GSFC 427-06-02
Revision -
Code 427

LANDSAT DATA CONTINUITY MISSION

CONTRACT DATA REQUIREMENTS LIST

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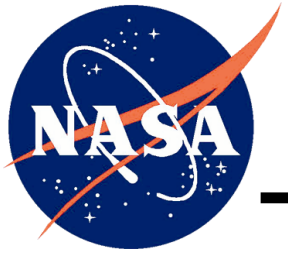

Goddard Space Flight Center
Greenbelt, Maryland

National Aeronautics and
Space Administration

CM FOREWORD

This document is a Landsat Data Continuity Mission (LDCM) Project Configuration Management (CM)-controlled document. Changes to this document require prior approval of the applicable Configuration Control Board (CCB) Chairperson or designee. Proposed changes shall be submitted to the LDCM CM Office (CMO), along with supportive material justifying the proposed change. Changes to this document will be made by complete revision.

Questions or comments concerning this document should be addressed to:

LDCM Configuration Management Office
Mail Stop 427
Goddard Space Flight Center
Greenbelt, Maryland 20771

Signature Page

Prepared by:

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LDCM PROJECT
DOCUMENT CHANGE RECORD

REV LEVEL	DESCRIPTION OF CHANGE	DATE APPROVED
Rev -	Baseline Release. Approved by CCR 427-07-02-010.	12/06/2007

SECTION 1 – Introduction

1.1 Scope

a) The Contract Data Requirements List (CDRL) is the basic contractual document that governs data required by and for the DO.

b) The Contractor shall furnish data described by the Data Requirements Descriptions (DRDs) included herein and listed on the CDRL for each item of data.

c) All data shall be prepared, maintained, and delivered to the Government in accordance with the requirements of this CDRL

d) Wherever possible, existing Contractor format for documentation is preferred. With Government concurrence, the Contractor may substitute internal format and content for any deliverable item in the CDRL.

1.2 Contract Data Requirements List

The CDRL provides a listing of the data requirements of the Delivery Order. Each entry contains the following:

a) The data item number, which corresponds to the data item description number.

b) The data item title.

c) The data item submission requirements.

The following definitions apply to the "Submission Category" column in the CDRL Table.

1. A: Approval – Documents in this category require written Government approval. The documents shall be considered approved if Government comments are not provided within 30 days of receipt. Delivery to the Government shall occur within the time specified in the contract. Requirements for resubmission shall be as specified in letter(s) of disapproval.

2. I: Information – Documents in this category require delivery to the Government within the time period specified in the contract for the purpose of determining current program status, progress, and future planning requirements. When Government evaluations reveal inadequacies, the Contractor will be requested to correct the documents.

The following definitions apply to the "DUE DATE, MATURITY" column in the CDRL Table.

1. Due Date: Dates DRDs due to Government:

   (1) w/ Prop. Items that are to be provided with the proposal submission.

   (2) CDR, PER, etc. Critical Design Review, Pre-Environmental Review, Pre-Ship Review, etc. Documentation to be delivered to the Government 10 working days prior to review, unless otherwise stated.

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

   (4) L. Launch Date

   (5) ARO. After Receipt of Order

2. Maturity:

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

   (2) Rev. An updated revision to a previous submittal.

   (3) Final. The complete thorough submission of an item for approval, review, or information. This does not preclude updating later. Any updates shall require the same "approval/review" process as was required for the previous submissions.

Other entries in the "Due Date, Maturity" column are self-explanatory.

d) Media:

There are two media in which data shall be documented and are defined as:

1. Hard Copy – Data typed, drawn or printed on paper by common, conventional practices. By these means, either the original, a reproducible copy, or the record copy shall be reproduced for distribution as printed copies.

2. Electronic – Data that is recorded in word processors, computerized data processing systems, or electronic storage devices such as magnetic tapes, disks and CD ROM.

Documentation delivery (in hardcopy or electronic format) shall be as specified in the CDRL. Additionally, all CDRL data that has been generated electronically shall be delivered via electronic transfer or electronic transfer media such as disks.

The Contractor shall supply instructions to facilitate the use of electronic media.

e) The number of copies of each data item to be delivered.

1.3 Data Requirements Document (DRD)

a) Each data deliverable listed on the CDRL is defined by a Data Requirements Document (DRD).

b) The DRD describes the purpose and required content of the data item, and provides specific format and preparation instructions as necessary.

c) Much of the information requested in the DRDs may already exist in the Contractor's documentation and format. The Contractor is strongly encouraged to use existing documents and formats whenever they will meet the requirements of the DRD.

1.4 Distribution and Delivery

The Contractor shall distribute and deliver data according to contract requirements and provisions. The data shall be delivered to the following address:

LDCM Contracting Officer
Mail Code 210.6
NASA/ Goddard Space Flight Center
Greenbelt, MD 20771

LDCM COTR
Mail Code 427
NASA/Goddard Space Flight Center
Greenbelt, MD 20771

The following shall be provided for each data item submission:

a) Copy of Record – The Copy of Record is the official file copy submitted in the form in which it is intended to be distributed and marked "Copy of Record" and suitable for reproduction, and shall comprise at least the cover sheet of the deliverable item.

b) Electronic Copies – Copies of each document specified in the CDRL shall be delivered in electronic format per paragraph 1.2 of this CDRL. Delivery of electronic media data items shall occur per the same delivery schedule as printed media.

c) Hard Copies – The Government will request hard copies of deliverable items on an exception basis, typically for specific drawings and spacecraft images.

1.5 Documentation Change Procedures

a) The Contractor shall issue documentation change notices (DCNs) whenever minor changes or updates occur in data items that have been delivered to the Government.

b) Change bars shall be used to indicate changes or updates.

c) When major changes to a document are made a complete revision of the document shall be issued and delivered to the Government in accordance with the original instructions for the data item.

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

LDCM SPACECRAFT CONTRACT DATA REQUIRMENTS LIST

DRD #	Title	A/I	Due Date/Maturity	Media	Copies
1	Monthly and Weekly Status Review Charts	I	Monthly (nominally last Wed of each Month); Weekly (date TBP)	E	1
2	Integrated Master Schedule (IMS)	I	Prel with Proposal Initial 45 ARO Baseline 60 ARO Updates Monthly	H,E	1
3	ECPs, Deviations, and Waivers, including Safety Waivers	A/I	As Generated	E	1
4	Specification Tree	I	SRR, Final	E	1
5	Final Report and Lessons Learned	I	Delivered incrementally at: ICDR, IPER, IPSR; Acceptance + 30 days	E	1
6	Photographs and Video	I	As Generated	E	1
7	Design Review Data Package	A	5 days prior to Review Hard Copies at Review	E H	1 20
8	Spacecraft Requirements Specification	I	Prelim SRR Rev PDR – 30 days Final CDR – 30 days Rev as generated	E	1
9	Spacecraft User's Manual	I	Prelim CDR-5days Rev IIRR-5days Final PSR Rev as generated	E	1
10	Contractor Generated Internal LDCM Material	I	As Generated	E	1
11	Engineering Drawings and Changes	I	CDR–5 days PSR–5 days Final L-30 days	E	1
12	Trend Analysis and Operations Log	I	Prelim CDR Final PER Reports – Monthly Log - PSR	E	1
13	Interface Control Documents	I,A	Prelim PDR-5days Rev CDR-5days Final IIRR-30days Rev as generated	E	1
14	Information for ICDs	I	Prelim CDR Final IIRR – 3 months	E	1
15	Launch Site Support Plan	I	L-34 weeks	E	5
16	Observatory Launch Site Operations and Test Plan	A	PSR + 75 days Update first use – 60 days	E	1

DRD #	Title	A/I	Due Date/Maturity	Media	Copies
17	Acceptance Data Package	A	Prelim CDR Rev PER Rev PSR Final OAR-30days	E	1
18	Launch Commit Criteria	I	L-36 weeks	E	1
19	On-orbit Commissioning Plan	I	Final PSR-90 days	E	1
20	On-Orbit Performance and Test Reports	I	Prelim L+1 day Rev daily Final at Acceptance-5days	E	1
21	Operations Transition Plan	I	Prelim CDR-5 days Final PER-5 days	E	1
22	Command and Telemetry Handbook	I	Prelim ARO+30 days Rev PDR-5days Rev CDR-5days Rev IIRR-5days Final MRR-5 days Rev as generated	E	1
23	Command and Telemetry Database	I	Prelim CDR-5days Rev as generated Final PSR-60 days	E	1
24	Operations Procedures and Scripts	I	Prelim CDR-5 days Rev Test-5 days	E	1
25	Flight Activation Operations Plan	I	Prelim CDR-5 days Final PSR-30 days	E	1
26	Playback Image Data	I	As requested	E	letter
27	Parts Lists 1. Parts Identification List (PIL) 2. Program Approved Parts List (PAPL) 3. As-Designed Parts List (ADPL) 4. As-Built Parts List (ABPL)	A	1st PCB – 10 days Subsequent PCBs – 15 days CDR – 30 days See CDRL 42	H/E	1
28	Contamination Control Plan	I	Prelim PDR-5 days Final CDR-5 days	E	1
29	Materials, Lubrication and Processes Lists (MLPL) 1. As-Designed Materials and Processes List 2. Polymeric Materials and Composites, Inorganic Materials and Composites, and Lubrication Lists and Material Process Utilization List 3. Materials Usage Agreement 4. Stress Corrosion Evaluation Form 5. As-Built Materials and Processes List	A	MPCB – 10 days PDR – 30 days CDR – 30 days As required with MLPL As required with MLPL See CDRL 42	H/E	1

DRD #	Title	A/I	Due Date/Maturity	Media	Copies
30	Non-Conformance Reports and Material Review Board Decisions 1. Material & Test Nonconformance Reports a. Minor material nonconformance reports b Major material and test nonconformance reports 2. MRB/FRB Reports	 I A I	 1.a As generated 1.b As generated 2 MRB/FRB + 5 days Update as required	 E	 1
31	GIDEP Alert/Advisory Responses & Submissions NASA Alert/Advisory Responses & Submissions	A	ARO + 60 days	H/E	1
32	Mass Properties Report	I	Prelim L-54 weeks Final L-20 weeks	E	1
33	Models	I	Rev as generated Final CDR-5 days	E	1
34	Analyses	I	Rev as generated Final CDR-5days	E	1
35	Probabilistic Risk Assessment	I	Prelim PDR -30 days Update CDR -30 days Final ORR – 30 days	E	1
36	Failure Mode and Effects Analysis (FMEA), Critical Items List (CIL), Critical Items Control Plan and Limited Life Items List, Fault Tree Analysis (FTA), Parts Stress Analysis, Worse Case Analysis (WCA), and Reliability Predictions	A	Prelim PDR -30 days Final CDR -30 days Rev as generated	E	1
37	Deleted				
38	Deleted				
39	Deleted				
40	Deleted				
41	Operations Hazard Analysis (OHA) and Hazard Tracking Log (HTL) 1. Operations Hazard Analysis (OHA) 2. Hazard Tracking Log (HTL)	 A A A A	 PER – 45 days I&T Start – 10 days PER – 45 days Final after all items closed	E	1
42	Safety and Mission Assurance (S&MA) Data Packages	A	PER – 30 days	E	1
43	Deleted				
44	Deleted				
45	Deleted				
46	Deleted				
47	Pre-Mishap Plan, Mishap Reporting and Mishap Investigations Pre-Mishap Plan Mishap Reporting and Investigations (including all Subcontractor Facilities) 1. Type A or Type B (As Defined in NPR 8621.1) 2. Other Mishaps or Close Calls	 I I I	 ARO + 45 days Within 1 hour of occurrence Within 24 hours of occurrence	 E E E	 1 1 1
48	Orbital Debris Assessment	A	Prelim PDR - 15 days Final CDR - 60 days	E	1

DRD #	Title	A/I	Due Date/Maturity	Media	Copies
49	Missile Systems Pre-Launch Safety Package 1. Safety Requirements Compliance Checklist 2. Preliminary Hazard Analysis 3. Operating and Support Hazard Analysis 4. Safety Verification Tracking Log 5. Miscellaneous Range Deliverables a. Material selection list for plastic films, foams, and adhesive tapes b. Radiation Forms/Analysis c. Process Waste Questionnaire d. Environmental Impact Statement	A A A	Initial PDR + 30 days Update CDR - 30 days Final PSR- 30 days 1. With Initial MSPSP 2. With Initial MSPSP 3. With 2d MSPSP and all updates 4. With Final MSPSP and all Hazard Control Closures 5a. LRD – 60 days 5b. LRD – 120 days 5c. LRD – 60 days 5d. LRD – 60 days	E	1
50	Observatory Performance Verification Plan and Matrix	I	Prelim PDR-10 days Rev CDR-10 days Final PER-15 days Rev as generated	E	1
51	System Environmental Verification Plan and Matrix	I	Prelim PDR-10 days Rev CDR-10 days Final PER-15 days Rev as generated	E	1
52	Observatory Performance and Functional Test Plans	I	Prelim PDR-10 days Rev CDR-10 days Final PER-15 days Rev as generated	E	1
53	Observatory Performance and Functional Test Procedures	I	Test-5 days	E	1
54	Observatory Performance and Functional Test Readiness Reviews	1	Test-5 days	E	1
55	Observatory Performance and Functional Test Reports	1	Test+10 days	E	1
56	Spacecraft and Observatory Integration and Test Plans		Prelim PDR-10 days Rev CDR-10 days Final PER-15 days Rev as generated	E	1
57	Spacecraft and Observatory Integration and Test Procedures	1	Test-5 days	E	1
58	Packaging, Handling, Storage, and Transportation Plan	I	Prelim PDR-10 days Rev CDR-10 days Final PER-15 days Rev as generated	E	1
59	DELETED				
60	Simulator Requirements Document	I	Prelim PDR-10 days Rev CDR-10 days Final PER-15 days Rev as generated	E	1

DRD #	Title	A/I	Due Date/Maturity	Media	Copies
61	Simulator I&T Plan	I	Prelim PDR-10 days Rev CDR-10 days Final PER-15 days Rev as generated	E	1
62	Simulator Test Report	I	Test + 10 days	E	1
63	Simulator User's Guide (Manual)	I	Delivery -30 days Rev as generated	E	1
64	Simulator Training Plan and Materials	I	Prelim PDR-10 days Rev CDR-10 days Final PER-15 days Rev as generated	E	1
65	Flight Operations Team Training Package	I	Prelim CDR-5 days Final PSR-14 days Rev as generated	E	1
66	Spacecraft and Observatory Storage Plan	I	Prelim PDR-10 days Rev CDR-10 days Final PER-15 days Rev as generated	E	1
67	LDCM Key Management Plan	I	Prelim PDR-10 days Rev CDR-10 days Final PER-15 days Rev as generated	E	1
68	In-Process Accounting Procedures Plan	I	Prelim PDR-10 days Rev CDR-10 days Final PER-15 days Rev as generated	E	1
69	Product Drawings	I	Prelim PDR-10 days Rev CDR-10 days Final PER-15 days Rev as generated	E	1
70	Configuration Audit	I	Prelim PDR-10 days Rev CDR-10 days Final PER-15 days Rev as generated	E	1
71	Security Verification Audit	I	Prelim PDR-10 days Rev CDR-10 days Final PER-15 days Rev as generated	E	1
72	Security Verification Report	I	Prelim PDR-10 days Rev CDR-10 days Final PER-15 days Rev as generated	E	1
73	Theory and Design of Operation	I	Prelim PDR-10 days Rev CDR-10 days Final PER-15 days Rev as generated	E	1
74	Previously Qualified Hardware and Software Report	I	SCR - 14 days Update as req	E	1

DRD #	Title	A/I	Due Date/Maturity	Media	Copies
75	Mission Assurance Implementation Plan and Quality Documentation 1. Quality Certificate 2. MAIP 3. MAR Cross-Reference Matrix 4. Subcontractor Assurance Verification Matrix 5. GOLD Rules Applicability, Compliance, Waivers a. GOLD Rules Applicability Assessment b. GOLD Rules Compliance Assessment	I A A A I I	With Proposal; ARO + 90d ARO + 60 days; + 90d With Proposal; ARO + 90d ARO + 60 days; + 90d With Proposal; Update each Review – 30d SCR – 30 Days	E	I

Title: Monthly and Weekly Status Review Charts	**DRD No.:** 1
Reference: SOW Paragraph 4.3.1.1, 4.3.1.5.1.7 MAR Paragraphs 2.5, 15.0	
Purpose: To evaluate contract status. Reports will be used during face-to-face discussions between the contractor and the Government regarding project status, plans, and issues.	
Related Documents:	

Preparation Information

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

The MPSR shall include but not be limited to:

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

The Weekly Status Review Charts shall be the developing interim status of the information to be presented at the Monthly. The Contractor shall not submit a weekly status the week an MPSR is held.

Title: Integrated Master Schedule	**DRD No.:** 2
Reference: SOW Paragraph 4.3.1.1, 4.3.1.5.1.8	
Purpose: To track the spacecraft design, build, and I&T status over the DO lifetime with a coherent, integrated scheduling tool.	
Related Documents: NPR 7120.5D, Program Project Management Processes and Requirements	

Preparation Information

The IMS shall be developed using the Critical Path Method-based scheduling technique. It will consist of the schedule baseline and the current schedule updated each reporting period. The IMS shall relate actual progress to the baseline, and contain the current forecast for the remaining tasks.

The IMS will be used to plan, monitor, communicate issues and control all activities, including pertinent resources and facilities necessary to accomplish assigned tasks in compliance with the LDCM SOW. The IMS will provide the contractor's time-phased plan, current status, key milestones, task interdependencies, and major development phases necessary to accomplish the total scope of work. Schedule will be used to provide management insight into contractor status, potential problem areas and critical path identification which will serve as the basis for evaluating contractor performance. The baseline IMS will be the basis for evaluating the impact of Government-directed changes to the Launch date.

The IMS shall be submitted in electronic format, in *Microsoft Project 2000* or later.

Title: ECPs, Deviations and Safety Waivers	**DRD No.:** 3

Reference:
SOW Paragraph 4.3.1.1, 4.3.1.4
MAR Paragraph 3.6

Purpose:
To coordinate and control all Deviations, Waivers and ECPs the evolving implementation requires.

Related Documents:

Preparation Information

The Contractor shall prepare and submit class I engineering change proposals (ECPs) using MIL-STD-973, ECP forms DG 1692 and DD1692-1 as guidelines. 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. GSFC may direct the Contractor to prepare ECPs under the "changes" clause of the contract. The Contractor shall allow access to class II changes for Government review.

For the purposes of this DRD, 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/property.

Waivers and deviations shall be handled using MIL-STD-973 as a guide.

Safety requirements that can not be met as defined in NPR 8715.3, NASA General Safety Program Requirements, must be documented with a Safety Waiver. The Safety Waiver or Variance shall include the following information resulting from a review of each waiver or deviation request.

1. 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
2. A detailed technical justification for the exception
3. Analyses to show the mishap potential of the proposed alternate requirement, method, or process, as compared to the specified requirement
4. 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 this determination should be provided.
5. A narrative on possible ways of reducing hazard(s) severity and probability as well as existing compliance activities (if any)
6. Starting and expiration date for waiver/deviation

NOTE: Risk trade-off evaluations based on PRA or other applicable analysis techniques may be required as part of the documentation for a variance, deviation, or waiver at the discretion of the GSFC Project management.

NOTE: The request for Safety Waiver or Safety Variance may require Range Safety concurrence;

however, before it is sought, the GSFC Project Office must concur with the waiver or variance.

Title: Specification Tree	**DRD No.:** 4
Reference: SOW Paragraph 4.3.1.4	
Purpose: To provide a hierarchy and breakout for the spacecraft technical specifications.	
Related Documents:	
Preparation Information The specification tree shall document the breakout of the contractor's specifications starting at the top-level Instrument Design Specification, showing all lower-level specifications to the sub-assembly (box/board) level, and indicating the relationships and interfaces between the documents.	

Title: Final Report and Lessons Learned	**DRD No.:** 5

Reference:
SOW Paragraph 4.3.1.4

Purpose:
Documents a summary of the performance of the contract, and any lessons learned from those activities. The purpose of the Lessons Learned is to collect and make available for use by all who may derive benefit from the experiences of others, the Spacecraft lessons learned from the integration and test of the LDCM Instrument(s), and interfaces with the USGS ground system.

Related Documents:

Preparation Information:
The Final Report shall document the execution of the Delivery Order in terms of progress vs plan, including problems that arose and their solutions. The Final Report shall include:

Initial Integrated Schedule and Final Schedule as of launch date
Spacecraft implementation flow, starting at subsystem integration through IIRR
Observatory I&T flow through LRR.
A table summary of all delivery order modifications (excluding administrative adjustments to the funding profile)
All deviations and waivers
All safety issues

The Contractor shall accumulate and document a Lessons Learned History throughout the DO.
A Lesson Learned is knowledge or understanding gained by experience. The experience may be positive, as in a successful test or mission, or negative, as in a mishap or failure. Successes are also considered sources of lessons learned. A lesson must be significant in that it has a real or assumed impact on operations; valid in that it is factually and technically correct; and applicable in that it identifies a specific design, process, or decision that reduces or eliminates the potential for failures and mishaps, or reinforces a positive result. Each Lessons Learned entry shall include the following information:

Lesson Date:
Submitting Organization:
Submitted by:
Subject/Title/Topic(s):
Description of Driving Event:
Lesson(s) Learned:
Recommendation(s):
Evidence of Recurrence Control Effectiveness:

Title: Photographs and Video	**DRD No.:** 6

Reference:
SOW Paragraph 4.3.4
MAR Paragraph 2.3

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

Related Documents:

Preparation Information

A. Still Photography

1. Pictures shall be made at appropriate points in the development of the Observatory.

2. Pictures shall be made of the major subsystems, critical components, the full-up system, and major GSE items. These pictures shall be in color and provided in a digital format on appropriate medium

3. The pictures shall serve as a record of the build-up of a major component or subsystem; e.g., a typical electronic card, mother board, electronic subsystem with cover off, etc.

4. Pictures of environmental test fixtures shall also be provided.

5. Full views of the completed Observatory will be provided, suitable for printing up to 4 x 8 foot size, for publication.

B. Video

1. Video media (DVD)

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

Title: Design Review Data Package	**DRD No.:** 7

Reference:
SOW Paragraph 4.3.1.5
MAR Paragraph 8.1, 8.3, 15.0

Purpose:
To document the Contractor's review materials.

Related Documents:
MAR

Preparation Information
The Contractor shall research the requirements in SOW Paragraph 4.3.1.5 and as detailed on the Code 300 web site referenced there, and prepare an agenda no later than four weeks prior to the meeting for the Government to review , correct, and approve. The material to be presented at the reviews, tailored for the appropriate level of detail and maturity for each review, includes:

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

- Mechanical and Electrical Ground support equipment
- Plans for shipping containers, environmental control and mode of transportation
- Problem areas/Open items
- Schedules

The Contractor shall submit the Design Review Data Package, for the approved agenda, for the following events:

7A Spacecraft Systems Requirements Review
7B Spacecraft Preliminary Design Review
7C Spacecraft Critical Design Review
7D Instrument Integration Readiness Review (one for each Instrument)
7E Observatory Pre-Environmental Review
7F Observatory Pre-Ship Review
7G Observatory On-Orbit Acceptance Review
7H Mission Preliminary Design Review
7I Mission C R Review
7J Mission Confirmation Review
7K Mission Critical Design Review
7L Mission Operations Review
7M Mission System Integration Review
7N Flight Operations Review
7O Operations Readiness Review
7P Mission Readiness Review
7Q Safety and Mission Success Review
7R Flight Readiness Review
7S Launch Readiness Review
7T Post Launch Assessment Review
7U Critical Events Review
7V Mission Design Review

The MDR occurs very near the receipt of order. The Contractor shall present a four-hour overview of the RSDO LDCM Offer in view graph form, and attend the three-day MDR. The overview shall include a description of the spacecraft design, spacecraft implementation risks, Observatory I&T risks, and the mitigation strategy for all risks.

Title: Spacecraft Requirements Specification	**DRD No.:** 8
Reference: SOW Paragraph 4.3.2.1	
Purpose: To document the Spacecraft system and subsystem specification derived from the Spacecraft Requirements Specification (SRS).	
Related Documents:	

Preparation Information

The Contractor shall document the detailed, integrated system and subsystem requirements of the Spacecraft as derived from the Spacecraft Requirements Document (SRD) and all applicable documents therein. The Contractor shall provide traceability of each Level 4 requirement to the SRD Specification and all applicable documents (Level 3).

"Level 4" for this CDRL item is the next level of design detail below the Level 3 Spacecraft Requirements Document

Title: Spacecraft User's Manual	**DRD No.:** 9
Reference: SOW Paragraph 4.3.2.2.2	
Purpose: To be used by the operations organization to develop detailed operations procedures and a description of the operation of the Spacecraft.	
Related Documents:	

Preparation Information

The Spacecraft User's Manual shall include the following:

A. Overview and discussion of the Spacecraft (including GF Instrument information), and the operations concept.
B. Description of unique factors associated with the operation of the Spacecraft.
C. Overview of Spacecraft interfaces.
D. Unique ground system logistics, software, software maintenance, and sustaining engineering required for sustained Spacecraft operations.
E. Sample operational scenarios.
F. Operation of the Spacecraft and all Spacecraft subsystems.
G. Contingency scenarios and procedures.
H. Redundancy management.
I. State of health maintenance.
J. Listing of operations limits (attitude, modes), cautions, and constraints.
K. On-orbit Spacecraft engineering telemetry trending approach

Title: Contractor Generated Internal LDCM Material	**DRD No.:** 10
Reference: SOW Paragraph 4.3.1.7	
Purpose: To provide a means for submitting information in the Contractor's internal format	
Related Documents:	

Preparation Information

The format and content of any CDRL item in this delivery order may be replaced by Contractor-internal documentation, upon concurrence by the Government.

Any relevant LDCM material the Government requests may be submitted under this CDRL.

Contractor-internal material does not include sensitive information such as corporate policy, personnel management, marketing, legal issues, etc.

Title: Engineering Drawings and Changes	**DRD No.:** 11

Reference:
SOW Paragraph 4.3.1.4

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

Related Documents:

Preparation Information

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

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

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

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

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

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

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

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

Title: Trend Analysis and Operations Log	**DRD No.:** 12

Reference:
SOW Paragraph 4.3.2.3, 4.3.5.3.1.4

Purpose:
Provides a list and a means of tracking critical engineering and performance parameters for the spacecraft. Provides a log of 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 spacecraft performance or reliability.

Related Documents:

Preparation Information

Trend List:
The list of parameters to be trended shall be subdivided by assembly or subassembly. A brief rationale for including the parameter shall be included. The list shall be coordinated with the Government prior to implementation. The trend list shall be revised with the on-orbit operational trend parameters prior to launch with Government Flight Operations Team input.

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 spacecraft operating time. 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
I. Flight Software image/patch version or firmware version used in the subsystem

Title: Interface Control Documents	**DRD No.:** 13

Reference:
SOW Paragraph 4.3.2.2.1, 4.3.2.2.2

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

Related Documents:

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

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

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

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

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

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

5. Safety – such as pyrotechnics, energy storage, trip-over, hazardous materials.

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

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

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

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

The Contractor shall submit ICDs for the following interfaces:

13A	Spacecraft-OLI
13B	Spacecraft-TIRS
13C	Spacecraft-TSIS
13D	Spacecraft-Space Network
13E	Spacecraft-Landsat Ground Network
13F	Spacecraft-PTP/MOE
13G	Spacecraft-NASA Ground Network
13H	Spacecraft-International Cooperators

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

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

Title: Information for ICDs	**DRD No.:** 14

Reference:
SOW Paragraph 4.3.2.2.3

Purpose:

Provides the information other organizations use to generate ICDs

Related Documents:

Preparation Information

At a minimum, information for ICDs shall include the following:

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

The type of information required, at a minimum, includes:

a. Type of interface (API, internet, phone, physical, etc.)
b. Data and media formats
c. Data rates
d. Duty cycles
e. Protocols
f. Physical interfaces
g. Error conditions
h. Timing
i. Security

Title: Launch Site Support Plan	**DRD No.:** 15

Reference:
SOW Paragraph 4.3.5.1.1

Purpose:

To document and define requirements and control all aspects of the interface between the Observatory and the LV to insure efficient integration and promote a successful launch to the mission orbit.

Related Documents:
External Interfaces, Models and Analysis, DRD #2

Preparation Information

This deliverable set of data defines the requirements of the Observatory for the LV provider and shall include the following as a minimum:

a. PRD, PGAA, Observatory Integrated Ops, and Observatory Environmental Test Results
b. Observatory and launch site processing questionnaire.
c. Observatory mathematical model for dynamic analysis.
d. Observatory environmental test results.
e. Observatory/launch system interface specification (electrical, mechanical, data) inputs.
f. Mission operations and support requirements.
g. Payload (Observatory) requirements
h. Observatory drawings.
i. Electrical wiring requirements.
j. Fairing requirements.
k. Observatory integrated test procedure inputs.
l. Mission analysis requirements.
m. Launch intervals (window).
n. Radio frequency applications (provide by the Government with support from Contractor).
o. Post-launch orbit confirmation data.
p. Launch hold criteria – Observatory go/no go.

The Observatory Launch Site Operations and Test Plans shall describe all aspects of the activities at the launch site beginning with arrival of the Observatory, including final testing and preparations, fueling, transportation between buildings and the LV, LV integration and testing, and removal of systems after launch. The data shall be originated to support launch site "test and inspection plans" requirements and the "ground operations plan" requirements.

Layout a schedule and timeline of proposed activities including Spacecraft and Instrument testing.
Specify what facilities and facility resources are needed.
Show equipment placement and personnel area requirements.
Fully explain staffing plan.
Explain schedule and personnel contingency methods.
Describe roles and responsibilities and the other equipment needed at each step of the plan.
Describe fueling methods, crew training, SCAPE operations, fuel storage locations.
Address cleanness methods, purge gasses and lines, garments.

Identify special test equipment needed on the launch tower or in the blockhouse. Identify specific communication links needed between locations at the launch site to support the Observatory on the LV up to the point of launch.

Title: Observatory Launch Site Operations and Test Plans	**DRD No.:** 16

Reference:
SOW Paragraph 4.3.2.2.3
MAR Paragraph 3.5

Purpose:
To provide a detailed understanding of the launch site activities, operations and testing planned for LDCM, to support requirements of the MSPSP, and to obtain launch site procedure approvals.

Related Documents:

Preparation Information

The Observatory Launch Site Operations and Test Plans shall describe all aspects of the activities at the launch site beginning with arrival of the Observatory, including final testing and preparations, fueling, transportation between buildings and the LV, LV integration and testing, and removal of systems after launch. The data shall be originated to support launch site "test and inspection plans" requirements and the "ground operations plan" requirements as referenced in EWR 127-1.

Layout a schedule and timeline of proposed activities including Spacecraft and Instrument testing.
Specify what facilities and facility resources are needed.
Show equipment placement and personnel area requirements.
Fully explain staffing plan.
Explain schedule and personnel contingency methods.
Describe roles and responsibilities and the other equipment needed at each step of the plan.
Describe fueling methods, crew training, SCAPE operations, fuel storage locations.
Address cleanness methods, purge gasses and lines, garments.
Identify special test equipment needed on the launch tower or in the blockhouse.

Identify specific communication links needed between locations at the launch site to perform Observatory Mission Readiness Testing and to support the Observatory on the LV up to the point of launch.

All ground operations procedures to be used at GSFC facilities or the launch site shall be included in this deliverable. All hazardous operations and all procedures to control them shall be identified and highlighted.

As part of this deliverable, the contractor shall verify that launch site procedures comply with applicable launch site safety regulations.

Title: Acceptance Data Package	**DRD No.:** 17

Reference:
SOW Paragraph 4.3.5.3.1.1

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

Related Documents:

Preparation Information

The Contractor shall provide the following information only to the extent it is not represented in other CDRL submissions. The Contractor shall identify prior submissions in the appropriate section of the Acceptance Data Package by referencing the appropriate CDRL, and the date submitted.

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

A. Contract End Item Specification with waivers and deviations
B. As-built configuration list
C. Hardware parts lists
D. Hardware materials and processes lists
E. Test Log Book (including total operating time and cycle records)
F. Non-conformance or Open item lists (including reasons for being open)
G. 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. On Orbit Performance Report
N. Anomaly reports and FRB disposition information

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

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

1. Launch and early orbit operations results
2. On-orbit checkout results, including a summary of results of each of the tests and verifications performed per the On Orbit Initialization and Validation Plan.
3. Algorithms and calibration coefficients used throughout the test period
4. Onboard environmental models (magnetic field, solar ephemeris, star catalog)
5. AOCS Instrument alignments, biases, scale factors, etc
6. The onboard Orbit Determination validation results, if performed
7. Anomalous behavior and resolution including any anomaly reports
8. Current Status of the LDCM Observatory, including redundancy
9. Lessons learned

Title: Launch Commit Criteria	**DRD No.:** 18
Reference: SOW Paragraph 4.3.5.1.3	
Purpose: To define the procedures, and the critical processes and events to achieve launch .	
Related Documents:	
Preparation Information The launch commit criteria describes the status of all spacecraft, GSE, communication, staffing, and facilities as the countdown progresses toward launch. Each criterion is described in terms of Mandatory or Critical, at each countdown poll. The criteria includes a complete list of all flight and ground telemetry and other parametric measurements, including the red, yellow, and green limits for each, tolerances, and any condition that would require resolution prior to launch. This deliverable documents the launch commit criteria and the criteria to be used to commit the LDCM Observatory for launch. The document shall address the LDCM Observatory, the Observatory launch control center(s), and associated activities prior to liftoff.	

Title: On-orbit Commissioning Plan	**DRD No.:** 19
Reference: SOW Paragraph 4.3.5.3.1.1, 4.3.5.3.2.1	
Purpose:. Details the steps to demonstrate that each subsystem and the spacecraft as a whole meet the post-launch nominal acceptance requirements.	
Related Documents: None	

Preparation Information

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

Identify the LDCM Observatory sequences required for the MOC to support the LDCM operational events during the commissioning phase of the mission. .

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

The On Orbit 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.

Title: **On-Orbit Performance and Test Reports**	**DRD No.:** 20
Reference: SOW Paragraph 4.3.5.3.1.1	
Purpose: Provides a daily snapshot of the Observatory configuration and operations.	
Related Documents: None	
Preparation Information The Contractor shall provide a daily summary of: • A timeline plan for the day • the configuration of all spacecraft subsystems at day's end • the planned versus actual contacts • planned versus actual spacecraft activities • old and new anomalies • resolved anomalies • assessment of ground support • plans for the next day • any other relevant information.	

Title: Operations Transition Plan	**DRD No.: 21**
Reference: SOW Paragraph 4.3.7	
Purpose: To define the transition activities and schedule of Observatory operation and monitoring from Contractor personnel to Government personnel.	
Related Documents:	
Preparation Information The Operations Transition Plan shall define in detail the procedure for transitioning operation of the Observatory from Contractor personnel to Government personnel. The Plan shall include conditions to be met prior to transition, any phasing of transition, inclusion of over-the-shoulder monitoring on the part of both Government personnel prior to transition and Contractor personnel just prior to Government acceptance. The Plan shall include opportunities for the Flight Operations Team to participate in Observatory integration and test activities. The plan shall include steps taken to ensure safety of the Observatory is maintained through the transition process. The Plan shall include a transition schedule including milestone activities or events that must be completed prior to each transition phase.	

Title: Command and Telemetry Handbook	**DRD No.:** 22
Reference: SOW Paragraph 4.3.2.2, 4.3.4.2.1	
Purpose: To detail the command and telemetry features of the Spacecraft, Instrument, and LV interfaces for launch and flight operations application.	
Related Documents: None	

Preparation Information

The Telemetry and Command Handbook shall include the following:

Detailed listing of all telemetry assignments.
Key parameters and information necessary for the description and interpretation of the telemetry requirements.
Summary of number and type of telemetry assignments, including spares.
Description of telemetry interfaces, format, requirements data, and limits (red and yellow).
Listing of telemetry assignments that confirm commands.
Transmission or sampling rates.
Methods of in-flight or ground-test verification.
Engineering units and calibration data, Analog to Digital for readout and calibration.

Detailed listings of all commands that can be applied to the Observatory that can effect a response or change in its configuration in anyway, either in test or in flight.
Key parameters necessary for description of commands.
Summary of number and type of commands used by each subsystem and the number of spares.
Description of command input, verification, rates, and filler commands.
Description of command requirements data and information necessary for interpretation.
Listing of commands verified by telemetry and telemetry verifies.
Listing of hazardous commands

Title: Command and Telemetry Database	**DRD No.:** 23
Reference: SOW Paragraph 4.3.4.2.1	
Purpose: To provide command and telemetry data required to control and operate the LDCM Spacecraft.	
Related Documents: None	

Preparation Information

The Spacecraft 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 Instrument, fine Sun Instrument and/or star trackers, magnetometers, and gyros calibrations sufficiently accurate to enable attitude determination, smoothing coefficients, antenna gimbal limits, deadbeat intervals, calibration biases, torque rod/magnetometer coupling matrix, phase shifter calibration data, and the location of the multiple access elements in body-fixed Cartesian coordinates.

Title: Operations Procedures and Scripts	**DRD No.:** 24
Reference: SOW Paragraph 4.3.5.2.2	
Purpose: Provides spacecraft procedures and scripts for the FOT to use for mission operations.	
Related Documents:	

Preparation Information

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

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

Each Operational Procedure shall contain the following information:

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

Title: Flight Activation Operations Plan	**DRD No.:** 25
Reference: SOW Paragraph 4.3.2.2.2, 4.3.5.2.2, 4.3.5.3.1.1	
Purpose: To describe the Contractor's plan for performing the flight operations of the Observatory starting at Observatory/LV integration and test, through launch, and throughout the on-orbit check out phase. Included is how the Contractor intends to perform anomaly resolution to the end of the check out phase.	
Related Documents: None	
Preparation Information The Flight Activation Operations Plan shall include the following: A. Description of roles and responsibilities and plans of how the Contractor will perform the operations of the Spacecraft during LV integrated test, launch, and on-orbit activation operations. B. Description and designation of any unique ground systems and responsibilities needed for Spacecraft operations. C. Plan for anomaly identification, investigation, and resolution process. D. Plan for initial and periodic performance assessments to determine Spacecraft viability and compliance with specifications. E. Description of complement of skills needed to perform this support and how the Contractor will provide these resources. F. Representative anomaly situations and scenarios for resolution.	

Title: Playback Image Data	**DRD No.:** 26
Reference: SOW Paragraph 4.3.1.4	
Purpose: Ground segment personnel will use the files to represent the downlink science digital data flow as it would be seen recovered from the RF downlink at a ground station.	
Related Documents:	
Preparation Information The Contractor shall provide, on appropriate media, playback science data in the format it would be presented to the downlink modulator. The playback period will be defined by the Government. The data shall contain all spacecraft science frame formatting structure and content. Fill bits shall not be used for science data. The Government will make OLI detector test data available for Contractor use.	

Title: Parts Identification List/ADPL/ABPL	**DRD No.:** 27

Reference:
SOW Paragraph 4.3.1.3
MAR Paragraphs 12.7, 15.0

Purpose:
Listing of all parts intended for use in space flight hardware.

Related Documents:
None

Preparation Information
Contents

The Parts Identification List (**PIL)** shall be prepared prior to the first PCB meeting. The PIL shall be compiled by spacecraft component and shall include the following information, as a minimum:

a. Part name
b. Part number
c. Part description
d. Manufacturer
e. Manufacturer's generic part number
f. Related specifications
g. Comments

The Program Approved Parts List (**PAPL)** shall include the PIL information with the addition of:

a. Spacecraft Name
b. Procurement Part Number
c. Flight Part Number
d. Package Type
e. Additional Testing Required
f. CAGE Code
g. Single Event Latch-Up (SEL) information
h. Single Event Up-Set (SEU) information
i. Displacement damage information
j. Total Ionizing Dose (TID) information

The As-Design Parts List (**ADPL)** shall include the PAPL information with the addition of:

a. Quantities
b. Distributor
c. Quantity needed/procured
d. Radiation Source Data (TID/SEE)

The As-Built Parts List (**ABPL)** (See CDRL SA-4) shall include the ADPL information with the addition of:

a. Parts location to the sub-assembly level (including box or board location)
b. Manufacturer's name
c. CAGE code (the manufacturer's plant-specific CAGE code is preferred, if known, but the supplier's general CAGE code is sufficient)
d. Lot Date Code (LDC)
e. Part serial number (if applicable)
f. Quantity used

Any format may be used provided the required information is included. All submissions to GSFC will include a paper copy and a computer readable form. Any changes since the document's prior submission will be clearly noted.

Title: Contamination Control Plan	**DRD No.:** 28

Reference:
SOW Paragraph 4.3.1.3, 4.3.3.6

Purpose:
Define the level of cleanliness, and the methods and procedures to be followed to achieve adequate cleanliness/contamination control, and to define the approach required to maintain cleanliness/contamination control through Spacecraft and Observatory integration test, shipment and flight.

Related Documents:
None

Preparation Information

The contamination/cleanliness control plan shall:
Define the methods, procedures, and schedule requirements for ensuring the adequacy of Observatory contamination control requirements;

Define levels of cleanliness and methods/procedures to be followed for the Observatory for each phase of the program (e.g., Spacecraft development, Instrument integration and test, Observatory environmental test, etc.) The plan shall detail the analyses to be performed to assess Instrument sensitivity and to define requirements.

Identify critical fabrication and assembly activities which will be performed in clean rooms at the Class 10,000 level.

Identify the controls over atmospheric contaminants, temperature, and humidity which will be used during electronic fabrication (including soldering), integration, testing, transportation, and launch. Indicate how others controls will meet the requirements, including a description of all facilities that will be used. Include a thermal vacuum test contamination monitoring plan including vacuum test data, QCM and cold-finger location and temperature, pressure data, system temperature profile and shroud temperature.

Identify design features of shipping containers which will keep contamination of flight hardware during shipment and storage within the contamination budget.

Define the requirements and methods/procedures required to maintain cleanliness during Spacecraft and Observatory fabrication, integration, and test.

Show that the efforts to control contamination are consistent with controls to prevent electrostatic damage.

Indicate the methods and frequency for monitoring cleanliness levels and accretions to ensure compliance with requirements.

Define criteria for materials selection and acceptance relative to contamination control. The criteria shall include outgassing as a function of temperature and time, the nature of outgassing chemistry, and areas, weight, location, view factors of critical surfaces.

Specify criteria for bake-out of critical subsystems.

Provide a contamination training program. All personnel required to work in clean areas with flight hardware must be trained in the proper clean area procedures.

Define overall vent location and orientation policy, indicating how unintentional venting shall be avoided. (All applicable drawings should show vent locations that comply with venting analysis.)

Identify cleaning, inspection, and bagging to be used for parts, flight subassemblies, and the assembled Spacecraft. Identify the schedule for Spacecraft and Observatory cleaning. Reference the procedures used for these activities.

Title: Materials Lubrication, and Processes List (MLPL)	**DRD No.:** 29

Reference:
SOW Paragraph 4.3.3.1
MAR Paragraphs 11.3, 11.4.3, 11.4.4, 11.4.8, 11.4.10, 11.4.11, 15.0

Purpose:
Listing of all Materials, Lubrication, and Processes. It is used in the evaluation and approval of materials, lubricants, and processes used in space flight hardware.

Related Documents:
None

Preparation Information
Contents

Any format may be used provided that the required information is included. All submissions to GSFC shall include a paper copy and a computer readable form.

The **As-Designed Materials and Processes List (ADMPL)** shall be compiled by spacecraft component and shall include, as a minimum:

1. MP name
2. MP number
3. Manufacturer
4. Manufacturer's generic MP number
5. Procurement specification

Polymeric Materials and Composites Usage List

The contractor shall provide the information requested on the polymeric materials and composites usage list form (LDCM MAR Figure 11-3) or the contractor's GSFC Project Office-approved paper or electronically-transmitted form.

The polymeric materials and composites usage list form (Note 1) requires, as a minimum, the following information: spacecraft and subsystem names, GSFC technical officer, contractor, address, prepared by, phone number, date of preparation, GSFC materials evaluator, evaluator's phone number, date received, date evaluated, item number, material identification (Note 2), mix formula (Note 3), cure (Note 4), amount code, expected environment (Note 5), outgassing values and reason for selection (Note 6). Notes 1 through 6 are listed below:

1. List all polymeric materials and composites applications utilized in the system except lubricants that should be listed on polymeric and composite materials usage list.
2. Give the name of the material, identifying number, and manufacturer; e.g., Epoxy, Epon 828, E.V. Roberts and Associates
3. Provide proportions and name of resin, hardener (catalyst), filler, etc.; e.g., 828/V140/Silflake 135 as 5/5/38 by weight
4. Provide cure cycle details; e.g., 8 hours at room temperature + 2 hours at 150^{o}C
5. Provide the details of the environment that the material will experience as a finished spacecraft

component, both in ground test and in space. List all materials with the same environment in a group.

For example: Thermal Vacuum Test: -20C/+60C, 2 weeks, 10E-5 torr, Ultraviolet (UV) radiation

a. Storage: up to 1 year at room temperature
b. Space: -10C/+20C, 2 years, 150 mile altitude, UV, electron, proton, atomic oxygen

6. Provide any special reason why the materials were selected. If for a particular property, please give the property; e.g., Cost, availability, room temperature curing or low thermal expansion.

Inorganic Materials and Composites Usage List

The contractor/subcontractor shall provide the information requested on the inorganic materials and composites usage list (LDCM MAR Figure 11-4) or the contractor's GSFC Project Office-approved paper or electronically-transmitted form.

The inorganic materials and composite usage list (Note 1) form requires, as a minimum, the following information: spacecraft and subsystem names, GSFC technical officer, contractor, contractor address, prepared by, phone number, date of preparation, GSFC materials evaluator, evaluator's phone number, date received, item number, materials identification (Note 2), condition (Note 3), application or usage (Note 4), expected environment (Note 5), stress corrosion cracking table number, MUA number and NDE method. Notes 1 through 5 are listed below
List all inorganic materials (metals, ceramics, glasses, liquids and metal/ceramic composites) except bearing and lubrication materials that should be listed on Form 18-59C (LDCM MAR Figure 11-5).

1. Give materials name, identifying number manufacturer. Examples:
   a. Aluminum 6061-T6
   b. Electroless nickel plate, Endplate Ni 410, Enthone, Inc
   c. Fused silica, Corning 7940, Corning Class Works
2. Give details of the finished condition of the material, heat treat designation (hardness or strength), surface finish and coating, cold worked state, welding, brazing, etc. Examples:
   a. Heat-treated to Rockwell C 60 hardness, gold electroplated, brazed.
   b. Surface coated with vapor deposited aluminum and magnesium fluoride
   c. Cold worked to full hard condition, TIG welded and electroless nickel-plated.
3. Give details of where on the spacecraft the material shall be used (i.e., in what component, etc.) and its function. Example: Electronics box structure in attitude control system, not hermetically sealed.
4. Give the details of the environment that the material will experience as a finished spacecraft component, both in ground test and in space. Exclude vibration environment. List all materials with the same environment in a group. Examples:
   a. Thermal Vacuum Testing: -20C/+60C, 2 weeks, 10E-5 torr, Ultraviolet (UV) radiation
   b. Storage: up to 1 year at room temperature
   c. Space: -10C/+20C, 2 years, 150 miles altitude, UV, electron, proton, Atomic Oxygen

Lubrication Usage List

The hardware provider shall provide the information requested on the lubricant usage list (LDCM MAR Figure 11-5) or the contractor's GSFC Project Office-approved paper or electronically-transmitted form. The lubricant usage list form requires, as the minimum: spacecraft and subsystem names, GSFC technical officer, contractor, contractor address, prepared by, phone number, date of preparation, GSFC materials

evaluator, evaluator's phone number, date received, item number, component type, size, material (Note 1); component manufacturer and manufacturer identification; proposed lubrication system and amount of lubrication; type and number of wear cycles (Note 2); speed, temperature and atmosphere of operation (Note 3); type and magnitude of loads (Note 4); and other details (Note 5). Notes 1 through 5 are listed below:

1. For Ball Bearing (BB), Sleeve Bearing (SB), Gear (G), Sliding Surfaces (SS), Sliding Electrical Contacts (SEC), give generic identification of materials used for the component; e.g., 440C steel, PTFE.
2. Continuous Unidirectional Rotation (CUR), Continuous Oscillation (CO), Intermittent Rotation (IR), Intermittent Oscillation (IO), Small Angle Oscillation (<30 degrees) SAM, Large Angle Oscillation (>30 degrees) (LAM), Continuous Sliding (CS), Intermittent Sliding (IS). Number of wear cycles: 1 to 1E2 (A), 1E2 to 1E4 (B), 1E4 to 1E6 (C), >1E6 (D)
3. Speed: Revolution Per Minute (RPM), Oscillation Per Minute (OPM), Variable Speed (VS), Sliding Speed in cm. Per Minute (CPM). Operational temperature range atmosphere: vacuum, air, gas sealed or unsealed and pressure
4. Type of loads: Axial, radial, tangential (gear load). Give magnitude of load.

For ball bearings, give type and material of ball cage, number of shields, type of ball groove surface finishes. For gears, give surface treatment and hardness. For sleeve bearings, give the bore diameter and width. Provide the torque and torque margins.

Material Process Utilization List

The contractor shall provide the information requested on the material process utilization list form (LDCM MAR Figure 11-6) or the contractor's GSFC Project Office-approved paper or electronically-transmitted form.

The material process utilization list requires, as a minimum, the following information: spacecraft and subsystem names, GSFC technical officer, contractor, address, prepared by, phone number, date of preparation, GSFC materials evaluator, evaluator's phone number, date received, date evaluated, item number, process type (Note 1), contractor spec. number (Note 2), Military, ASTM, Federal or other specification number, description of material processed (Note 3) and spacecraft/instrument application (Note 4). Notes 1 through 4 are listed below:

1. Give generic name of the process; e.g., anodizing (sulfuric acid)
2. If the process is proprietary, please state so.
3. Identify the type and condition of the material subjected to the process; e.g., 6061-T6
4. Identify the component or structure for which the materials are being processed; e.g., antenna dish

All welding and brazing of all flight hardware including repairs shall be performed by certified operators in accordance with requirements of the appropriate industry or Government standards listed in the Materials Process Utilization List (Figure 11-6). A copy of the Procedure Qualification Record (PQR) and a current copy of the operator qualification test record shall be with the Materials Process Utilization List. Copies of processes shall be made available to the GSFC Project Office upon request.

Materials Usage Agreement (MUA)

A MUA shall be provided for each non-compliant off-the-shelf-hardware material usage, non-compliant polymeric material outgassing, flammability or toxicity usage, and non-compliant inorganic material stress corrosion cracking usage.

The MUA shall be provided on a Material Usage Agreement form (LDCM MAR Figure 11-1) or the

contractor's GSFC Project Office-approved paper or electronically-transmitted form.

The MUA form requires the minimum following information: material rating (per MSFC-STD-3029 found in MAPTIS database), usage agreement number, page number, drawing numbers, part or drawing name, assembly, material name and specification, manufacturer and trade name, use thickness, weight, exposed area, pressure, temperature, exposed media, application, rationale for safe and successful flight, originator's name, project manager's name, and date.

The off-the-shelf-hardware usage shall identify the measures to be used to ensure the acceptability of the hardware such as hermetic sealing, material changes to known compliant materials, vacuum bake-out to the error budget requirements listed in the LDCM Contamination Control Plan, etc.

Stress Corrosion Evaluation Form

The contractor shall provide the information requested on the stress corrosion evaluation form (LDCM MAR Figure 11-2) or the contractor's GSFC Project Office-approved paper or electronically-transmitted form.
The stress corrosion evaluation form requires, as a minimum, the following information: part number, part name next assembly number, manufacturer, material heat treatment, size and form, sustained tensile stresses, magnitude and direction, process residual stress, assembly stress, design stress, static stress, special processing, weld alloy form, temper of parent weldment metal, weld filler alloy, welding process, weld bead removal process if any, post-weld thermal treatment, post-weld stress relief, environment, protective finish, function of part, effect of failure, evaluation of stress corrosion susceptibility, originator's name, project manager's name, and date.

The **As-Built Materials and Processes List (ABMPL)** shall be compiled by spacecraft component and shall be delivered in accordance with CDRL 42

Title: Non-Conformance Reporting	**DRD No.:** 30
Reference: SOW Paragraph 4.3.1.3 MAR Paragraph 2.2.3, 2.2.4, 4.4	
Purpose: Used to record instances of material nonconformances and test failures.	
Related Documents: None	

Preparation Information

Contents

Document all material and test nonconformances on existing contractor forms that identify all relevant nonconformance information. Relevant information includes (who, what, when, and where):

1. Identification of project, system, and sub-system
2. Identification of nonconforming/failed assembly, sub-assembly, or part
3. Description of nonconforming/failed item and nonconformance/failure
4. Identification of next higher assembly
5. Description of failure including activities leading up to failure, if known
6. Names and contact information of individuals involved with the nonconformance
7. Date and time of report
8. Status of nonconforming/failed item(s)
9. Individual originating report including contact information
10. Date nonconformance/Failure Report submitted

At a minimum, MRB/FRB Reports shall contain:

1. Attendance list for MRB/FRB meeting
2. Date of MRB/FRB meeting
3. Minutes for the MRB/FRB meeting, as appropriate

A contractor-formatted matrix summarizing the open/closed status for all MRB/Failure Reports

Title: Government Industry Data Exchange Program (GIDEP) Alert/Advisory and NASA Alert/Advisory Responses and Submissions	**DRD No.:** 31

Reference:
SOW Paragraph 4.3.1.3
MAR Paragraph 15.0

Purpose:
Review and disposition of GIDEP Alerts and NASA Alerts and Advisories and other Industry/Government alerts, warnings, etc. which are provided to the contractor by GSFC or another source. Prepare, or assist GSFC in preparing, working, and dispositioning Alerts/Advisories, warnings, etc. based on anomalies/concerns resulting from the contractor's own experience. GSFC experience, or other relevant industry, NASA, DOD or other relevant organizational experience. GIDEP alerts shall include Alerts, Safe-Alerts, Problem Advisories, Agency Action Notices and Lessons Learned.

Related Documents:
None

Preparation Information
Contents

The contractor shall compile a table or matrix of all Alerts (as defined above related to the LDCM Program) issued on or after the contract award date as well as any Alerts that were issued prior to the contract award that are determined to affect LDCM Program hardware. At a minimum, this table/matrix shall include:

1. The dates the Alert was issued, added to the table/matrix, dispositioned, and closed by the contractor.
2. The Alert's applicability and impact to the LDCM Program
3. Identification of the affected item, its next assembly, subsystem and system information
4. Spacecraft or ground support equipment affected
5. Contractor, subcontractors, suppliers, and vendors affected
6. Background information on the Alert including responsible organizations and personnel, initiation date, technical information, and current status
7. Disposition plans and responsibilities including the status and (expected and/or actual close-out date)
8. All required/implemented corrective actions taken by the contractor, subcontractors, suppliers, and vendors
9. The rationale/justification for using parts/materials covered by Alerts
10. Project impact and risk identification

The contractor shall submit a completed GSFC Form 4-37, "Problem Impact Statement: Parts, Materials and Safety," to the LDCM Project Office for each part or material covered by an Alert. These forms, which can be found at http://gdms.gsfc.nasa.gov/gdmsnew/home.jsp, and shall be submitted to the LDCM Project Office on a monthly basis.

Title: Mass properties Report	**DRD No.:** 32

Reference:
SOW Paragraph 4.3.4.2

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

Related Documents:
None

Preparation Information

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

The mass properties report shall contain the following:

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

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

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

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

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

Title: Analytical Models	**DRD No.:** 33

Reference:
SOW Paragraph 4.3.2.2, 4.3.2.2.1.1, 4.3.2.2.1.2

Purpose:
To provide the Instrument, launch vehicle and ground system teams with Spacecraft analytical models needed to assist them in their designs and preparations to support the Observatory for launch and mission operations.

Related Documents:
None

Preparation Information
The Contractor shall provide to the Instrument(s), launch vehicle, and ground systems team the required external interface information (data, models, and analysis) for the development of the Instrument or ground system. This shall include as a minimum:

A. Spacecraft and Observatory reduced finite element models to support 2 coupled loads cycles. (@ CDR – 4 months, and @ PSR – 6 months).
B. Structural interface analysis.
C. Pointing and alignment budgets.
D. Spacecraft and Observatory Thermal Math Models and mission analyses report.
E. Ground system protocols and data rates compatibility analysis.
F. Data contact scenarios and optimization .
G. Flight dynamics and orbital maintenance analysis and ground requirements (e.g., ephemeris uploads).
H. Reliability analysis (worse case, parts stress, single event effects).
I. Failure mode and effects analysis (FMEA) as described in section 4.3.1.2 of the SOW and MAR Section 2.2.
J. All other models and analysis the Contractor prepares or uses in implementing the LDCM spacecraft.

Title: Analyses	**DRD No.:** 34
Reference: SOW Paragraph 4.3.2.2, 4.3.2.2.1	
Purpose: To provide detailed analyses and margins of safety calculations for all major components and functions in the observatory	
Related Documents: None	
Preparation Information The following information shall be provided: 1. Mechanical stress analysis 2. Launch-to-orbit mission analysis 3. Structural and mathematical analysis 4. Load transformation matrices 5. Jitter analysis 6. Propulsion subsystem analysis 7. ACS analysis 8. Link analysis 9. Thermal analysis 10. Power subsystem analysis 11. C&DH performance analysis The Contractor shall describe the analysis method used, its constraints and execution, limiting cases, and the analysis results.	

Title: Probabilistic Risk Assessment (PRA) Report Limited Scope PRA	**DRD No.:** 35

Reference:
SOW Paragraph 4.3.1

Purpose:
Provides a structured, disciplined approach to analyzing system risk to support management decisions to ensure mission success; improve safety in design, operation, maintenance and upgrade; improve performance; and reduce design, operation and maintenance costs.

Related Documents
None

Preparation Information:

Contents

The PRA Report and associated analyses/reports shall be in the contractor's formats.

The Limited Scope PRA shall comply with a Class B mission as defined in NPR 8705.4, Risk Classification for NASA Payloads. It shall identify and assess:

1. Undesirable events
2. The scenarios leading to those events beginning with the initiating event or events
3. The frequency or likelihood of those events
4. Uncertainties that exist in the assessment
5. Risk dominant scenarios and their consequences and associated uncertainties
6. Recommendations for project/risk managers on risk reduction and mitigation actions

The PRA shall consider all relevant critical factors including safety of the public and the NASA workforce; adverse impacts on the environment, high value equipment, and property; national interests, security, etc. Potential candidates for PRA analysis may come from mission operational working group meetings, reliability working group meetings, safety hazard analyses, FMEA's, reliability prediction analyses, integration and test problem reports, etc. The PRA shall span every phase of the LDCM life-cycle.

The Fault Tree Analysis (FTA),shall be developed under CDRL-12, integrated with the PRA as defined in NPR-8705.4, and developed to a level that encompasses the dependencies between systems or to a level where failure data exists for the basic events, whichever is more detailed (i.e., at a lower level).

Title: Failure Mode and Effects Analysis (FMEA), Critical Items List (CIL), Critical Items Control Plan**,** Limited Life Items List, Fault Tree Analysis (FTA), Parts Stress Analysis, Worst Case Analysis (WCA), and Reliability Predictions	**DRD No.:** 36

Reference:
SOW Paragraph 4.3.1.3
MAR Paragraphs 4.3.2, 4.3.3, 4.3.4, 4.3.5, 4.3.6, 4.4

Purpose: The FMEA is used to evaluate the design against requirements and to identify single point failures and hazards to assure mission success. It is used to identify all modes of failure within a system design. Its first purpose is the early identification of all catastrophic and critical failure possibilities so they can be eliminated or minimized through design correction at the earliest possible time. The CIL is a list of critical items which require the highest level of attention during design, fabrication, and verification as well as the highest level of problem correction during the development, handling, and mission use of the system. The Critical Items Control Plan describes the procedures and provides traceability of specific and verifiable processes in the design manufacturing and test phases of the program to control and reduce the likelihood that critical items will fail in orbit. The Limited Items Lists identifies all components that potentially may not meet lifetime requirements and the corresponding rationale for their use. The FTA is a top-down technique to analyze what may cause a particular fault or failure events to occur. The Parts Stress Analysis is used to ensure that all electrical, electronic, and electro-mechanical devices meet both their specification and derating limits.

Related Documents

Preparation Information:
Contents

The FMEA, Critical Items List, Critical Items Control Plan and Limited Life Items List shall be in the contractor's format.

The **FMEA** Report shall be performed on at least a "black box" or "circuit block diagram" level. It shall include:

1. A discussion of the approach of the analysis, methodologies, assumptions, results, conclusions, and recommendations
2. Objectives
3. Level of the analysis
4. Ground rules
5. Functional description
6. Functional block diagrams
7. Reliability block diagrams
8. Equipment analyzed
9. Data sources used
10. Problems identified
11. Single-point failures
12. Corrective action
13. Work sheets identifying failure modes, causes, severity category, and effects at the item, the next higher level, and mission level, detection methods, and mitigating provisions

Critical Items List (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.

The **Critical Items Control Plan** shall describe the procedure for introducing specific, traceable, and verifiable processes into the design, manufacturing, and test phases of the program to control and reduce the likelihood that critical items will fail on-orbit.

The **Limited Life Items List** shall list life-limited items and their impact on mission parameters. Define expected life, required life, duty cycles, and rationale for selecting and using the items. Include selected structures, thermal control surfaces, solar arrays, and electromechanical mechanisms. Atomic oxygen, solar radiation, shelf-life, extreme temperatures, thermal cycling, wear and fatigue are used to identify limited-life thermal control surfaces and structural items. When aging, wear, fatigue, and lubricant degradation limit their life; include batteries, compressors, seals, bearings, valves, recording devices, momentum wheels, gyros, actuators and scan devices.

The **Fault Tree Analysis (FTA)** shall be developed to a level that encompasses the dependencies between systems or to a level where failure data exists for the basic events, whichever is more detailed (i.e., at a lower level). The Fault Tree Analysis Report shall contain:

1. Analysis ground rules including definitions of the undesirable end states
2. References to documents and data used
3. The fault tree diagrams
4. Results and conclusions

The **Parts Stress Analysis Report** shall contain:

1. Analysis ground rules
2. Reference documents and data used
3. Results and conclusions including design trade study results
4. Parts stress analysis results impacting design or risk decisions analysis worksheets. At a minimum, the worksheets shall include:
   - Part identification (traceable to circuit diagrams)
   - Assumed environmental (consider all expected environments)
   - Rated stress
   - Applied stress (considering all significant operating parameter stresses at the extremes of anticipated environments)
   - Ratio of applied-to-rated stress

The **Worst Case Analysis (WCA) Report** shall:

a. Address worst case conditions performed on each component
b. Discuss how each analysis takes into account/affects the mission life
c. Discuss consideration of critical parameters at maximum and minimum limits
d. The effect of environmental stresses on the operational parameters being evaluated

The **Reliability Predictions** or **Spacecraft Reliability Model Analysis and Reports** shall;

a. Present clearly and concisely, predictions, reliability block diagrams, mathematical models, and other supporting information necessary to develop and evaluate space segment mission reliability at the component, subsystem, system and service levels.

b. Contain sufficiently detailed information so that the results are directly applicable to other reliability tasks without special effort or adaptation.

All calculations shall be performed in accordance with standard reliability modeling techniques supplemented by special MARKOV or MONTE CARLO models. Parts reliability data may be obtained from MIL-HDBK-217F notice 1 or Mil-HDBK-217Plus. Other data sources such as HSC in-orbit experiences or special studies shall be used for items not covered by, or considered more applicable, than data in MIL-HDBK-217 or Mil-HDBK-217Plus. Rationale for the parts reliability data used should be provided

Title: Deleted	**DRD No.:** 37
Reference:	
Use:	
Related Documents	
Preparation Information:	

Title: Deleted	**DRD No.:** 38
Reference:	
Purpose:	
Related Documents:	
Preparation Information	

Title: Deleted	**DRD No.:** 39
Reference:	
Purpose:	
Related Documents:	
Preparation Information	

Title: Deleted	**DRD No.:** 40
Reference:	
Purpose:	
Related Documents:	
Preparation Information	

Title: Operations Hazards Analysis (OHA) and Hazard Tracking Log (HTL)	**DRD No.:** 41

Reference:
SOW Paragraph 4.3.2.4
MAR Paragraphs 3.2.3.4

Purpose:
The Operations Hazard Analysis (OHA) is used to demonstrate that the planned I&T activities are compatible with the facility safety requirements, and that any inherent hazards associated with those activities is mitigated to an acceptable level. During I&T activities, a Hazard Tracking Log (HTL) shall be used to track and close all remaining items.

Related Documents:

Preparation Information
Contents

The OHA shall include the following information:

1. 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. System Description
   a. Provide a description of the system hardware and configuration, listing the subsystems components.
   b. Provide the most recent schedules for the integration and testing (I&T) of spacecraft.
   c. Include photographs, diagrams, and sketches to support the analysis.
3. Analysis of System Hazards
   a. Identify all real or potential hazards presented to personnel, equipment, and property during I&T processing.
   b. List all identified hazards in a tabulated format. Each hazard shall be numbered and include the following information:
      1) System Component/Phase - The particular phase/component with which the analysis is concerned. This could be a system, subsystem, component, operating/maintenance procedure or environmental condition. System Description and Hazard Identification/Indication – provide:
         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 the hazard will/may 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.

2) Effect on System - Describe the detrimental results that an uncontrolled hazard could inflict on the whole system.
3) Risk Assessment - Provide a risk assessment for each hazard as defined in the project Risk Management Plan.
4) Caution and Warning Notes - Provide a complete list of specific warnings, cautions, and procedures required in operating and maintenance manuals, training courses, and test plans.
5) Status/Remarks – Provide:
   b) The status of actions to implement the recommended, or other, hazard controls.
   c) Any information relating to the hazard, not covered in the other blocks, e.g., applicable documents, previous failure data in similar systems, or administrative directions.

4. References - List all pertinent references such as test reports, preliminary operating and maintenance manuals, and other hazard analysis.
5. 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. They may also contain detailed formulation or analysis which is more conveniently placed in an appendix.

In association with the OHA, a HTL shall be maintained by the contractor to track and close-out the documented operations hazards.

Title: Safety and Mission Assurance (S&MA) Data Package	**DRD No.:** 42
Reference: SOW Paragraph 4.3.2.4 MAR Paragraphs 2.3, 4.3.7, 4.4, 10.3.2.1, 11.3, 12.7.4, 15.0	
Purpose: This data shall be used to support the acceptance of each of the flight spacecraft.	
Related Documents:	

Preparation Information

The initial submittal of the S&MA Data Package shall contain items "a" through "l" below. Item "m" shall be due starting with the second submittal of the S&MA Data Package. After the initial submittal of each item, subsequent S&M Data Package deliveries shall include these items only when a change has been made to the item. A complete updated version of the item shall be delivered as part of a subsequent delivery when appropriate as for "a" through "f." Only changes since the initial submittal shall be reviewed; hence, they shall be clearly identified including the date of and reason for the change. If absolutely no changes have been made to a specific item since the last submittal of the S&MA Data Package, the contractor shall verify the same in the S&MA Data Package cover letter and not deliver a repeat/identical version of that specific item. Safety non-compliances shall be reported in accordance with CDRL 30.

a. As-Built Parts List
b. As-Built Polymeric Materials and Composites Usage List
c. As-Built Inorganic Materials and Composites Usage List
d. As-Built Lubrication Usage List
e. As-Built Material Process Utilization List
f. PWB Coupons and Their Analysis Test
g. Photographic documentation of all flight printed wiring assemblies, subsystem, and system level boxes and structures, wiring harness routing, and procured flight articles
h. Test Log Books and verification reports including total operating time and cycle records for system, subsystem, assembly, and other lower levels of assembly
i. List of Open Items with reasons for items being open and appropriate authorization/approvals.
j. Listing and status of all identified Limited-Life Items
k. Trend Data
l. Configured Articles List (As-Built Report)
m. Results of the spacecraft level performance acceptance testing

Title: Deleted	**DRD No.:** 43
Reference:	
Purpose:	
Related Documents:	
Preparation Information	

Title: Deleted	**DRD No.:** 44
Reference:	
Purpose:	
Related Documents:	
Preparation Information	

Title: Deleted	**DRD No.:** 45
Reference:	
Purpose:	
Related Documents:	
Preparation Information	

Title: Deleted	**DRD No.:** 46
Reference:	
Purpose:	
Related Documents:	
Preparation Information.	

Title: Pre-Mishap Plan, Mishap Reporting and Mishap Investigations (including all Subcontractor Facilities)	**DRD No.:** 47

Reference:
SOW Paragraph 4.3.2.4
MAR Paragraph 3.10

Purpose:
Provides a plan for procedures to be followed to respond to and control a mishap or an emergency that may have personnel or hardware safety implications, or may cause flight or GSE hardware damage.
Ensures NASA requirements for Program and Project Pre-Mishap Plans are met.
Provide the GSFC Project Office and NASA with information on any mishaps, incidents, and close calls related to the developer's LDCM Program.

Related Documents:
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Preparation Information
The plan shall identify the processes and procedures to be followed to respond to and control a mishap or an emergency, as well as identify the chain of individuals to be contacted in the event hazardous events occur. "Hazardous events" include any and all situations and unplanned happenings that have resulted in, or could have resulted in, danger or actual harm to people, capital facilities, flight and ground equipment, and the environment.

The Contact Plan shall ensure emergency shut-down procedures are available and reviewed prior to the execution of each integration and test procedure, as needed. The Government will review and approve the plan and the contact chain. The intent of this plan is to make sure that in the event personnel, facilities, or hardware is/are damaged or if there is a "close-call", clear and simple steps are quickly taken to ensure correct recovery actions are immediately invoked, the appropriate Government and contractor management staff are promptly notified, secondary or collateral damage is minimized, and corrective procedures are ultimately implemented to avoid a recurrence.

When a hazardous event occurs, at least one Government person on the contact chain shall be spoken to directly; text messaging, voice messages, email, paging, written notification, and any other indirect means shall not be acceptable forms of contact. After at least one direct contact is made, indirect means may be used for any others on the contact list.

Provide supporting data for GSFC Pre-Mishap Plan prior to initiating any project operations with potential for personnel injury or flight hardware damage, and prior to operations with hazardous potential and flight hardware damage (includes GSE that could cause a flight delay or be of high value).

Mishap Reporting and investigation shall be conducted in accordance with the Project's Pre-Mishap Plan. The developer shall report any mishaps, incidents, and close calls in the NASA Incident Reporting System (IRIS), in accordance with NPR 8621.1, "NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Record Keeping". All accidents, mission or test failures, or other mishaps shall be promptly investigated to determine the dominant root cause.

IRIS can be accessed through: https://nasa.ex3host.com/Iris

Title: Orbital Debris Assessment	**DRD No.:** 48

Reference:
SOW Paragraph 4.3.2.4
MAR Paragraph 3.8
NASA Directive NPR 8715.6, "NASA Procedural Requirements for Limiting Orbital Debris" Dated August 17, 2007 (http://nodis3.gsfc.nasa.gov/displayDir.cfm?t=NPR&c=8715&s=6)
NSS 1740.14 "Guidelines and Assessment Procedures for Limiting Orbital Debris Dated August 1995

Purpose:
Ensure NASA that the contractor meets requirements for post mission orbital debris control

Related Documents:

Preparation Information
The assessment shall be done in accordance with NSS 1740.14, "Guidelines and Assessment Procedures for Limiting Orbital Debris." Prior to the Spacecraft PDR, the preliminary debris assessment shall be conducted to identify areas where the program or mission might contribute debris and to assess this contribution relative to the guidelines to the extent feasible. Prior to the CDR, another debris assessment shall be completed. This report shall comment on changes made since the PDR report. The level of detail shall be consistent with the available information of design and operations. When there are design changes after CDR that impact the potential for debris generation, an update of the debris assessment report shall be prepared, approved, and coordinated with the GSFC Project Office.

Orbital Debris Assessment Software is available for download from Johnson Space Center at URL:

http://sn-callisto.jsc.nasa.gov/mitigate/das/das.html

NOTE: NASA HQ needs to provide approval prior to shipment to the launch ranges.

Title: Missile Systems Pre-Launch Safety Package	**DRD No.:** 49

Reference:
SOW Paragraph 4.3.2.4
MAR Paragraphs 3.2.2, 3.2.3.1, 3.2.3.2, 3.2.3.3, 3.2.3.5, 3.3, 3.4, 3.11
AFSCM 91-710, "Range Safety User Requirements Manual"
Note: Other launch vehicle and/or contractor or commercial facility requirements may apply.

Purpose:
Provides 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, ground support equipment, and their interfaces. The developer shall take measures to control and/or minimize each significant identified hazard.

In addition to identifying hazards, the MSPSP shall also identify applicable hazard controls and verifications methods for each hazard, documenting them in Hazard Reports. The analysis shall be updated as the hardware progresses through the stages of design, fabrication, and test. A list of all hazardous/toxic materials and associated material safety data sheets shall be prepared and included in the final MSPSP as well as a detailed description of the hazardous and safety critical operations associated with the payload.

The safety assessment shall begin early in the program formulation process and continue throughout all phases of the mission lifecycle. The spacecraft developer shall demonstrate compliance with these requirements and shall certify to the GSFC Project Office and the launch range, through the MSPSP, that all safety requirements have been met.

Related Documents:

Preparation Information

Contents

The MSPSP shall include the following information:

1. Introduction - State, in narrative form, the purpose of the safety data package.
2. System Description - This section may be developed by referencing other program documentation such as technical manuals, the system program plan, the system specification, etc. Include, as applicable, photos, charts, flow/functional diagrams, sketches, or schematics to support the system description, test, or operation.
3. System Operations – This section shall include:
   a. A description or reference of 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. A description of any special safety procedures needed to assure safe operations, test and maintenance, including emergency procedures.
   c. A description of anticipated operating environments and any specific skills required for safe operation, test, maintenance, transportation, or disposal.

d. A description of 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. Hazard Reports for all hazards by subsystem or major component level that have been identified and considered from the inception of the program. These reports shall include:
      1) A discussion of the hazards and the actions that have been taken to eliminate or control these items.
      2) A discussion of the effects of these controls on the probability of occurrence and severity level of the potential mishaps
      3) A discussion of the residual risks that remain after the controls are applied or for which no controls could be applied
      4) 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 Verification Tracking Log (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 the 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. Appropriate radiation forms/analyses
   d. Reference material including a list of all pertinent references such as test reports, preliminary operating manuals, and maintenance manuals
   e. A statement signed by the developer's System Safety Manager and 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 any other system(s).

Attachments or appendices to the MSPSP shall include:

A. Safety Requirements Compliance Checklist

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. Resolution
7. Reference
8. Copies of all Range Safety approved non-compliances including waivers and equivalent levels of safety certifications

B. Preliminary Hazard Analysis

Perform and document a PHA, based on the hazard assessment criteria provided in Chapter 3 of NPR 8715.3, 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, at a minimum, the following for identification and evaluation of hazards:

1. Hazardous components
2. Environmental constraints including the operating environments
3. Operating, test, maintenance, built-in-tests, diagnostics, and emergency procedures
4. Facilities, real property installed equipment, and support equipment
5. Safety related equipment, safeguards, and possible alternate approaches
6. 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.

   Malfunctions to the system, subsystems, or software. Each malfunction shall be specified including its causing and resulting sequence of events and the degree of hazard that were determined and the appropriate specification and/or design changes that were subsequently developed.
8. A system description and a description of the methodology used to develop the analysis shall be included.

C. Operating and Support Hazard Analysis (O&SHA)

The contractor shall perform an O&SHA to evaluate procedurally controlled activities for hazards or risks introduced into the system during pre-launch processing (i.e., at the launch site or processing facilities) and to evaluate the adequacy of procedures used to eliminate, control, or abate identified hazards or risks.

The term "operation" may include, but is not limited to, activities such as testing, installation, maintenance, transportation, contingency operations, and others. This analysis shall consider the planned system configuration or state at each phase of activity, the facility interfaces, the planned environments (or their ranges), the supporting tools or other equipment specified for use, operational/task sequence, concurrent task effects and limitations, biotechnological factors, regulatory or specified personnel safety and health requirements, and the potential for unplanned events including hazards introduced by human errors.

The O&SHA shall identify the safety requirements (i.e., constraints, limitations, conditions) to eliminate hazards or to reduce the associated risk to an acceptable level. The O&SHA shall also be used to validate design safety by verifying that the system will perform as expected if the operator

correctly performs each step of approved procedures. The O&SHA shall be updated when system design or operational changes are included to ensure any needed hazard control changes.

D. Safety Verification Tracking Log (VTL)

The VTL provides documentation that demonstrates the process of verifying the control of all hazards by test, analysis, inspection, similarity to previously qualified hardware, or any combination of these activities. All verifications that are 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:

- Verification Tracking Log Number
- Hazard Report Number
- Safety Verification Number
- Description (Identifying procedures/analyses by number and title)
- Constraints on Launch Site Operations
- Is Independent Verification Required (i.e., mandatory inspection points)? Yes/No
- Scheduled Completion Date
- Completion Date
- Method of Closure

A VTL identifying hazard controls still not verified closed shall be prepared and delivered with the final MSPSP to GSFC OSSMA. Regular updates to this log shall be provided as requested until all hazard control verifications have been closed. Open VTL items must be closed with appropriate documented rationale prior to first operational use/restraint.

E. Miscellaneous Range Deliverables

Analyses and standard range forms that are required by KSC and the Eastern Test Range (ETR) to obtain authorization to proceed with a launch.

1. Material Selection List for Plastic Films, Foams, and Adhesive Tapes - The list is published in GP-1098, "KSC Ground Operations Safety Plan, Volume I, Safety Requirements," and is updated quarterly and available online at http://rtreport.ksc.nasa.gov/techreports/95report/msf/ms10.html. Materials are evaluated for electrostatic discharge (ESD), flammability, and compatibility with hypergols.
2. Radiation Forms/Analysis - KHB 1860.1, "KSC Ionizing Radiation Protection Program," and KHB 1860.2, "KSC Non-Ionizing Radiation Protection Program," includes forms for ionizing and non-ionizing radiation from RF, light, laser, and radioactive sources. Forms must be completed to provide information on the radiation source(s) and the source user(s).
3. Process Waste Questionnaire (PWQ) - PWQ records all the hazardous materials that are brought to the range with the payload. Specific information on storage, containment, and spill control are required.
4. Environmental Impact Statement (EIS) - An EIS is required to define the impact of an aborted/terminated launch.

Title: Observatory Performance Verification Plan and Matrix	**DRD No.:** 50

Reference:
SOW Paragraph 4.3.2.2

Purpose:
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.

Related Documents:

Preparation Information

The Observatory Performance Verification Plan (OPVP) shall:

A. Be separated into sections such that it is clear which spacecraft requirements are verified at the spacecraft and Observatory levels.

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

The OPVP describes the approach (test, analysis, etc.) that will be utilized to verify performance against the requirements documents (SRD, OIRD, LSIRD, MAR, LEVR). If verification relies on measurements, tests, or analyses at lower (or other) levels of assembly, this dependence shall be described.

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.

This Plan describes an operational methodology for controlling, documenting, and approving activities not part of an approved. On-orbit verification tests shall be cross-referenced to the On-Orbit Commissioning Plan.

System Performance Verification Matrix

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

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

Title: System Environmental Verification Plan and Matrix	**DRD No.:** 51

Reference:
SOW Paragraph 4.3.4.2

Purpose:
The Environmental Verification Plan documents the contractor's approach for environmental qualification and acceptance tests. The Environmental Test Matrix summarize the tests performed. This DRD also satisfies the environmental verification requirements of the launch services provider.

Related Documents:

Preparation Information

The Environmental Verification Plan shall provide the general test philosophy and an overview of the systems-level environmental testing to be performed to demonstrate that the hardware and software comply with the environmental verification requirements.

The verification plan shall include test objectives, test specimen configuration, general test methods, and a schedule. It should not include detailed test procedures.

The environmental verification plan shall provide the overall approach to accomplishing the environmental verification program. For each test, it shall include the level of assembly, the configuration of the item, objectives, facilities, instrumentation, safety considerations, contamination control, test phases and profiles, necessary functional operations, personnel responsibilities, and requirement for procedures and reports. It shall also define a rationale for retest determination that does not invalidate previous verification activities. When appropriate, the interaction of the test and analysis activity shall be described.

Limitations in the environmental verification program which preclude the verification by test of any system requirement shall be documented. Examples of limitations in the ability to demonstrate requirements include:

- Inability to deploy hardware in a 1-g environment.
- Facility limitations which do not allow testing at system level of assembly.
- Inability to perform certain tests because of contamination control requirements.
- Inability to perform powered-on testing because of voltage breakdown concerns.
- Alternative tests and analyses shall be evaluated and implemented as appropriate, and an assessment of program risk shall be included in the System Performance Verification Plan.

The Environmental Verification Plan shall have separate sections for the instrument and the spacecraft.

As an adjunct to the environmental verification plan, an environmental test matrix shall be prepared that summarizes all tests that will be performed on each component, each subsystem, and the payload. The purpose is to provide a ready reference to the contents of the test program in order to prevent the deletion of a portion thereof without an alternative means of accomplishing the objectives; it has the additional purpose of ensuring that all flight hardware has been subjected to environmental exposures that are sufficient to demonstrate acceptable workmanship. In addition, the matrix shall provide traceability of the

qualification heritage of hardware. All flight hardware, spares and prototypes (when appropriate) shall be included in the matrix. Details of each test shall be provided (e.g., number of thermal cycles, temperature extremes, vibration levels). It shall also relate the design environments to the test environments and to the anticipated mission environments. The matrix shall be prepared in conjunction with the initial environmental verification plan and shall be updated as changes occur.

A complementary matrix shall be included showing the tests that have been performed on each component, subsystem, or payload (or applicable level of assembly). This should include tests performed on prototypes or engineering units used in the qualification program, and should indicate test results (pass/fail or malfunctions).

Title: Spacecraft Performance and Functional Test Plans	**DRD No.:** 52

Reference:
SOW Paragraph 4.3.4.2

Purpose:
Provide information on how the spacecraft will be functionally tested and how the performance will be verified.

Related Documents:

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. 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)

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

FOT's generation of similar plans for MRTs.

Title: Observatory Performance and Functional Test Procedures	**DRD No.:** 53
Reference: SOW Paragraph 4.3.4.2	
Purpose: Provides details of the process followed to execute the plan in CDRL 52	
Related Documents:	

Preparation Information

Unless already provided under CDRL 52, the Contractor shall provide draft and final procedures for the performance and functional tests. These procedures shall detail the staffing, facilities, test set-up, initial conditions, and any emergency or hazardous protections required prior to running the test.

The procedures shall address:

1. the objectives
2. test requirements
3. test limits
4. pass/fail criteria
5. test fixtures and instrumentation
6. handling procedure
7. environment
8. test recording requirements

Title: Observatory Performance and Functional Test Readiness Reviews	**DRD No.:** 54
Reference: SOW Paragraph 4.3.1.5.1.6	
Purpose: Provides the information to be reviewed showing all preparations are complete for the proposed test, and leads toward approval to conduct the test	
Related Documents:	
Preparation Information The Contractor shall provide a summary of the material in the Test Plan (CDRL 52) and Test Procedures (CDRL 53) that demonstrates all preparations are successfully completed, all entry requirements have been met, and it is acceptable to proceed with the test.	

Title: Observatory Performance and Functional Test Reports	**DRD No.:** 55

Reference:
SOW Paragraph 4.3.4.2

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

Related Documents:

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 tests
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.

5. A copy of the as-run test procedure(s)

e. 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.

Title:	**DRD No.:** 56
Spacecraft and Observatory Integration and Test Plans	

Reference:
SOW Paragraph 4.3.4, 4.3.4.2

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

Related Documents:

Preparation Information

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

Spacecraft level:
- Final Spacecraft comprehensive performance tests.

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

Spacecraft Interface Simulator I&T with the Instrument(s)
Spacecraft/Observatory Simulator I&T with the Instrument Simulators and the PTP/MOE

The Contractor may submit separate deliverables under this CDRL according to content and coverage. Each distinct deliverable shall be designated “56A”, “56B”, etc.

Title: Spacecraft and Observatory Integration and Test Procedures	**DRD No.:** 57
Reference: SOW Paragraph 4.3.4.1	
Purpose: To define test procedures for establishing Spacecraft and Observatory compliance to LDCM specifications	
Related Documents:	

Preparation Information

Unless already provided under CDRL 56, the Contractor shall define the Spacecraft and Observatory Integration and Test Procedures following for each procedure in CDRL 56:

1. the objectives
2. test requirements
3. test limits
4. pass/fail criteria
5. test fixtures and instrumentation
6. handling procedure
7. environment
8. test recording requirements

The Contractor may submit separate deliverables under this CDRL according to content and coverage. Each distinct deliverable shall be designated “57A”, “57B”, etc., coherent with the separate designations submitted under CDRL 56.

Title: Packaging, Handling, Storage and Transportation Plans and Procedures	**DRD No.:** 58

Reference:
SOW Paragraph 4.3.4.3
MAR Paragraph 13.6

Purpose:
To understand the Contractor's role, responsibility, and plans to ship the integrated Spacecraft and Instrument(s) along with the supporting equipment, from the integration and test facility to the launch site.

Related Documents:

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 data provided in the plan shall address the following as a minimum:

A. Description of shipping container.
B. Methods of transporting Observatory and GSE.
C. Transportation handling flows.
D. Bagging and purging requirements.
E. Environmental controls and monitoring equipment.
F. Expected roles and responsibilities of the Contractor and the Government.
G. Staging area plans and diagrams
H. Trip planning, schedule of events, transportation/arrangements.
I. Shipping crew support, convoy support, route, contingency plans, permits
J. Compliance with local, state, and federal regulations
K. Procedures for maintaining contact with the flight hardware
L. Off-loading of Observatory at the launch site.
M. Movement between facilities at the launch site.
N. Fueling GSE.
O. Lifting slings.
P. Electrical and mechanical support equipment general description.

The Contractor shall provide procedures, as appropriate, for the above activities.

Title: DELETED	**DRD No.:** 59
Reference: SOW Paragraph	
Purpose: .	
Related Documents:	
Preparation Information	

Title: Simulator Requirements Document	**DRD No.:** 60

Reference:
SOW Paragraph 4.3.3.3.3, 4.3.3.4.1.1, 4.4.3

Purpose:
To describe the capabilities and performance requirements of the Spacecraft Interface Simulator, the Spacecraft/Observatory Simulator, and Software Development Verification Facility.

Related Documents:

Preparation Information

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

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

The Contractor shall submit CDRL 60 in three editions:

1. CDRL 60A - Spacecraft Interface Simulator
2. CDRL 60B - Spacecraft/Observatory Simulator
3. CDRL 60C - Software Development Verification Facility

Title: Simulator I & T Plan	**DRD No.:** 61
Reference: SOW Paragraph 4.3.3.3.3, 4.3.3.4.1.1, 4.4.3	
Purpose: The Simulator I&T Plan describes the integration and test activities for each of the simulators	
Related Documents:	

Preparation Information

The Simulator Integration and Test Plan shall:

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

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

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

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

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

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

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

The Contractor shall submit CDRL 60 in three editions:
1. CDRL 61A - Spacecraft Interface Simulator
2. CDRL 61B - Spacecraft/Observatory Simulator
3. CDRL 61C - Software Development Verification Facility

Title: Simulator Test Reports	**DRD No.:** 62
Reference: SOW Paragraph 4.3.3.4.1.1, 4.4.3	
Purpose: Documents the results of each acceptance/interface/performance test completed by the Simulators	
Related Documents:	

Preparation Information

Each Simulator Test Report shall document the results of each integration and test activity in CDRL 61, including:

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

The Contractor shall submit CDRL 62 in three editions:

1. CDRL 62A - Spacecraft Interface Simulator
2. CDRL 62B - Spacecraft/Observatory Simulator
3. CDRL 62C - Software Development Verification Facility

Title: Simulator's User's Guide (Manual) for Spacecraft Interface Simulator, Spacecraft/Observatory Simulator, and Software Development Verification Facility	**DRD No.:** 63

Reference:
SOW Paragraph 4.3.3.3.3, 4.3.3.4.1.1, 4.4.3

Purpose:
The Simulator User's Guide (or manual) describes the Simulator operation for use by the FOT.

Related Documents:

Preparation Information

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

The Simulator User's Guide shall:

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

The Contractor shall submit CDRL 63 in three editions:
1. CDRL 63A - Spacecraft Interface Simulator
2. CDRL 63B - Spacecraft/Observatory Simulator
3. CDRL 63C - Software Development Verification Facility

Title:	**DRD No.:** 64
Simulator Training Plan and Materials: Spacecraft Interface Simulator, Spacecraft/Observatory Simulator, Software Development Verification Facility	

Reference:
SOW Paragraph 4.3.3.3.3, 4.3.3.4.1.1, 4.4.3

Purpose:
Provides details of the training plan, materials, SC – instrument simulator, SC, SDVF and RF Suitcase data, interfaces and the ground data system.

Related Documents:

Preparation Information

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

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

Title:	**DRD No.:** 65
Flight Operations Team (FOT) Training Package	

Reference:
SOW Paragraph 4.3.5.2, 4.3.5.3.1.1

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

Related Documents:

Preparation Information

The FOT Training Package shall include the following items:

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

Title:	**DRD No.:** 66
Spacecraft and Observatory Storage Plan	

Reference:
SOW Paragraph 4.3.6

Purpose:
To define how the spacecraft or Observatory can be stored in the event launch is significantly delayed.

Related Documents:

Preparation Information

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.

Title: LDCM Key Management Plan	**DRD No.:** 67
Reference: SOW Paragraph 4.3.3.2	
Purpose: The Key Management Plan (KMP) describes the use and control of all key management products and services used by a cryptographic application (cryptographic engine, End Cryptographic Unit (ECU), or system) throughout its lifetime. The KMP also documents the capabilities that the cryptographic application requires from the current and planned Key Management Infrastructure (KMI). This ensures that any lifecycle key management services are supportable by and available from the KMI.	
Related Documents:	
Preparation Information The Government will lead the development of the LDCM Key Management Plan (KMP). The KMP will follow an NSA-approved format. The Contractor shall review and provide inputs regarding the Contractor's specific roles and responsibilities related to COMSEC and key management.	

Title: In-Process Accounting Procedures Plan	**DRD No.:** 68
Reference: SOW Paragraph 4.3.3.2	
Purpose: The In-Process Accounting Procedures Plan addresses the handling, control and marking of in-process classified and controlled cryptographic items (CCIs) during development and manufacture/assembly.	
Related Documents:	
Preparation Information The In-Process Accounting Plan shall be prepared in accordance with Sections 7 and 8 of NSA/CSS Policy Manual 3-16.	

Title: Deleted	**DRD No.:** 69
Reference:	
Purpose:	
Related Documents:	
Preparation Information	

Title: Configuration Audit	**DRD No.:** 70
Reference: SOW Paragraph 4.3.3.2	
Purpose: The Configuration Audit Summary Report provides text and marked-up technical documents (e.g., specifications, engineering drawings) which identify discrepancies between the material (including software) and the requirements delineated in the applicable technical documents. Depending on the type of audit, the identified discrepancies may be attributable to the material, technical documents, or both.	
Related Documents:	
Preparation Information The Configuration Audit Summary Report shall be prepared in contractor format. The plan content shall be in accordance with the contractor's processes and procedures, or as specified in the contract. The following references may be useful in further defining content: ANSI/EIA-649-1998, National Consensus Standard for Configuration Management (paragraph 5.5.2); ISO 10007, Quality Management-Guidelines for Configuration Management; and MIL-HDBK-61, Configuration Management Guidance (paragraphs 6.2 and 6.3).	

Title: Security Verification Plan	**DRD No.:** 71
Reference: SOW Paragraph 4.3.3.2	
Purpose: The plan describes a series of tests to verify that cryptographic principles and protective alarms embodied in equipment agree with those stipulated in the contract. It describes the Information Assurance (IA) circuitry and functions incorporated, outlines the proposed verification techniques and procedures to be employed, and identifies the test data parameters to be measured.	
Related Documents:	
Preparation Information Functional description. The functional description includes a detailed description of critical Information Assurance (IA) circuitry using flow charts, descriptions shall address, as a minimum, the following listed functions, and any others specified in the Functional Security Requirements Specification supplied with the contract. Each description shall be in a context suitable to allow a functional computer simulation specifying as necessary, time-referenced functional signals. a. Alarm. b. Alarm check. c. Safety device. d. Key generate. e. Variable load/change/generate. f. Parity check/generate. g. Remote keying. h. Randomization. i. Synchronization. j. Zeroization.	

Title: Security Verification Report	**DRD No.:** 72

Reference:
SOW Paragraph 4.3.3.2

Purpose:
The report contains the results of tests to verify that cryptographic principles and protective alarms embodied in equipment agree with those stipulated in the contract. It describes the tests performed and compares the results with contract performance requirements. It is used by the Government to support decisions on item acceptance or future developmental and testing requirements.

Related Documents:

Preparation Information

Introduction. The introduction shall include the following:
1. Purpose of test (as specified in the contract tasking document).
2. Item tested. The items tested section shall include the following:
    a. The equipment nomenclature, including TSEC JTEDS number, if applicable.
    b. Functional description of the equipment. This includes a detailed description of critical Information Assurance (IA) circuitry using flow charts, networks, and narrative as appropriate to depict time-referenced signals.
3. Test requirements. The test requirements shall include the following, relating each to the prescribing contract requirement paragraph (specification, standard, plan, or work statement).
    a. Required tests and parameters to be measured.
    b. Performance requirements, acceptance or compliance limits, and environmental criteria.

References. The references shall include identification of the following, as applicable:
1. Prior test reports on the same item.
2. Test plan and procedure documents.
3. Requirement specifications and standards.

Body of report. The body of the report shall include:
1. Test equipment identification. The following shall be included for each item of the test equipment used:
    a. Nomenclature.
    b. Model number.
    c. Serial number.
    d. Software Version number.
    e. Manufacturer.
    f. Calibration status.
    g. Accuracy data.

2. Test installation and setup. This section shall include a description of the physical setup for conducting the tests. Drawings and photographs may be used for clarification. The following shall be identified:
    a. Settings of equipments and instrumentation.
    b. Location of sensors and probes.
    c. Interconnections and hook-ups.

d. Input parameters used.
e. Trigger mechanism or signal and appropriate timing information (sample period, etc.)

3. Test procedures. This section shall include an outline of the procedures followed in conducting the test. If these procedures are contained in a previously delivered document, reference that document in lieu of repeating its contents. These procedures shall address:

a. Summarized sequence of testing steps, including a description of how the test item was operated during test, and any control conditions imposed.
b. Data reduction techniques employed.

4. Test results and analysis.

a. Recorded data. Copies of actual recorded data (i.e., log book entries, oscillographs, instrument readings, plotter graphs). If these are extensive, provide in an appendix.
b. Test results. The test results shall include the following:
i. A complete description of the data provided.
ii. Matrices, tables, graphs comparing results achieved against performance objectives or requirements. Includes a discussion of these as to there significance, and how they compare to any prior tests. Explain how and where the trigger signal is relative to the desired data.
iii. Calculation examples with all associated assumptions and parameters.
c. Tabulations of reduced data from 4.a, identified to the related test procedure generating the data.
d. Discussion of anomalies, deviations, discrepancies or failures; their impact, causes, and proposed corrective actions.

5. Conclusions. The conclusions shall include statements addressing the following (distinguish between opinion and subjective):

a. Effectiveness of the test in measuring tests item performance.
b. Success of failure of the test item to meet required performance objectives.
c. The need for repeat, additional, or alternative testing.
d. The need for test item re-design or further development.

6. Recommendations. The recommendations shall refer to the appropriate test results and conclusions drawn. These could address such actions as:

a. Acceptability of the tested item.
b. Additional testing required.
c. Redesign required.
d. Problem resolution.

Title: Theory of Design and Operation	**DRD No.:** 73

Reference:
SOW Paragraph 4.3.3.2

Purpose:
The Theory of Design & Operation provides sensitive but unclassified information about the architectural design of an information assurance system and its intended operation. This information is segregated in this CDRL for appropriate control and protection. It provides enough detail to determine the adequacy of the communications subsystem design approach to accommodate the CARIBOU decryption device.

Related Documents:

Preparation Information
The Contractor shall provide the following information only to the degree needed to augment the product literature provided with the CARIBOU decryption equipment, and the other documentation provided elsewhere in this CDRL.

The Theory of Design & Operation (TDO) is a report providing information about the architectural design of the CARIBOU information assurance system and its intended operation for LDCM. At a high level this document describes the functional and physical design of the system, the interrelationships of the system, and the security requirements and goals to be met by the system.

The TDO is divided into four chapters. The first chapter describes the top level requirements of the system, the system's operational environment, and the top level security requirements of the system. The second chapter breaks the system down into functional blocks. The third chapter describes the physical configuration of the system and where each function described in chapter 2 is performed. The fourth chapter identifies the design features of the system which satisfy each security requirement and goal.

Chapter 1. System Requirements and Operational Environment:
Description of the top level requirements and goals of the system design, a description of the operational environment and constraints (i.e. USGS MOC), and a statement of the top level system security requirements and goals. This chapter states the system performance, environmental and operational security requirements.

Chapter 2. Functional Architecture
Functional description of the system design, including the hierarchy of functions within the system and how this functional architecture satisfies the top level requirements and goals identified in Chapter 1. The description logically flows from the system's top level functions, down through several layers of functional partitioning, to a functional design level where each function represents an individual task that is identified as occurring within or by a specific physical element of the system.

Chapter 3. Physical Architecture
Physical description of the system design, including the physical elements of the system (i.e. hardware, software, databases, communication paths, etc.) and their relationships to each other (e.g. Master/Slave, sub element, etc.). It associates the functions identified in Chapter 2 with specific elements, explaining the interdependencies among the elements in achieving the functionality.

Chapter 4. Security Architecture.
Assures that the security requirements and goals identified for the system have been addressed, and that an adequate design approach has been proposed. Each requirement and goal in the system security requirements is addressed separately and the design approach proposed for satisfying that requirement or goal is described. This description provides system specific detail on how the design (built with custom or off-the-shelf components) and configuration satisfies the requirement or goal. The description is not just a restatement of the requirement or goal. It describes how various elements of the system work together to carry out a requirement, and what each element relies on from the others to do so. If that requirement or goal applies to more than one area of the design, the design approach for each area is addressed separately.

Title: Previously Qualified Hardware and Software Report	**DRD No.:** 74

Reference:
SOW Paragraph 4.3.3.1
MAR Paragraph 1.2,

Purpose:
Provides detailed information on previously qualified hardware and software intended for use on the LDCM Program spacecraft.

Related Documents:

Preparation Information
Contents

The contractor is required to submit the following comparison studies, performance history, application, manufacturing, and anomaly data for all hardware and software proposed for use on the LDCM spacecraft at any level of assembly (component,, sub-system, system, module, spacecraft):

Comparison Studies: Compare LDCM qualification requirements with those of the proposed hardware and software to include (lifetime, thermal, electrical, radiation, Electrostatic Discharge (ESD), RFI, vibration, acoustics, shock, loads, operations margins. etc.) and identify any shortfalls in meeting LDCM requirements. For all shortfalls, identify the modifications required to meet LDCM requirements, or present a rationale for use without modification. Compare prior application functional, operational, and performance parameters of the proposed hardware and software to the equivalent LDCM application parameters and identify any shortfalls. For all shortfalls, identify the modifications required to meet LDCM requirements, or present a rationale for use without modification.

Performance History: Provide a comprehensive history of the application of the proposed hardware and software, and identify any malfunctions and/or anomalies. Identify all waivers and deviations granted to qualification and performance requirements. For all malfunctions and anomalies identify the cause, corrective action, and performance or reliability impacts to the spacecraft on which the problem occurred. For all proposed software identify how any anomaly was corrected and whether the proposed software contains patches, idle, or unreachable code. If new code was generated, provide its application history.

Manufacturing: Provide the manufacturing history information for all proposed hardware to include identification of the source of the item and the number of units provided. Identify when the units were delivered and whether the manufacturing line remains in operation. Identify any changes in design, parts, packaging, materials, fabrication, or assembly processes and controls necessary for LDCM production. Identify the pedigree of all flight software, and identify the changes in prior resources, and the availability of all necessary resources (environments, personnel, tools, etc.) for LDCM production.

Title: Mission Assurance Implementation Plan (MAIP) and Quality Documentation	**DRD No.:** 75

Reference:
SOW Paragraph 4.3.1.3
MAR Paragraph 2.1, 2.2.1, 2.2.3, 2.2.4, 2.2.7, 3.1, 3.2.1, 3.2.3.6, 4.1, 4.3.1, 5.1, 5.1.1, 5.2.1, 7.2, 10.1, 10.3.3, 11.1, 11.4.9, 11.4.10, 11.5.3, 11.5.4.1, 12.1, 12.3, 12.4.3, 13.1, 13.3, 13.6, 14.1

Purpose:
Documents the contractor's specific LDCM System Safety and Mission Assurance Program

Related Documents:

Preparation Information

Contents

1. **Quality Certificate:** First, second, and/or third party certificate(s) issued to verify their compliance to ANSI/ISO/ASQC Q9001:1994 or ANSI/ISO/ASQ Q9001:2000 or AS9100:

2. **Mission Assurance Implementation Plan (MAIP):** A plan/methodology for implementing the requirements of each chapter of the LDCM MAR. This may be accomplished by calling-out specific contractor Quality Manual documentation as well as by referencing specific contractor S&MA plans. The contractor may use existing documentation or newly prepared documentation as appropriate. In addition to the general requirements for the majority of the MAIP's chapters there are specific requirements for the following chapters:

   a. S&MA Management Plan: Describe the S&MA organization, responsibilities and authorities including the organizations responsible for the various activities/responsibilities delineated in each Chapter of the LDCM MAR.

   b. **Hardware Quality Plan**: This plan shall address all program hardware quality requirements. At a minimum it shall contain discussions of the following:
   - Flow-down of MAR requirements to suppliers including internal and supplier audits
   - Inspections, test monitoring, and quality record maintenance
   - Use of photographic documentation of flight hardware
   - Control of nonconforming product, material and failure nonconformance reporting, including Material Review Board (MRB) and Failure Review Board (FRB) procedures/processes
   - Control of monitoring and measuring devices
   - Contractor S&MA policy
   - S&MA reporting to the GSFC Project Office

   c. System Safety Program Plan (SSPP): Describe how the project will implement its 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:
   - Define the required safety documentation; applicable documents; associated schedules for completion; roles and responsibilities of project personnel; and methodologies for the conduct of any required safety analyses, reviews, and safety package.
   - Provide for the early identification and control of hazards to personnel, facilities, support equipment, the flight system during all stages of project development including design, fabrication, test, transportation and ground activities.

- Ensure the project 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 included in the range requirements.
- 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, "Standard for Lifting Devices and Equipment") and any special contractually imposed mission unique obligations (including applicable safety requirements).
- Address the software safety effort to identify and mitigate safety-critical software products in compliance with NASA-STD-8719.13, "NASA Software Safety Standard".

d. Reliability and Probabilistic Risk Assessment (PRA) Program Plan:

GSFC will perform the PRA and will write the PRA Plan. The contractor shall provide the Reliability Program Plan. The full plan shall:

- Identify the reliability and PRA tasks to be performed and how those tasks will be implemented and controlled throughout the life cycle of the project
- Discuss the scheduling of the reliability and PRA tasks relative to project milestones
- Describe scenarios that call for the use of PRA tools
- Describe how the contractor will ensure that reliability and PRA functions are an integral part of the design and development process and that the reliability functions interact effectively with other project disciplines including systems engineering, hardware design, parts engineering, safety, quality assurance, etc.
- Describe how the contractor will ensure reliability and PRA functions are an integral part of the fabrication and mission's operational life cycle and that the reliability functions interact effectively with other project disciplines including systems engineering, hardware, design, parts engineering, safety, quality assurance, etc.
- Describe how reliability and the PRA are integrated with the design process and other assurance practices.
- Describe how failure definitions and alternate and/or degraded modes of operations, that include credible failure conditions, can be mitigated by implementing workarounds.
- Describe how they will flow down reliability and PRA requirements to their subcontractors, suppliers and vendors, and ensure that the system elements obtained will meet project reliability requirements.
- Describe how they will ensure that all subcontracts include provisions for the review and evaluation of subcontractor, supplier, and vendor reliability efforts by the contractor at the contractor's discretion and by GSFC at its discretion.
- The Reliability section shall include:
  - A discussion of how the contractor intends to implement and comply with GSFC reliability program requirements
  - Charts and statements describing organizational responsibilities and the functions conducting each task to be performed as part of the Reliability Program
  - A summary (matrix or other brief form) which indicates, for each requirement, the organization responsible for implementing and generating the necessary documents
  - Identification in the summary the approval, oversight, or review authority for each task execution and management plan for each task
  - Directives, methods and procedures specific to each task in the plan
- The PRA section shall include:

- A definition of the objective and scope of the PRA Plan and the development of end-states-of-interest to the decision-maker
- Definitions of the mission phases and success criteria
- Initiating event categories and top level scenarios
- Initiating and pivotal event models (e.g., fault trees and phenomenological event models)
- Data development for probability calculations
- An integrated model and quantification to obtain risk estimates
- Describe an integrated hazard analysis process, identifying top level hazards that require the use PRA to assess their risk impact to safety and mission success.
- Use of a systematic methodology to identify credible initiating events and the associated risk scenarios for the mission.
- Define the scope of PRA modeling activities based on identified hazards and accident initiators
- Identify a process of data development for the PRA modeling and quantification requirements
- Describe the uncertainties associated with the PRA model and the dominant risks produced
- Summary of results and conclusions including a ranking of the lead contributors to risk
- Identify the types of analyses to be performed for each scenario, and the modeling tools and techniques to be used; e.g., Master Logic Diagrams (MLD), Failure Mode and Effects Analysis (FMEA), Fault Tree Analyses (FTA), Event Tree Analyses (ETA), and Event Sequence Diagrams.

e. Software Assurance Plan (SAP): This plan shall address all program software assurance requirements including those for software quality, safety, reliability, internal and independent verification and validation, and configuration management. It shall follow the format specified in IEEE Standard 730-2002. At a minimum it shall contain:

- Reference documents and definitions
- Management
- Documentation
- Standards, practices, conventions, and metrics
- Software Reviews
- Test
- Problem Reporting and Corrective Action
- Tools, techniques, and methodologies
- Media control
- Supplier control
- Records, collection, maintenance, and retention
- Training
- Risk Management
- SAP Change procedure and history
- Test Plan
- Requirements verification matrix

f. Risk Management Plan (RMP): This plan shall be a configuration controlled document. The RMP shall include:

- Introduction. Specify the project risk objectives and policy toward risk. Explain the purpose, scope, assumptions, constraints, key ground rules, and policy pertaining to the CRM process.
- Overview of Process. Provide an overview of the CRM process and information flow, describe how the CRM process integrates and relates to other project management and system engineering activities. Include general risk mitigation strategies to be used

throughout the project life cycle.

- Organization. Show the organization, roles, and responsibilities of program, project, customer, and supplier key personnel with regard to CRM. Document how team members will be trained in the application of CRM methodology.
- Process Details. Provide the CRM process details and related procedures, methods, tools, and metrics. Include the specific methodologies to be used for activities of CRM (identify, analyze, plan, track, control, communicate and document) either here, or in an appendix. Include the process to be used for continual assessment of the Risk Profile. Describe how risk information will be communicated both internally to the project staff and throughout the NASA management chain.
- Provide PRA result details on top risk drivers identified with respect to their scenarios, likelihood, consequences and uncertainties. Describe how these risks are handled with risk mitigation and reduction activities and how the effectiveness is verified.
- Describe how the risk information database is established or managed within the project environment and how it will be utilized. Describe how it will be communicated effectively for critical inputs to support project risk trade-off studies and risk-informed decision-making.
- Documentation of Risks. Specify the format and data elements that will comprise the project Risk List (and/or Risk Database), how configuration control will be applied, and how the list will be used and updated. State how team members will be able to access the current list at any time. Include in the RMP the initial set of identified risks and the action plan (for research acceptance, tracking, or mitigation) for each risk.
- Appendix. Material that is too detailed or sensitive to be placed in the main body of the text may be place 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 place under CM control as such. Include an alphabetized list of the 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).

g. Workmanship Control Plan: This plan shall address all program workmanship requirements. At a minimum it shall contain discussions of the following:

- Rework and repair procedures
- Qualification procedure for new and advanced packaging materials and applications (got this already in M&P)
- Layout design configuration management
- Layout design for manufacturability guidelines (design rules)
- Layout design traceability with the applicable as-built parts list
- Rules for documenting polymeric applications on assembly drawings
- PCB coupon analysis, storage and resolution of non-conformances
- Test specimen and conformal coating specimen processing, test and storage
- Cure cycle and solder reflow process parameter validation and control
- Workmanship inspection and control of non-conforming product
- Operator, inspector, in-house trainer (Level B instructor) certification

h Integrated Independent Review Plan: This plan shall address the contractor's overall approach to the LDCM Integrated Independent Review Program including both reviews chaired/co-chaired by the Government and internal peer reviews.

h. Design Verification Plan: This plan shall address the requirements of GSFC 427-03-05, the "LDCM Environmental Verification Requirements" (LEVR), and may be delivered as a separate

deliverable or as part of the MAIP.

i. **Materials and Processes Control Plan (MPCP)**: This plan shall address all Materials and Processes (MP) program requirements. At a minimum it shall contain discussions of the following:

- **Materials and Processes Control Board (MPCB) Plan** including operating procedures; membership; responsibilities; authority; meeting schedules; MP review procedures; MP approval/disapproval procedures; GSFC Project Office, CSO, and Materials Engineering Branch involvement; and plans for updating the operating procedures; the definition of the role and authority of each MPCB member; and relationships with various groups within the prime contractor, subcontractor/vendor/supplier and GSFC organizations. If the contractor deems that a MPCB is impractical, the GSFC Materials Assurance Engineer shall serve in its place.
- Shelf life control plan
- MP vendor surveillance and audit plan
- MP qualification plan that describes how new MP shall be qualified for the intended end item application
- Incoming inspection and test plan
- DPA plan
- Defective materials controls program
- MPCB coordination and interactions with other program control boards; e.g., the CCB, the FRB, the mass properties control board, and the MRB
- Corrosion prevention and control plan
- Contamination Control Plan, as required
- Standardization of program MP
- Traceability control plan
- Fastener Control Plan: This plan shall address the following for flight hardware threaded fasteners that are used in structural or critical applications:
  - Acquisition/supplier control
  - Documentation/traceability
  - Receiving inspection/testing

k. **Parts Control Plan (PCP)**: This plan shall address all parts program requirements. The PCP shall contain, as a minimum, detailed discussions of the following:

- The contractor's plan or approach for conforming to parts requirements.
- The contractor's parts control organization identifying key individuals and specific responsibilities.
- Detailed Parts Control Board (PCB) procedures including a description of PCB membership, designation of the Chairperson, responsibilities, review and approval procedures, meeting schedules, the method of notification, meeting minutes, etc.
- Part tracking methods and approach including tools to be used such as databases, reports, NASA Parts Selection List (NPSL), etc. Describe system for identifying and tracking part approval status.
- Parts procurement, processing and testing methodology and strategies. Identify internal operating procedures to be used for incoming inspections, screening, qualification testing, de-rating, testing of parts pulled from stores, destructive physical analysis, radiation assessments, etc.
- Part vendor surveillance and audit plan
- Flow down of PCP requirements to subcontractors
- Shelf life control plan

- Parts application de-rating
- Part vendor surveillance and audit plan
- Part qualification plan that describes how parts shall be qualified for the intended end item application
- Incoming inspection and test plan
- Destructive Physical Analysis (DPA) plan
- Defective parts controls program
- PCB coordination and interactions with other program control boards; i.e., CCB and the failure review board (FRB)
  - Radiation Hardness Assurance Plan**:** At a minimum, this plan shall address qualification procedures against threats due to destructive and nondestructive single-event effects and cumulative damage due to total ionizing dose and displacement damage in EEE parts. The plan shall discuss test procedures and standards, and analysis methods used to verify component compliance with requirements, as well as procedures for worst-case analysis of single-event related errors and failure modes. The plan shall specifically address issues such as enhanced low dose rate sensitivity, susceptibility to errors arising from single-event transients, and derating criteria for power Metal-Oxide-Semiconductor Field Effect Transistors (MOSFETs), Field Effect Transistors (FETs), and bipolar junction transistors (BJT) devices.
  - ESD Control Plan
  - Standardization of parts program
  - Alternate Quality Conformance Inspection (QCI) and small lot sample plans
  - Traceability control
  - A description of how the PCB shall develop, update and maintain a Project Approved Parts List (PAPL)

j. Contamination Control Plan: This plan shall contain data on material properties, on design features, on test data, on system tolerance of degraded performance, on methods to prevent degradation shall be provided to permit independent evaluation of contamination hazards. The items should be included in the plan for delivery:

- Materials
  - Outgassing as a function of temperature and time
  - Nature of outgassing chemistry
  - Areas, weight, location, view factors of critical surfaces
- Venting: size, location and relation to external surfaces
- Thermal vacuum test contamination monitoring plan including vacuum test data, Quartz Crystal Microbalance (QCM) location and temperature, pressure data, system temperature profile and shroud temperature
- On-orbit spacecraft performance as affected by contamination deposits
  - Contamination effect monitoring
  - Methods to prevent and recover from contamination in orbit
  - How to evaluate in orbit degradation
  - Photo polymerization of outgassing products on critical surfaces
  - Space debris risks and protection
  - Atomic oxygen erosion and re-deposition
- Analysis of contamination impact on the Spacecraft on orbit performance
- On-orbit contamination impact from other sources such as STS, the ISS, and other Spacecrafts.

k. Electrostatic Control Plan: This plan shall cover at a minimum:

- ESD Control Program Manager/Coordinator responsibilities
- Permanent, Temporary, Provisional and Intermittent-Use EPAs
- Audits and Inspections
- Training and Certification
- Identification and Access to ESD Areas
- Temporary Use of ESD Benches for Non ESDS Work
- Prohibited Materials and Activities
- ESD-Protective Work Surfaces
- ESD-Protective Floor Surfaces
- Integrity Testing of Personal Grounding Devices
- Equipment and Facilities
- Humidity
- Air Ionizers
- Hand Tools, Equipment, and Fixtures
- Protective Packaging
- Temperature Chambers and Cooling Agents
- Cleaning and Cleaning Agents
- Clothing Requirements
- Requirements for Handling ESDS Items
- Special Requirements for Highly Sensitive Items
- Receiving, Internal Handling, and Shipping
- Equipment Level Test and Maintenance
- Equipment Level Installation

l. Alerts and Problem Advisories Control Plan: This plan shall describe the contractor's process for handling and responding to Government-Industry Data Exchange Program (GIDEP) Alerts, GIDEP Safe-Alerts, GIDEP Problem Advisories, GIDEP Agency Action Notices, NASA Alerts, and NASA Advisories and any informally documented component or materials issues presented by GSFC's OSSMA. It shall also describe the contractor's process for preparing GIDEP Alerts.

m. Appendices:

- Definitions and glossary section
- If the contractor (or their subcontractors or suppliers) elects to utilize in-house workmanship documentation that does not fully meet the requirements of this MAR, the contractor (etc.) shall either:
  - State that they will adopt the applicable documents listed in the MAR for LDCM hardware
  - State how they will modify their standards/processes/procedures to meet the requirements of the applicable documents listed in the MAR
  - Request a waiver to use their standards/processes/procedures based on either:
    - The history of their successful use on NASA RSDO or non-RSDO programs in recent years including a list the program(s), the years, and any modifications to the documents since it/they was/were used for the cited program(s)
    - A detailed list of the differences between the applicable documents cited and the contractor's/supplier's proposed documents and the justification (in addition to cost and schedule savings) for using the contractor's/supplier's documents
- If the contractor and their subcontractor elect to use the standard workmanship procedures/processes listed in the MAR, they may just be listed in the appendix for reference along with the version that will be utilized.
- Standard and Non-Standard Rework and Repair Procedures

- Qualification basis for the use of new or advanced packaging technologies or assembly methods
- Supportive data/information, if appropriate

3. **MAR Cross-Reference Matrix:** A listing of each MAR requirement and the corresponding MAIP-related deliverable/DRD or internal contractor processes that meet this requirement. The matrix shall include columns listing:
   a. The title and document number for the contractor's processes, standards, procedures, etc. that enable the contractor to meet this MAIP requirement.
   b. A clear statement that the contractor "fully complies" with this requirement and a summary of corresponding evidence (i.e., A list of any commercial or Government programs that have successfully met this MAR requirement using the identical cited contractor/subcontractor processes, standards, procedures, etc., including any other pertinent information the contractor wishes to offer concerning the applicability of the process, etc.) Any significant process/etc. changes since the process/etc. was utilized will be noted
   c. If the requirement is judged non-applicable or the contractor is unable or unwilling to fully comply, the associated rationale and any planned deviation from the MAR must be described to fully convey why the Government should grant a waiver to the MAR requirement to the contractor against this specific requirement.
4. **Subcontractor Assurance Verification Matrix**: The contractor's/supplier's S&MA programs shall ensure flow-down of requirements to all suppliers including a process to verify compliance. Specifically, contract review and purchasing processes shall indicate the processes for documenting, communicating, and reviewing requirements with sub-tier suppliers to ensure requirements are met. These processes shall be defined in the contractor's documentation. Examples include, but are not limited to the following: Technical, safety, parts and materials, reliability, hardware and software quality assurance, NASA Advisories, and Government Industry Data Exchange Program (GIDEP) (Alerts, Safe-Alerts, Problem Advisories, and Agency Action Notices). The contractor shall prepare and update as necessary a requirements verification matrix showing how these requirements will be met by all suppliers. The final version of this document will be delivered at the Pre-Environmental Review and will show how the requirements were met for by each supplier.

5. **GOLD Rules Applicability, Compliance, and Waivers**: The contractor shall provide information on their compliance with GSFC's "GOLD Rules," GSFC-STD-1000, "Rules for Design, Development, Verification, and Operation of Flight Systems." To meet this requirement, the contractor shall provide the following documentation:
   a. A GOLD Rules Applicability Assessment shall identify each rule's applicability, relative to the LDCM project. Applicability should be determined based upon a number of factors such as the payload mission/risk class (NPR 8705.4), expected system/subsystem design elements, and components. Rationales shall be provided for each rule assessed as non-applicable. This Applicability Assessment shall be provided to GSFC in conjunction with the developer's proposal. Upon award, all identified and agreed upon non-applicable rules shall be implicitly waived as project requirements. The contractor shall maintain compliance for all GOLD Rules assessed as applicable.
   b. The GOLD Rules Compliance Assessment shall identify the project's compliance relative to each applicable rule, per GPR 8070.4. Compliance shall be determined based upon the implementation of the project's design, development, verification, and operation elements. Upon a determination of noncompliance with an applicable rule, the contractor shall modify its design, for compliance, or formally request a waiver for the existing design.

c. GOLD Rules Compliance Updates shall reassess the project's compliance status, per GPR 8070.4. Noncompliances shall continue to be addressed as outlined in paragraph "b" above.