. Provide a list and description of all Observatory commands and command parameters
i. Provide a list of all telemetry values stored and processed by the MOE System

j. Provide a list of all operator roles supported by each MOE Subsystem and the privileges associated with each role
k. Provide a description of lights out automation provided with the MOE System and its effect on staffing and paging of staff members
l. Provide a description of the MOE shifts, MOE roles and staffing for each shift
m. Indicate recovery methods for each MOE Subsystem in cases of irrevocable errors or faults
n. Indicate data types expected within each field of each MOE Subsystem GUI
o. Provide details of the interface operations between the MOE Subsystems and the LDCM Ground System
p. Provide details of the interface operations between the MOE Subsystems and the LDCM Observatory Simulator
q. Provide details of the interface operations between the MOE Subsystems and all external interfaces.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
MO-15	MOE OBSERVATORY HANDBOOK

3. Reference:

SOW 5.1.1

4. Use:

The MOE Observatory Handbook describes the LDCM Observatory operations and functionality and is used as the basis for providing MOE Flight Operations team training along with the MOE Operations Handbook.

5. Preparation Information:

The LDCM Observatory Handbook shall contain all information required to understand the operations and functionality of the LDCM Observatory including the following items:

a. A list of the Observatory modes of operation along with a description of each mode
b. A list and description of each Observatory software and hardware subsystem
c. A list and description of the Observatory software and methods for updating the software
d. A list of commands accepted by the Observatory along with the required format(s)
e. A list of telemetry values sent by the Observatory to the ground system along with the required format(s)
f. A description of the operations of the Observatory Solid State Recorder
g. A description of the operations of the Observatory Instrument(s)
h. A description of the Observatory On-Board Computer
i. A description of the Observatory memory and memory management
j. A description of the interfaces between the Observatory subsystems
k. A description of the interfaces and interoperability between the Observatory and Mission Operations Element
l. A list of all alerts or warnings produced by each Observatory Subsystem along with their meanings
m. A list of possible Observatory anomalies along with procedures, command and personnel needed to perform anomaly resolution
n. A list and description of all Observatory activities along with the commands that accomplish each activity
o. A list and description of all Observatory nominal and contingency command procedures available to be processed by the Observatory
p. Indicate data types and formats used by the Observatory
q. Provide details of the interface operations between the Observatory and TDRS

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
MO-16	MOE PRE-LAUNCH AND COMMISSIONING PROCEDURES DOCUMENT

3. Reference:

SOW 5.1.1

4. Use:

The MOE Pre-Launch and Commissioning Procedures Document contains the complete set of procedures required to perform LDCM launch deployment, checkout, and Observatory commissioning. This document is used by the MOE Flight Operations Team for training of FOT members and to conduct pre-launch activities.

5. Preparation Information:

The MOE Pre-Launch and Commissioning Procedures Document shall provide a detailed set of pre-launch operations procedures for the LDCM Observatory. These procedures shall include testing, pre-launch activities, checkout, Observatory commissioning, and contingency procedures for the pre-launch phase.

The MOE Pre-Launch and Commissioning Procedures Document shall define expected results in telemetry and associated caution and warning levels.

The MOE Pre-Launch and Commissioning Procedures Document shall describe the equipment, methods, accuracies, and command sequences for pre-launch activities.

The MOE Pre-Launch and Commissioning Procedures Document shall describe the modes of operation during pre-launch activities, the transitions from one to another, and the command sequences necessary to configure the observatory in any phase of any pre-launch mode described in the specifications.

The MOE Pre-Launch and Commissioning Procedures Document shall be organized in two categories: Pre-Launch Operational Procedures and Test Procedures. Operational Procedures are those procedures to be used in launch operations. Test Procedures are those procedures to be used during the commissioning phase to test the performance of the Observatory and validate Observatory performance requirements and are not expected to be used in routine operations.

Each Operational Procedure shall contain the following information:

a. Procedure Purpose
b. Procedure Methodology
c. Support Resources Required
d. Observatory Configuration before and after the procedure is executed
e. Step-by-step commands to be issued and expected Observatory response after each step
f. Caution and warning parameters

Each test procedure shall contain the following information:

a. Test Purpose
b. Test Objective
c. Test Methodology
d. Specification or Validation Requirement(s) being tested
e. Test Equipment and Interfaces
f. Observatory Configuration during the test
g. Step-by-step test procedures including commands to be issued
h. Cautions and warnings
h. Data Recording (forms and format)
i. Data Accept/Reject Limits
j. Measurement Tolerances
k. Support Resources Required

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: MO-17

2. Title: ON-ORBIT PROCEDURES

3. Reference:

SOW 5.1.1

4. Use:

The MOE Operations On-Orbit Procedures Document contains the complete set of procedures required for operating the LDCM Observatory following completion of commissioning activities and delivery to the Government customer.

5. Preparation Information:

The MOE Operations On-Orbit Procedures Document shall provide a detailed set of operations procedures for operating the LDCM Observatory. These procedures shall include:

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:

a. Procedure Purpose
b. Procedure Methodology
c. Support Resources Required
d. Observatory Configuration before and after the procedure is executed
e. Step-by-step commands to be issued and expected Observatory response after each step
f. Cautions and warnings

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
MO-18	MOE Design Specification and Description

3. Reference:

SOW 5.1.1

4. Use:

To ensure that the MOE design requirements flow correctly from the MOERD, and to present the MOE architecture and design.

5. Preparation Information

The MOE Design Specification and Description shall delineate the architecture and design of the MOE. It shall establish the top-level design and interface specification(s) placed on the MOE that flows from the MOERD.

The MOE Design Specification and Description shall contain the following, at a minimum:

- Hardware architecture
- Software architecture
- Specifications
- HCI display images and descriptions
- Interface designs
- Data flows

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: MO-19

2. Title: FLIGHT OPERATIONS TEAM TRAINING PLAN

3. Reference:

SOW 5.2.1

4. Use:

The Flight Operations Team Training Plan is used to train the Flight Operations Team in the operation and functionality of the Observatory, use of the MOE System software and hardware and simulation activities. The Training Plan includes the use of Launch Rehearsals for FOT training.

5. Preparation Information:

The Flight Operations Team Training Plan shall describe course methodology and curriculum and shall include the following items:

a. Operations concepts
b. Flight Operations Team positions, responsibilities, chain of command and shifts
c. All modes of operation and functionality of the Observatory
d. Observatory Procedures
e. Observatory activities
f. Describe and include execution of time lines for launch, Observatory deployment, on-orbit checkout, and Observatory commissioning activities
g. All modes of operation and use of the simulator
h. Operation and functionality of the MOE System
i. Operation and functionality of each MOE Subsystem
j. Operation and functionality of the MOE System hardware
k. Ground System Element locations and functionality
l. Interfaces between DPAS and the MOE System
m. Interfaces between the Ground System Element and the MOE System
n. Interfaces between the Observatory Simulator and the MOE System
o. Observatory Anomaly scenarios and procedures
p. MOE System Anomaly scenarios and procedures
q. Ground System Element Anomaly scenarios and procedures
r. Lights Out Automation functionality
s. Required meetings, status reports, etc.

In addition, the Training Plan shall include Launch Rehearsals as part of the training curriculum per the following:

Exercises prepare the launch team, including the MOC Operators, for Observatory checkout, commissioning, and on-orbit operation. Exercises focus on activities to be performed after launch and deployment, and include execution and validation of procedures and time lines, providing training, and assessment of team proficiency. The Training Plan shall require exercises to the extent required to satisfy Contractor defined MOC operator training and certification requirements.

The training plan shall include three launch rehearsals with the MOC. The primary objective of launch rehearsals is to exercise the Launch and Early Orbit (L&EO) time line of activities. Launch rehearsals build on execution of the nominal time line, graduating in level of complexity, i.e. introducing anomalies/contingencies to prepare and train the launch team to perform a successful L&EO. The Contractor shall lead a third and final Launch Rehearsal as a "full dress rehearsal" and include participation by all LDCM Space, Ground, and Flight Operations segment personnel and resources required for L&EO activities.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: 2. Title:

MO-20 MOE Requirements Facility Implementation Plan

3. Reference:

SOW 5.1.2.1

4. Use:

The MOE Requirements Facility Implementation Plan details the physical requirements for the MOC facility to accommodate the MOE and also provides a plan detailing the installation process and schedule. These requirements will be incorporated into the Government LDCM MOC Facility Plan.

5. Preparation Information

The enumeration of the facility physical requirements shall include as a minimum:

- Square footage requirements
- AC Power requirements including grounding plan.
- Cooling requirements
- Number of racks and operator consoles.
- Maximum weight per rack
- Type of floor required
- Cable routing requirements
- Clearance requirements

The MOE Requirements Facility Implementation Plan shall include the MOE installation process and a project plan (GANTT Chart) detailing the sequence of major work elements required to install the equipment in the Government provided facility.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
MO-21	MOE Software Trade Study Report

3. Reference:

SOW 5.1.1

4. Use:

To provide the Government information related to the future cost and maintainability of the proposed MOE software solution.

5. **PREPARATION INFORMATION**

The MOE COTS Software Trade Study Report shall address the trade between best uses of a COTS-based solution vs. new implementation for the LDCM MOE System. The MOE COTS Software Trade Study Report shall address the existing industry COTS products available for implementation of the various parts of a MOE, and compare these products to one another. The MOE COTS Software Trade Study Report shall make recommendations on which specific COTS products are best suited to fulfill the functional and performance requirements of the LDCM MOE. Relative to the proposed LDCM MOE design (including any and all MOE hardware, software and personnel) the MOE COTS Software Trade Study Report shall address:

b. Approximate cost of a newly developed MOE System versus cost of a COTS-based MOE System
c. Pros and Cons of a newly developed MOE System
d. Pros and Cons of a COTS-based MOE System
e. Available COTS Products (including COTS owned by the contractor) which fulfill part or all of the envisioned MOE functionality
f. Pros and Cons of the functionality delivered with each of the available COTS products
g. Costs of the available COTS products
h. Licenses and support needed for each of the available COTS products
i. Amount of specialized development needed for each available COTS product in order to make it successful within the LDCM MOE
j. Recommendation on which parts of the LDCM MOE System should be newly implemented and which parts should be fulfilled using COTS Products
k. Determination as to which COTS Products best fulfill the functional and performance requirements of the LDCM MOE
l. Recommended COTS Products and the required functionality which each would fulfill as purchased

m. Any software/COTS long lead items that may effect development or have schedule impacts
n. Software maintenance costs

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
MO-22	MOE Hardware Trade Study Report

3. Reference:

SOW 5.1.1

4. Use:

To provide the Government information related to the future cost and maintainability of the proposed MOE hardware solution.

5. **PREPARATION INFORMATION**

The MOE Hardware Trade Study Report shall address the candidate hardware and network equipment available to implement the LDCM MOE System. The MOE Hardware Trade Study Report shall present findings on available hardware and network equipment and make recommendations about which specific hardware best fulfills the LDCM MOE functional and performance requirements. Relative to the proposed LDCM MOE design the MOE Hardware Trade Study Report shall address:

a. All needed equipment to implement the MOE System including servers, workstations, monitors, all network equipment, any needed front end equipment, simulation-specific equipment and security related equipment
b. Equipment available to meet the implementation needs of the MOE System along with the pros, cons and costs of each
c. Recommended hardware and network equipment for the LDCM MOE
d. Ability of the recommended equipment to meet the needs of related functional and performance requirements
e. Any hardware long lead items that may effect development or have schedule impacts
f. Hardware maintenance costs
g. Replacement and operations costs

ON ORBIT DIDS

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: OO-1

2. Title: ON ORBIT COMMISSIONING PLAN

3. Reference:

SOW 7.3.1

4. Use:

To define how the on-orbit observatory will be activated, calibrated, and tested (functionally and performance); and how its on-orbit performance will be verified. The Plan should include test activities, test equipment and plans for inclusion of the Government test team.

5. Preparation Information:

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

a. A summary of the initialization and verification methodology
b. 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.
c. 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.
d. The schedule of initialization and verification activities, including start times and durations.
e. Procedure numbers of the Observatory On-Orbit Test Procedures to be used during initialization and verification
f. Constraints to operations
g. The roles and responsibilities for conducting operations
h. Contact information for operators, engineers and system support
i. 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.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
OO-2	SENSOR USERS MANUAL

3. Reference:

SOW 2.3

4. Use:

The report shall be a self-contained document in that a reader not familiar with the instrument can obtain a reasonably complete understanding of the instrument without recourse to another document or drawing. The document is not meant to be an engineering working document but a reference document for LDCM sensor data users including: Government personnel, scientists, Observatory contractor personnel, and the general public.

5. Preparation Information:

The Sensor User's manual shall provide non-proprietary description of the system, subsystems, functions and operations, with illustrations, block diagrams and circuitry descriptions. The instrument to spacecraft interface shall be described. The report shall be a self-contained document in that a reader not familiar with the instrument can obtain a reasonably complete understanding of the instrument and its operation without recourse to another document or drawing. The document is not meant to be an engineering working document but a reference document for Government personnel, scientists, Observatory contractor personnel, and the general public of LDCM sensor data users.

The LDCM Sensor User's Manual shall characterize instrument performance with respect to: relative spectral response, radiometric accuracy, sensitivity, and stability; and line-of-sight accuracy. Each Manual shall provide pre-flight test results characterizing performance and a flight performance evaluation with updates at major milestones. The document shall describe the sensor modes of operation and the equipment, methods, accuracies, and concepts of operation for in-flight calibration of radiometric response and line-of-sight.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: OO-3

2. Title: ON ORBIT PERFORMANCE REPORT

3. Reference:

SOW 7.3.1

4. Use:

For documenting the results of the testing program and the performance of the LDCM Observatory following on orbit initialization, calibration, and validation of performance.

5. Preparation Information:

The on Orbit Performance Report shall contain the following at a minimum:

A. Launch and early orbit operations results
B. 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.
C. Calibration/Validation results, including a comparison to observatory-level pre-launch environmental test results and baselines
D. As-run test procedures
E. Algorithms and calibration coefficients used throughout the test period
F. Onboard environmental models (magnetic field, solar ephemeris, star catalog)
G. ACS sensor alignments, biases, scale factors, etc
H. The onboard Orbit Determination validation results, if performed
I. Anomalous behavior and resolution including any anomaly reports
J. Current Status of the LDCM Observatory, including redundancy
K. Lessons learned

DESCRIPTION OF REQUIRED DATA

1. CDRL No.: OO-4

2. Title: OBSERVATORY ON ORBIT TEST REPORTS

3. Reference:

SOW 7.3.1

4. Use:

For documenting the results of each on-orbit test.

5. Preparation Information:

For each test required to validate on-orbit performance, per the On Orbit Initialization and Validation Plan, the following information shall be reported:

a. The requirement(s) being validated by the test
b. Test date(s)
c. Test procedure number used
d. Configuration of the Observatory
e. Expected test results
f. Test results
g. Any test anomalies or failures

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
OO-5	ON-ORBIT ANOMALY RESOLUTION SUPPORT PLAN

3. Reference:

SOW 7.3.1

4. Use:

The on-orbit anomaly resolution support plan describes the contractor's plan for the timely identification and resolution of observatory problems and potential problems. It also includes the collection, archival, retrieval, and trending of observatory performance data.

5. Preparation Information:

The on-orbit anomaly resolution support plan shall describe how the contractor will conduct its anomaly identification and resolution process. This process is required during launch, initialization, and commissioning phase. The plan shall include a description of the anomaly reporting system mechanisms for problem identification, investigation, resolution, and formal closure. It shall also describe the interfaces between the contractor's resolution team to Government 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.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
OO-6	OPERATIONS TRANSITION PLAN

3. Reference:

SOW 7.3.2

4. Use:

To define the transition activities and schedule of Observatory operation and monitoring from Contractor personnel to Government personnel.

5. 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.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
OO-7	TELEMETRY AND COMMAND REQUIREMENTS DOCUMENT

3. Reference:

SOW 7.3.1

4. Use:

Establishes the command and telemetry definitions for the LDCM Space Segment

5. Preparation Information:

The Telemetry and Command Requirements Documents shall be delivered in two volumes.

Volume 1 shall contain the telemetry requirements.

This volume shall provide at least, but not be limited to, the following:

a. Detailed listing of all telemetry assignments and Parameter IDs.

b. Key parameters necessary for description of the telemetry requirements as a part of the list.

c. Summary quantifying the number and type of telemetry assignments for each subsystem and the number of spares remaining.

d. Description of telemetry interfaces, telemetry format, telemetry requirements data, and caution and warning levels.

e. Descriptive information necessary for interpretation of the telemetry requirements.

f. Listing of telemetry assignments that confirm commands.

g. Schematic reference for each telemetry assignment.

Volume 2 shall contain the command requirements.

This volume shall provide at least, but not be limited to, the following:

a. Detailed listing of all serial and digital commands

b. Key parameters necessary for description of the commands as part of this listing

c. Summary quantifying the number of types of commands used by each subsystem and by each unit and the number of spares remaining

d. Description of command input, command verification, command rate and filler (no-op) commands.

e. Description of command requirements data and information necessary for interpretation.

f. Listing of commands verified by telemetry and the telemetry verifiers.

g. Schematic reference for each command.

DESCRIPTION OF REQUIRED DATA

1. CDRL No.:	2. Title:
OO-8	OBSERVATORY SIMULATOR TRAINING PLAN AND MATERIALS

3. Reference:

SOW 4.7.2.1

4. Use:

The Observatory Simulator Plan is used to train the Flight Operations Team in the use of the Observatory Simulator.

5. Preparation Information:

The Observatory Simulator Team Training Plan shall describe course methodology and curriculum and shall include the following items:

a) All modes of operation and use of the Observatory Simulator
b) The use of the Observatory Simulator for testing of all Observatory subsystem functionality
c) The use of the Observatory Simulator for testing of the Observatory Sensor functionality
d) The use of the Observatory Simulator for testing of the SSR functionality
e) The use of the Observatory Simulator for testing updates to Observatory flight software
f) The use of the Observatory Simulator for testing Observatory anomalies
g) The use of the Observatory Simulator for receiving command loads
h) The use of the Observatory Simulator for sending telemetry and imaging data back to the MOE
i) The use of telemetry scripts along with the Observatory Simulator in order to simulate telemetry back to the ground
j) The use of scripts along with the Observatory Simulator in order to simulate imaging data sent back to the ground
k) The ability of the operator to alter environmental conditions during simulation activities
l) The ability of the operator to alter Observatory and telemetry parameters during simulation activities
m) The ability of the Observatory Simulator to simulate Observatory maneuvers
n) The ability of the Observatory Simulator to simulate Observatory attitude changes
o) The functionality of the actual Observatory that is not capable of being simulated by the Observatory Simulator.