

GODDARD TECHNICAL STANDARD

GSFC-STD-1001A

Goddard Space Flight Center
Greenbelt, MD 20771

Approved: 10-01-2009
Revalidation Date: 11-04-2027
Superseding GSFC-STD-1001

Criteria for Flight and Flight Support Systems Lifecycle Reviews

October 1, 2009

THIS STANDARD HAS BEEN REVIEWED FOR EXPORT CONTROL RESTRICTIONS; APPROVED FOR PUBLIC RELEASE
DISTRIBUTION IS UNLIMITED

FOREWORD

This standard is published by the Goddard Space Flight center (GSFC) to provide a consistent set of guidelines that detail the purpose, timing, success criteria and evaluation factors to be considered in the preparation and conduct of both Agency and Center-level mission and element reviews starting at Pre-Phase A, Concept Studies, through Phase F, Close Out. These guidelines have been derived from best practices in use at GSFC as compiled both internally and at the NASA Agency level.

Approved by:

Original Signed by:
George Alcorn Date
Goddard Technical Standard Coordinator
NASA/GSFC Code 300

Original Signed by:
Steven Scott Date
Chief Engineer
NASA/GSFC Code 500

For any questions concerning this standard, please contact:
Code 300,
Associate Director for Independent
Reviews
Goddard Space Flight Center
Greenbelt, Maryland 20771

Approved by:

Original signed by:

_____

Orlando Figueroa Date
Director
Applied Engineering and Technology Directorate
NASA/GSFC Code 500

Approved by:

Original signed by:

_____

George W. Morrow Date
Director
Flight Programs and Projects Directorate
NASA/GSFC Code 400

Approved by:

Original signed by:

_____

Marcus Watkins Date
Director
Safety and Mission Assurance Directorate
NASA/GSFC Code 300

Approved by:

Original signed by:

_____

Arthur Obenschain Date
Deputy Center Director
NASA/GSFC Code 100

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
-	02/19/2005	Baseline Release
A	10/01/2009	Modified to reflect changes to NPR 7120.5 Rev. D, and NPR 7123.1 Rev. A.
A	09/17/2015	Updated responsible office and extended for 18 months from original expiration date.
A	04/22/2016	Updated responsible office and extended for 12 months from expiration date.
A	4/1/2017	Updated responsible office, removed references to IPAO and IPAO Review Manager and extended for 12 months from expiration date
A	3/28/2018	Extended for 12 months from current expiration date
A	03/01/2019	Removed references to SRO. Removed references to NPR 7120.5D and NPR 7123.1A. (NPR 7120.5E and NPR 7123.1B are the current versions.) Replaced IIRT with GSRT.
A	11/04/2026	Extended for 12 months from current effective date.

TABLE OF CONTENTS

SECTION **PAGE**

CHANGE HISTORY LOG....iv

TABLE OF CONTENTS....v

LIST OF TABLES....vi

1.0 SCOPE....1

2.0 MISSION AND ELEMENT-LEVEL REVIEWS....2

3.0 MISSION CONCEPT REVIEW (MCR)....5

4.0 SYSTEM REQUIREMENTS AND SYSTEM DEFINITION REVIEWS (SRR/SDR)....7

5.0 PRELIMINARY DESIGN REVIEW (PDR)....10

6.0 CRITICAL DESIGN REVIEW (CDR)....12

7.0 MISSION OPERATIONS REVIEW (MOR)....14

8.0 SYSTEMS INTEGRATION REVIEW (SIR)....16

9.0 PRE-ENVIRONMENTAL REVIEW (PER)....18

10.0 FLIGHT OPERATIONS REVIEW (FOR)....20

11.0 PRE-SHIPMENT REVIEW (PSR)....22

12.0 OPERATIONAL READINESS REVIEWS (ORR)....24

13.0 POST-LAUNCH ASSESSMENT REVIEW (PLAR)....26

14.0 CRITICAL EVENT READINESS REVIEW (CERR)....28

15.0 DECOMMISSIONING REVIEW (DR)....29

ACRONYM LIST....31

LIST OF TABLES

TABLE **PAGE**

2-1 Chairing Organizations of Key Mission and Element-Level Reviews 4
3-2 MCR Success Criteria 6
4-2 SRR/SDR or MSRR/MDR Success Criteria 8
5-2 PDR Success Criteria 11
6-2 CDR Success Criteria 13
7-2 MOR Success Criteria 15
8-2 SIR Success Criteria 17
9-2 PER Success Criteria 19
10-2 FOR Success Criteria 21
11-2 PSR Success Criteria 23
12-2 ORR Success Criteria 25
13-2 PLAR Success Criteria 26
14-2 CERR Success Criteria 28
15-2 DR Success Criteria 30

1.0 SCOPE

1.1 Purpose

The guidelines and criteria contained in this document are intended for use by the project team, the GSFC System Review Managers, the Chair of the Goddard System Review Team (GSRT) and the Chair of the NASA appointed Standing Review Board (SRB) in support of planning and implementing the reviews conducted under the authority of each organization. Such reviews range from subsystem and functional reviews to the mission-level reviews, many of which serve as Key Decision Point (KDP) gateways. The criteria defined in this document have been developed to encompass those specified by NPR 7123.1.

As a supplement to this document, the GSFC STD-1001- Appendix, "Lifecycle Review Success Criteria Key Evaluation Factors", provides sample evaluation factors intended to be used in assessing the project's achievements toward meeting the success criteria in the development of associated system. The sample lists are organized by review type (i.e., SRR, PDR, CDR, PER, etc.) and are a compilation of evaluation factors acquired from lesson's learned and NASA best practices. Key evaluation factors may be tailored to suit the needs of the individual project. They are typically provided as reference material to the project in support of review preparation and to the independent review panels to support the conduct of the review (agenda definition, line of questioning, etc.). The Key Evaluation Factors are not success criteria for the associated review.

1.2 Applicability

This document describes the mission and lower level element reviews (e.g., spacecraft, instrument, ground system, operations, etc.) conducted during the development and operations lifecycle for Goddard Space Flight Center (GSFC) managed projects, and incorporates the requirements for:

(a) Agency-level mission reviews as prescribed by National Aeronautics and Space Administration (NASA) Procedural Requirement (NPR) 7120.5, "NASA Space Flight Program and Project Management Requirements" and NPR 7123.1, "NASA Systems Engineering Processes and Requirements",

(b) Center unique mission, flight, and flight support system reviews as prescribed by GSFC Procedural Requirement (GPR) 8700.4, "Integrated Independent Reviews", the results of which are flowed up to the Agency level reviews that are conducted in support of the Agency level mission reviews at a lower level.

The Project/Product Manager should use this guide when preparing the Systems Review Plan (SRP) for conducting a comprehensive set of mission, spacecraft, instrument and ground system reviews as required by Agency and GSFC review process documents. In collaboration with the Systems Review Manager (SRM) and SRB Chair should use this document to assess compliance with unique Agency requirements and to prepare the Terms of Reference (ToR) that documents the charter of the SRB.

2.0 MISSION AND ELEMENT-LEVEL REVIEWS

The Safety and Mission Assurance Directorate (Code 300) is responsible for the implementation of the GSFC independent review requirements as approved by the Center Management Council (CMC) for all flight projects, including mission and element reviews. This document should be used by the Project Manager, and the Chairs of the GSRT and SRB, to determine the project's readiness to proceed with a review and to finalize the specific objectives, agenda, and success criteria prior to each review. It provides specific information for the reviews identified in GPR 8700.4 including descriptions of review objectives, typical timing, and success criteria.

The mission-level reviews described in this document include those conducted to meet the unique requirements of the Center in addition to the reviews required by the Agency to be conducted by the SRB at specific progress points along the development lifecycle for NASA missions. These reviews are supported by element reviews that are conducted by a GSFC-convened GSRT and include spacecraft, instrument, operational and ground systems. Furthering the continuity of the Center's review process, the mission and element reviews are supported by project implemented Engineering Peer Reviews (EPRs) with a principal focus on discipline or subsystem related technical considerations. These reviews are addressed in a project Engineering Peer Review Plan (EPRP) as required by GPR 8700.6, "Engineering Peer Reviews".

It is recognized that the full set of mission and element-level reviews described herein will not be appropriate for every project. Therefore, not all projects will conform to the complete lifecycle review process described in NPR 7120.5 and GPR 8700.4, and may require a waiver and/or tailoring of the requirements and criteria to match the specific needs of the project. To accommodate this, project-unique review requirements may be negotiated with the responsible review team chair and System Review Manager to tailor the review requirements and success criteria as appropriate. The details of the agreed upon tailoring are documented in the SRP and/or the ToR and shall be supported by a waiver to the requirements of GPR 8700.4 or NPR 7120.5 as may be required.

It is also recognized that the final complement of reviews, individual review content, review titles, and the timing for the conduct of the individual reviews may vary with each project. However, unless otherwise agreed upon and documented in the SRP, the complete set of success criteria provided herein relative to the product being developed (end-to-end mission, flight or ground element, etc.) shall be addressed within the total set of reviews being proposed by the project. The distribution of criteria amongst the specific reviews may vary from what is specified in this document to best meet the needs of the specific project.

2.1 Results of Review

Some projects may not fully satisfy all of the criteria at the time of the milestone/gateway review. In making a judgment as to whether the review has accomplished its objectives and has been successfully completed, each member of the review team will assess the degree to which the above success criteria have been met based on the key evaluation factors. Each member should also take into account (a) the criticality of the areas where there are shortfalls, (b) how Straightforward the path forward is and the likelihood of success, as well as (c) any other relevant

factors. Individual findings from each review team member are conveyed to the convening authority in the panel's final report, including RFA's. An RFA is a formal written request sponsored by the review panel asking for additional information or action by the project team. They are generally developed as a result of insufficient safety, technical, or programmatic information being available at the time of the review.

2.2 General Criteria

The sections that follow provide the criteria to be used by the independent review panel members during their assessment of a flight or flight support system. The criteria have been divided into five categories: Review Process, Technical Management, System Design and Demonstration, Safety and Mission Assurance (SMA), and Project Management. In section 3.0, a table is provided within the description of each review defining the success criteria within each of these categories. The criteria evolve as the project progresses through its lifecycle to reflect expected changes in the maturity of the system. The following provides a general description of the criteria associated with each category.

Review Process: (a) the identification and reporting of peer reviews conducted since the last element/system review, (b) the status of all critical issues (e.g. critical Requests for Action) surfaced at prior reviews, and (c) Request for Action (RFA) disposition from all preceding reviews and associated risk status.

Technical Management: (a) trade-studies and alternative solutions, (b) system effectiveness, life cycle resources, risk, and customer requirements, (c) requirements traceability, (d) schedules for development and delivery are mutually supportive, (e) integration of technical disciplines, (f) validity, consistency, desirability, and attainability of functional and performance requirements, and (g) traceability of design requirements to the functional and performance requirements and vice-versa, (h) identification and control of critical interfaces, and (i) trending plans/analyses.

System Design and Demonstration: (a) baseline designs and documentation, (b) system level performance specifications, (c) fabrication of engineering demonstration models, (d) processes associated with system/product integration including end-item traceability and product quality, (e) verification of requirements grounded by sound engineering analysis and test practices, and (f) production and manufacturing.

Safety and Mission Assurance: (a) quality engineering, (b) quality assurance, (c) safety assurance processes associated with flight, ground, and operational systems/subsystems, and d) reliability engineering (including EEE parts program).

Project Management: (a) cost estimates, (b) control processes, and (c) schedules that indicate the mission will be ready to launch on time and within budget. Examples of control processes being evaluated include a Project Plan, Systems Engineering Management Plan, Configuration Management Plan, and a Risk Management Plan, etc.

Table 2-1 identifies the typical mission and element-level reviews recognized by the GSFC, in adherence to the Center's requirements and consistent with those specified by NPR 7120.5.

Table 2-1 Chairing Organizations of Key Mission and Element-Level Reviews

Review Title	Mission	Element				
	Observatory[1]	S/C	Grnd Sys	Payloads		
				Instr 1	Instr 2	Instr n
Mission Concept Review (MCR)	SRB [2]	-	-	-	-	-
Systems Requirements Review / System Definition Review (SRR/SDR)	SRB [2]	GSRT	GSRT	Project [3]	Project [3]	Project [3]
Preliminary Design Review (PDR)	SRB	GSRT	GSRT	GSRT	GSRT	GSRT
Critical Design Review (CDR)	SRB	GSRT	GSRT	GSRT	GSRT	GSRT
Mission Operations Review (MOR)	GSRT	-	-	-	-	-
System Integration Review (SIR)	SRB	-	-	-	-	-
Pre-Environmental Review (PER), or Test Readiness Review (TRR)	GSRT	GSRT	GSRT	GSRT	GSRT	GSRT
Flight Operations Review (FOR)	GSRT	-	-	-	-	-
Pre-Shipment Review (PSR)	GSRT[4]	GSRT	-	GSRT	GSRT	GSRT
Operational Readiness Review (ORR)	SRB	-	-	-	-	-
Mission Readiness Review [5]	CMC	-	-	-	-	-
Flight Readiness Review (FRR) [6]	KSC	-	-	-	-	-
Launch Readiness Review (LRR) [6]	KSC	-	-	-	-	-
Post-Launch Assessment Review (PLAR)	Project [3]	-	-	-	-	-
Critical Event Readiness Review (CERR) [7]	Project	-	-	-	-	-
Decommissioning Review (DR)	Project [3]	-	-	-	-	-

[1] Observatory is assessed at the Mission-level review which encompasses both the ground and flight segments.
[2] Conducted by the GSRT in instances where an SRB has not yet been established or an SRB is not required.
[3] Chairing organization is negotiable with the project and can be GSRT.
[4] Conducted concurrently with the ORR by the SRB as the operational status warrants.
[5] Conducted by the GSFC CMC prior to KDP-E and supported by GSRT and SRB Chairs.
[6] Chaired by Kennedy Space Center (KSC) and supported by GSRT and SRB Chairs as needed; requirements/criteria not included in this document.
[7] Supported by GSRT as needed.

3.0 MISSION CONCEPT REVIEW (MCR)

The MCR affirms the mission need and examines the proposed mission's objectives and the concept for meeting those objectives. Key technologies are identified and assessed. It is an internal review that is usually conducted by the system development organization. ROM budget and schedules are presented. At the MCR, the project demonstrates to the review panel that the:

Proposed mission meets the science.
Objectives proposed mission is feasible.
Proposed mission and operations design concepts are viable.
Preliminary plan for lifecycle activities suitably illustrates reasonable execution of the mission within resource budgets and other foreseen constraints.

3.1 Timing

The MCR is normally held upon completion of mission feasibility studies and represents the conclusion of project pre-formulation activities. In advance of the review, the project should highlight and discuss with the review chairperson any areas that may warrant consideration in establishing the composition of the review team (e.g., problematic mission requirements, critical technology dependencies, critical trade studies, or anticipated resource constraints). Depending upon the intended acquisition approach for the mission, GSFC management may decide that an MCR need not be conducted or that it will be replaced by a management review as permitted within the guidance of NPR 7120.5. Such determination shall be made early in the lifecycle and in conjunction with the development of the project Systems Review Plan (SRP) and consequently the Terms of Reference (ToR) for the Standing Review Board (SRB) as an applicable document incorporated by reference**.**

3.2 Success Criteria

The review agenda, success criteria, and charge to the independent review board shall be discussed for concurrence by the Principal Investigator (PI-mode only), Program Executive (SRB reviews only), Project Manager, Review Board Chairperson, Systems Review Manager, and distributed to all parties prior to the review. The Systems Review Manager is responsible for initiating this discussion. Excluding any required tailoring, projects must at a minimum meet the following criteria as part of the MCR or demonstrate an adequate path to completion. Table 3-2 depicts the criteria for a successful MCR.

Table 3-2: MCR Success Criteria

Category	MCR Criteria
Review Process	A preliminary Systems Review Plan (SRP) including an Engineering Peer Review Plan (EPRP) is available and deemed compliant with all applicable requirements.
Technical Management	Mission objectives are clearly defined and unambiguous. Potential technology needs are identified and the gaps between such needs and the current and/or planned technology readiness levels have been assessed with acceptable results. The evaluation criteria and trade space for candidate systems that fulfill the conceptual design requirements have been identified and prioritized. Technical planning is sufficient to proceed to the next phase.
System Design and Demonstration	An operations concept and system architecture is provided that meets these requirements, demonstrating the feasibility of the mission and technical solution. A search was conducted to identify existing assets or products that have a potential to be implemented to satisfy the mission or parts of the mission. The preliminary set of requirements meeting the objectives is provided and is consistently stated within the project.
Safety & Mission Assurance	Safety and mission assurance activities (i.e., safety, reliability, maintainability, quality, and Electrical, Electronic and Electromechanical [EEE] parts) related to the mission and conceptual design have been adequately addressed.
Project Management	Initial risk identification and mitigation strategies have been provided and are acceptable. A rough order of magnitude cost estimate is provided and is both credible and within an acceptable cost range. The schedule estimates are credible.

3.3 Key Evaluation Factors for the Assessment of Success Criteria

The MCR should contain a complete description of the conceptual mission design. The project team presents the design using block diagrams, flowcharts, schematics, etc., depicting system interfaces with external supporting systems, as well as interfaces between independent system elements. Preliminary modeling and analysis results should be presented in order to illustrate feasibility of achieving science objectives. Programmatic planning and resource estimates shall also be discussed in sufficient detail to permit assessment of relevant review objectives.

The GSFC STD-1001-Appendix provides sample key evaluation factors often applied by individual review team members when assessing the satisfactory achievement of the established criteria.

4.0 SYSTEM REQUIREMENTS AND SYSTEM DEFINITION REVIEWS (SRR/SDR)

The purpose of this review is to verify that the functional and performance requirements are defined for the system under review and to ensure the requirements are satisfied by the selected concept. To justify proceeding with detailed definition and the flow-down of requirements to the major elements of the system, the project must convey to the review panel that the:

Baseline mission requirements are clearly understood.
Top-level requirements for each system element have been determined.
Proposed mission design and operations concept satisfies baseline mission requirements plans for future activities justify expectations the mission design will accommodate imposed constraints and accomplish the mission within allocated resources.

4.1 Timing

An SRR can be conducted for selected elements (e.g., spacecraft, instruments, ground systems, operations, etc.) as well as the mission. An SRR is typically conducted once a feasible system definition is available and while changes to the particular element under review can be accommodated with minimal impact. The SRR for any particular element is typically conducted concurrently with the associated System Definition Review (SDR).

Similarly, as part of the GSFC process, the Mission-level SRR (MSRR) is conducted concurrently with the Mission Definition Review (MDR) toward the end of Phase A and provides the relevant data for the Key Decision Point "B" (KDP-B) gateway at which the decision to proceed with the preliminary design is made. When scheduling the review, the project should highlight and discuss with the review Chair any significant risk areas (e.g., problematic requirements, critical technology dependencies, outstanding trade studies, or significant resource constraints) that may warrant consideration in the timing of the review or the composition of the review team. The determination of the readiness of a project to proceed with the review will be based on these discussions and at the discretion of the Chair and in consultation with the Project, Systems Review Manager, Program Office and Convening Authority as applicable.

4.2 Success Criteria

The SRR/SDR and MSRR/MDR criteria provided below should be consulted early enough in the project schedule to select a suitable date for the review and to properly plan an agenda that fulfills the objectives of a System Requirements Review (SRR) simultaneously with those of a System Definition Review (SDR). The system under review may include elements such as ground systems, instruments, and spacecraft; or the observatory which includes the flight and ground segments. The review agenda, success criteria, and charge to the independent review board shall be discussed for concurrence with the Principal Investigator (PI-mode only), Program Executive (SRB reviews only), Project Manager, Review Board Chairperson, and Systems Review Manager; and distributed to all parties prior to the review. The Systems Review Manager is responsible for initiating this discussion. Excluding any required tailoring, projects must at a minimum meet the following criteria as part of the SRR/SDR or MSRR/MDR, or demonstrate an adequate path to completion. Table 4-2 depicts the criteria for a successful SRR/SDR or MSRR/MDR.

Table 4-2: SRR/SDR or MSRR/MDR Success Criteria

Category	
Review Process	The Mission Concept Review (MCR), if applicable, was successfully completed with every Request for Action (RFA) reaching an acceptable disposition. Planned peer reviews associated with the system under review have been successfully completed. MSRR/MDR Only- A baseline Systems Review Plan (SRP) and Engineering Peer Review Plan (EPRP) have been approved and implemented.
Technical Management	The system design builds upon the initial concept by providing a complete definition of the interfaces and key higher-level performance and technical requirements; which have been appropriately flowed to the systems and/or subsystems. The major risks have been identified and viable mitigation strategies are defined. The project utilizes a sound process for the allocation and control of requirements at all levels. Requirements are clearly understood and the project is ready to fully flow requirements to the lower levels. MSRR/MDR Only- Top level requirements exhibit alignment with NASA needs, goals, and objectives, and has been adequately flowed down to the appropriate mission elements.
System Design and Demonstration	The system and subsystem design approaches and operational concepts are reasonable, feasible, complete, responsive to the performance requirements, and are consistent with system requirements. Preliminary approaches have been determined for verifying and validating subsystem requirements.
Safety & Mission Assurance	A system safety plan is completed that details the safety management and engineering requirements for identifying, evaluating, and eliminating or controlling hazards. A baseline of the mission assurance requirements is available. The level of quality assurance to be implemented is appropriately defined.
Project Management	A plan has been defined to complete the definition activity within schedule constraints. The overall concept is consistent with available resources. MSRR/MDR Only- A cost estimate is provided along with a clearly defined basis of estimate and is both credible and within an acceptable cost range.

4.3 Key Evaluation Factors for the Assessment of Success Criteria

The SRR/SDR and MSRR/MDR should contain a complete and comprehensive description of the element and mission design, respectively, with relevant conceptual systems designs. It should present the design by means of block diagrams that depict system interfaces with external supporting systems, as well as depicting internal interfaces between independent system elements. Completed modeling and analyses results should be presented as required to illustrate that science objectives will be achieved.

Programmatic considerations shall also be discussed in sufficient detail to permit assessment of relevant review criteria.

The GSFC STD-1001-Appendix provides sample key evaluation factors often applied by individual review team members when assessing the satisfactory achievement of the established criteria.

5.0 PRELIMINARY DESIGN REVIEW (PDR)

At the PDR, the project discloses the complete system or subsystem design to the review panel. The ability of the preliminary design to meet all requirements with acceptable risk is presented. The projections for completing the project within the identified cost and schedule constraints are also provided. The readiness to proceed with the detailed design is demonstrated by:

Completing a credible and acceptable preliminary design that meets performance requirements.

Selecting a suitable design solution, making necessary resource allocations, and identifying critical interfaces and requirements verification methods.

Confirming requirements compliance with supporting design analyses.

Presenting acceptable plans for the completion of system or subsystem development and the subsequent operations (if applicable) within the identified cost and schedule constraints.

5.1 Timing

The PDR is the first major review of the overall system design and is normally held prior to the preparation of detailed design drawings and the initiation of any full-scale flight hardware or software development. A PDR is held when the design is advanced sufficiently to begin some breadboard testing and/or the fabrication of design models. A PDR is required for all mission elements (i.e., spacecraft, instruments, ground systems, and operations) as well as the mission itself. The Mission Preliminary Design Review (MPDR) is the last mission-level review in Phase B prior to the Key Decision Point “C” (KDP-C) gateway identified in NPR 7120.5.

When scheduling a design review of this type, the project should highlight and discuss with the chairperson any significant development areas that may warrant attention when establishing the timing of the review or composition of the review team due to the magnitude of the effort, technical difficulty, complexity, or criticality of success.

5.2 Success Criteria

The review agenda, success criteria, and charge to the independent review board shall be discussed for concurrence by the Principal Investigator (PI-mode only), Program Executive (SRB reviews only), Project Manager, Review Board Chairperson, and Systems Review Manager,; and distributed to all parties prior to the review. The Systems Review Manager is responsible for initiating this discussion. Excluding any required tailoring, projects must at a minimum meet the following criteria as part of the PDR or demonstrate an adequate path to completion. Table 5-2 depicts the criteria for a successful PDR.

Table 5-2: PDR Success Criteria

Category	PDR Criteria
Review Process	The SRR or MSRR/MDR was successfully completed, if applicable, and responses made to each Request for Action (RFA). All subsystem PDRs and the associated peer reviews have been successfully completed. All assigned actions have an acceptable disposition including plans to complete for work in process.
Technical Management	All processes (design, implementation, interface controls, risk management, safety, test & verification, operations, etc.) used to develop and operate the system are at expected maturity level. The preliminary design is expected to meet the requirements within the resource allocation.
System Design and Demonstration	The preliminary design is consistent with the top-level requirements. The operations concept, if applicable, is technically sound. The defined technical interfaces are consistent with the overall technical maturity. Adequate margins exist with respect to technical performance. Any required new technology has been developed to an adequate state of readiness or viable options exist.
Safety & Mission Assurance	Safety, reliability, maintainability, quality, and Electrical, Electronic and Electromechanical (EEE) parts have been adequately addressed in preliminary designs and any applicable S&MA products (i.e., hazard analysis and failure modes and effects analysis) have been identified.
Project Management	Design definition is sufficient to support initial parametric and bottoms-up cost estimating. Cost estimates, control processes, and schedule indicate the system will be ready on time (i.e., integration, delivery, launch, etc.) and within budget.

5.3 Key Evaluation Factors for the Assessment of Success Criteria

The PDR should contain a complete and comprehensive presentation of the entire design. It should present the design and interfaces by means of block diagrams, power flow diagrams, signal flow diagrams, interface circuits, software logic flow and timing diagrams. Appropriate modeling results should be presented. The traceability of all deliverable items discussed at previous reviews shall be updated and presented. Programmatic considerations shall also be discussed in sufficient detail to permit assessment of relevant review objectives.

The GSFC STD-1001-Appendix provides sample key evaluation factors often applied by individual review team members when assessing the satisfactory achievement of the established criteria.

6.0 CRITICAL DESIGN REVIEW (CDR)

At the CDR, the project discloses the complete system design to the review panel. The project demonstrates that the maturity of the design and development effort:

Justifies proceeding with full scale fabrication activities, assembly, integration and test.
Is on track to complete flight system, ground system, and mission operations development.
Meets mission performance requirements within the identified cost and schedule constraints.

6.1 Timing

The CDR is held near the completion of the final design stage, including the completion of engineering model evaluations, as applicable, and breadboard development and test. Although substantial completion of drawings is expected, the review should be held prior to any design freeze and before any significant flight fabrication activity begins. A CDR is required for all elements (i.e., spacecraft, instruments, and ground systems) as well as the mission (MCDR).

When scheduling the review, the project should highlight and discuss with the review Chair any significant development areas (significant due to the amount, the criticality, the technical difficulty/complexity, etc.) which may not be sufficiently mature and may warrant consideration regarding either timing of the review or composition of the review team. The start of limited fabrication (typically long lead items, off-the-shelf hardware or common buy items) before CDR is common and generally acceptable. The project should, however, consult with the review Chair to obtain concurrence with respect to any significant flight hardware fabrication that will take place before CDR.

6.2 Success Criteria

A review agenda, success criteria, and charge to the independent review board shall be discussed for concurrence by the Principal Investigator (PI-mode only), Program Executive (SRB reviews only), Project Manager, Review Board Chair, and Systems Review Manager; and distributed to all parties prior to the review. The Systems Review Manager is responsible for initiating this discussion. Excluding any required tailoring, projects must at a minimum meet the following criteria as part of the CDR or demonstrate an adequate path towards completion. Table 6-2 depicts the criteria for a successful CDR.

Table 6-2: CDR Success Criteria

Category	CDR Criteria
Review Process	The Preliminary Design Review (PDR) has been successfully completed and responses made to each Request for Actions (RFA). All subsystem CDRs and the associated peer reviews have been successfully completed. All assigned actions have an acceptable disposition including plans to complete for work in process.
Technical Management	Interface Control Documents are appropriately mature to proceed with implementation. Plans are in place to manage any open items. System design (including key element interfaces and performance specifications) is complete and the processes used to develop and operate the system are sufficiently defined to start procurement, fabrication, manufacture, integration, and testing.
System Design and Demonstration	The maturity of the applicable systems and operations designs warrant proceeding to implementation. High confidence exists in the product baseline, and adequate documentation exists and/or will exist in a timely manner to enter the next phase including fabrication, assembly, integration, and test activities. The detailed design is expected to meet the requirements with adequate margins. Adequate resources exist to complete system development within accepted risk constraints.
Safety & Mission Assurance	Safety, reliability, maintainability, quality, and Electrical, Electronic and Electromechanical (EEE) parts have been adequately addressed in system and operational designs and any applicable S&MA products (i.e., hazard analysis and failure modes and effects analysis) have been completed and approved.
Project Management	Adequate technical and programmatic margins and resources exist to complete the development within budget and on schedule.

6.3 Key Evaluation Factors for the Assessment of Success Criteria

The CDR should represent a complete and comprehensive presentation of the entire final design. It should present the final design and interfaces by means of completed drawings, block diagrams, power flow diagrams, signal flow diagrams, interface circuits, software logic flow and timing diagrams, modeling results, and breadboard and engineering model test results. Traceability for all items specified for previous reviews, updated to the present stage of the development process, shall be presented. Programmatic considerations shall also be discussed in sufficient detail to permit assessment of relevant review objectives. The GSFC STD-1001-Appendix provides sample key evaluation factors often applied by individual review team members when assessing the satisfactory achievement of the established criteria.

7.0 MISSION OPERATIONS REVIEW (MOR)

At the MOR, the project demonstrates to the review panel that:

Requirements for all phases and modes of mission operations, data processing, and analysis are thoroughly understood.
All operations will be adequately staffed and executed.
Planned implementation of the ground system satisfies all operational requirements preliminary plans for the execution of a comprehensive end-to-end verification and validation program are complete.

7.1 Timing

The MOR is the first of two ground system reviews designed to focus on mission operations. It is typically held upon completion of detailed design and in all cases should be held prior to initiation of major integration activities of flight subsystem elements.

When scheduling the review, the project should highlight and discuss with the review Chair any extenuating circumstances or problem areas that may deserve consideration regarding timing of the review or composition of the review team.

7.2 Success Criteria

The review agenda, success criteria, and charge to the independent review board shall be discussed for concurrence by the Principal Investigator (PI-mode only), Program Executive (SRB reviews only), Project Manager, Review Board Chairperson, and Systems Review Manager,; and distributed to all parties prior to the review. The Systems Review Manager is responsible for initiating this discussion. Excluding any required tailoring, projects must at a minimum meet the following criteria as part of the MOR or demonstrate an adequate path towards completion. Table 7-2 depicts the criteria for a successful MOR.

Table 7-2: MOR Success Criteria

Category	MOR Criteria
Review Process	The MPDR was successfully completed with an acceptable disposition of each mission operations specific Request for Action (RFA). The associated peer reviews have been successfully completed. All assigned actions have an acceptable disposition including plans to complete work in process. Ground system and operations requirements have been adequately defined.
Technical Management	Linkage of mission requirements to the ground system support requirements and subsequent flow-down to the operations personnel and technical elements within the ground system is complete, traceable, and verifiable. The operations approach is expected to meet the mission requirements with an acceptable level of risk.
System Design and Demonstration	Planning for all phases and modes of mission operations (including observatory operations, data processing, and analyses) adequately addresses all ground system requirements. An acceptable level of maturity has been demonstrated for the overall operations design including the definition of mission operations requirements, ground system requirements, logistics, training, Information Technology (IT) security, verification tests, and operator certification.
Safety & Mission Assurance	Safety related requirements for real-time operations, including safety monitoring and safe-mode operation, have been suitably defined and allocated for the operations design.
Project Management	Identified risk mitigation plans are supported by suitable procedures and resources for the effective management of the risks. System design meets mission performance requirements within identified cost, schedule, and resource constraints.

7.3 Key Evaluation Factors for the Assessment of Success Criteria

The MOR should focus predominately upon the planning in areas driven by operational considerations. To that end, it is not an in-depth review of the design. Project peer review activity and other mission-level reviews address those considerations. Consequently, information on development tasks should focus on current status and plans for interacting with verification and operations related activities in a coordinated fashion.

Programmatic considerations shall also be discussed in sufficient detail to permit assessment of relevant review objectives.

The GSFC STD-1001-Appendix provides sample key evaluation factors often applied by individual review team members when assessing the satisfactory achievement of the established criteria.

8.0 SYSTEMS INTEGRATION REVIEW (SIR)

The SIR evaluates the readiness of the overall system (all elements working together) to commence Integration and Test (I&T). At the SIR, the project demonstrates that:

Required validation & verification plans, integration plans and procedures, and test plans are available and approved to begin integration.
Required system components, support personnel, integration facilities, and test procedures are available and ready to begin system testing and data acquisition, reduction, and control required Ground Support Equipment (GSE) is ready to support I&T

8.1 Timing

The SIR is a mission-level review normally held after completion of the integration and test of the associated flight and ground elements and subsystems that make up the final system. This review marks the beginning of Phase D (system assembly, integration, test, and launch) and precedes the Key Decision Point "D" (KDP-D) gateway review conducted by the Agency. Successful element/subsystems functional and performance testing are required for baseline performance and trending information prior to the initiation of system integration.

8.2 Success Criteria

The review agenda, success criteria, and charge to the independent review board shall be discussed for concurrence by the Principal Investigator (PI-mode only), Program Executive (SRB reviews only), Project Manager, and Review Board Chairperson, and Systems Review Manager; and distributed to all parties prior to the review. The Systems Review Manager is responsible for initiating this discussion. Excluding any required tailoring, projects must at a minimum meet the following criteria as part of the SIR or demonstrate an adequate path towards completion. Table 8-2 depicts the criteria for a successful SIR.

Table 8-2: SIR Success Criteria

Category	SIR Criteria
Review Process	Successful completion of the MCDR with responses made to each Request for Action (RFA). All subsystem PERs and PSRs, as applicable, have been successfully concluded with acceptable disposition of every RFA. Associated peer reviews have been successfully completed. All assigned actions have an acceptable disposition including plans to complete for work in process.
Technical Management	Element and component designs have been satisfactorily qualified and the engineering and performance requirements verified. All integration plans and procedures are approved and ready to begin system integration.
System Design and Demonstration	All support personnel and facilities are available and system components are ready to be integrated into the system. System elements and components have satisfactorily completed verification testing as required at the lower levels.
Safety & Mission Assurance	The identification of safety hazards for ground hardware and operations is complete and the required controls are implemented.
Project Management	Adequate programmatic margins and resources exist to complete the integration effort within accepted risk constraints (i.e., probability versus impact). System design meets mission performance requirements within identified cost, schedule, and resource constraints.

8.3 Key Evaluation Factors for the Assessment of Success Criteria

The SIR focuses on assessing the integration plans and procedures for the system. Confirmation that all required elements and/or components are available for integration and that applicable functional, unit-level, subsystem, and qualification testing have been conducted successfully. Finally, the readiness and availability of integration facilities, including clean rooms, ground support equipment, handling fixtures, overhead cranes, and electrical test equipment, are assessed.

Programmatic considerations shall also be discussed in sufficient detail at the SIR to permit assessment of relevant review objectives.

The GSFC STD-1001-Appendix provides sample key evaluation factors often applied by individual review team members when assessing the satisfactory achievement of the established criteria.

9.0 PRE-ENVIRONMENTAL REVIEW (PER)

At the PER, the project discloses the complete project status to the review panel. The project demonstrates that the flight system is:

Ready to proceed with environmental testing as an integrated system.
On track to complete development and conduct operations, if required, within allocated cost and schedule resources.

9.1 Timing

The PER is held after completion of the initial successful comprehensive systems test of the fully-integrated flight system and prior to initiation of the system level environmental test sequence. A PER is required for elements such as the spacecraft, instruments, and ground systems as well as for the all-up observatory as a mission-level review. Spacecraft bus testing is often conducted at the observatory level, in which case the Spacecraft PER is performed in conjunction with the Mission PER.

When scheduling the review, the project should highlight and discuss with the review chairperson any extenuating circumstances or problem areas that may deserve consideration regarding timing of the review or composition of the review team.

9.2 Success Criteria

The review agenda, success criteria, and charge to the independent review board shall be discussed for concurrence by the Principal Investigator (PI-mode only), Program Executive (SRB reviews only), Project Manager, Review Board Chairperson, and Systems Review Manager; and distributed to all parties prior to the review. The Systems Review Manager is responsible for initiating this discussion. Excluding any required tailoring, projects must at a minimum meet the following criteria as part of the PER or demonstrate an adequate path towards completion. Table 9-2 depicts the criteria for a successful PER.

Table 9-2: PER Success Criteria

Category	PER Criteria
Review Process	The CDR or SIR, whichever is applicable as the latest review, has been successfully completed and responses made to each Request for Action (RFA). Test Readiness Reviews (TRRs) have been defined and scheduled as required.
Technical Management	A review of the test plans, procedures, environments, and the configuration of the test item, provide a reasonable expectation that the objectives of the testing will be met. Planning for subsequent flight system activities, satisfactory progress on development of other system elements, and adequacy of available resources to complete remaining project activities was demonstrated.
System Design and Demonstration	A requirements-compliant flight system design has been integrated and subjected to a successful comprehensive systems test establishing a baseline for future tests. Support system components have been successfully integrated into the system and required personnel and facilities are available for system testing. The objectives of the testing have been clearly defined and documented.
Safety & Mission Assurance	The status of safety data submissions, procedures, and verification activities indicate a proper maturity level at this point in the life-cycle. The identification of safety hazards for flight, range, ground hardware and operations is complete. The disposition and status of previous anomalies, deviations, and waivers have been assessed in their entirety and the identified risks are acceptable to proceeding.
Project Management	System design meets mission performance requirements within identified cost, schedule, and resource constraints. Programmatic risk levels are appropriately identified and have been accepted by the project as required.

9.3 Key Evaluation Factors for the Assessment of Success Criteria

The PER should present a complete and comprehensive status of the final system with emphasis on changes to the requirements and the design since CDR and/or System Integration Review (SIR) (if applicable). It should trace all fabrication and lower level verification activities with emphasis on discrepancies and their resolution. It should detail the composition and results of the comprehensive system test. It should detail all remaining project activities and detail status of all other mission system elements.

Programmatic considerations shall be discussed in sufficient detail to permit assessment of relevant review objectives. The GSFC STD-1001-Appendix provides sample key evaluation factors often applied by individual review team members when assessing the satisfactory achievement of the established criteria.

10.0 FLIGHT OPERATIONS REVIEW (FOR)

The FOR is the second of two ground system reviews held to examine mission operations status during which the project demonstrates or verifies:

Compliance with all mission operations requirements and the ability to execute all phases and modes of mission operations, data processing, and analysis.
Adequate planning and resources are in place for any remaining activities associated with interactive flight and ground testing, network compatibility testing, and other remaining pre-launch testing.
Acceptable staffing, training and certification of the flight team.

10.1 Timing

The FOR is held during the test flow of the fully integrated flight system, after completion of the initial successful comprehensive systems test but prior to the last major interactive test between the flight and ground system elements that is conducted before shipment of flight system elements to the launch site.

When scheduling the review, the project should highlight and discuss with the review Chair any extenuating circumstances or problem areas that may deserve consideration regarding timing of the review or composition of the review team.

10.2 Success Criteria

A review agenda, success criteria, and charge to the independent review board shall be discussed for concurrence by the Principal Investigator (PI-mode only), Program Executive (SRB reviews only), Project Manager, and Review Board Chairperson, and Systems Review Manager; and distributed to all parties prior to the review. The Systems Review Manager is responsible for initiating this discussion. Excluding any required tailoring, projects must at a minimum meet the following criteria as part of the FOR or demonstrate an adequate path towards completion. Table 10-2 depicts the criteria for a successful FOR.

Table 10-2: FOR Success Criteria

Category	FOR Criteria
Review Process	The MOR has been successfully completed and responses made to every operations related Request for Actions (RFA). The associated peer reviews have been successfully completed. All assigned actions have an acceptable disposition including plans to complete for work in process.
Technical Management	Planning for all phases, modes, and aspects (development, Verification and Validation (V&V), sustaining engineering, staffing, Information Technology (IT) and physical security) of mission operations, data processing, and analysis adequately addresses all Ground System requirements at the proper level of maturity.
System Design and Demonstration	Completion of all phases and modes of mission operations, data processing, and analysis has been verified. Ground System mission elements are ready to proceed with final integrated flight and ground system testing as well as remaining support to pre-launch, launch, mission operations, data processing, and analysis activities. Results of activities since the MOR as well as plans for all remaining work prior to launch were presented.
Safety & Mission Assurance	All safety processes related to the operation of the ground system are at expected maturity level.
Project Management	The flight operations approach is expected to meet the mission requirements with an acceptable level of risk. Identified risk mitigation plans are supported by suitable procedures and resources for the effective management of the risks. The system design meets mission performance requirements within identified cost, schedule, and resource constraints.

10.3 Key Evaluation Factors for the Assessment of Success Criteria

The FOR should highlight any changes to requirements or design since the MOR. It should provide details of verification and checkout of ground system elements with emphasis on discrepancies and their resolution. It should detail all remaining activities and emphasize adequacy of operations planning and planned testing to demonstrate that all operations scenarios can be handled successfully.

Programmatic considerations shall also be discussed in sufficient detail to permit assessment of relevant review objectives.

The GSFC STD-1001-Appendix provides sample key evaluation factors often applied by individual review team members when assessing the satisfactory achievement of the established criteria.

11.0 PRE-SHIPMENT REVIEW (PSR)

At the PSR the project demonstrates to the review panel that:

All system verification activities have been successfully completed and the system meets its requirements.
The system and support (flight and ground) hardware, software, personnel, procedures, and user documentation accurately reflect the final operational state of the system under review.
The system is ready for shipment and/or final processing prior to integration or launch, whichever is applicable.

11.1 Timing

The PSR is conducted prior to shipment of flight system elements to the site for the next level of integration, or to the launch site. Entry criteria for this review include the successful completion of all verification activities of any associated flight and ground systems. The PSR is required for all applicable elements (i.e., spacecraft, instruments, ground systems, etc.) as well as for the mission.

When scheduling the review, the project should highlight and discuss with the review Chair any significant problem areas that may pose difficulty during the review.

11.2 Success Criteria

A review agenda, success criteria, and charge to the independent review board shall be discussed for concurrence by the Principal Investigator (PI-mode only), Program Executive (SRB reviews only), Project Manager, and Review Board Chairperson, and Systems Review Manager; and distributed to all parties prior to the review. The System Review Manager is responsible for initiating this discussion. Excluding any required tailoring, projects must at a minimum meet the following criteria as part of the PSR or demonstrate an adequate path towards completion. Table 11-2 depicts the criteria for a successful PSR.

Table 11-2: PSR Success Criteria

Category	PSR Criteria
Review Process	The PER has been successfully completed and each Request for Action (RFA) is closed. All subsystem PSRs have been successfully completed. All assigned actions have an acceptable disposition including plans to complete for work in process.
Technical Management	The system meets the established acceptance criteria. Planning and preparation for shipping and subsequent ground processing and post-deployment operations (e.g., post-shipment checkouts, launch, operations, etc.) is complete. The existing residual risks and criticality ratings identified on the NASA standard 5x5 risk matrix have been assessed as acceptable.
System Design and Demonstration	The required tests and analyses are complete and indicate that the system will perform properly in the expected operational environment and meets the established acceptance criteria. The system including any enabling products is ready to be placed in an operational status. Planning and preparation for continued ground processing, launch, and mission operations is complete.
Safety & Mission Assurance	All waivers and anomalies have been closed. Could-not-duplicate failures are identified and assessed at an acceptable level of residual risk to proceed. The required approvals of the safety status and hazard assessments for flight, range, ground hardware and operations are completed.
Project Management	System design meets mission performance requirements within identified cost, schedule, and resource constraints.

11.3 Key Evaluation Factors for the Assessment of Success Criteria

Programmatic considerations shall be discussed at the PSR in sufficient detail to permit assessment of relevant review objectives.

The GSFC STD-1001-Appendix provides sample key evaluation factors often applied by individual review team members when assessing the satisfactory achievement of the established criteria.

12.0 OPERATIONAL READINESS REVIEWS (ORR)

At the ORR the project demonstrates to the review panel that:

All flight and ground system verification activities have been successfully completed the system is ready for final processing prior to launch and mission operations
All system and support (flight and ground) hardware, software, personnel, procedures, and user documentation accurately reflect the deployed state of the system

12.1 Timing

The ORR is conducted prior to shipment of flight system elements to the launch site and after successful completion of all verification activities of flight and ground system elements.

When scheduling the review, the project should highlight and discuss with the review Chair any significant problem areas that may pose difficulty during the review.

12.2 Success Criteria

A review agenda, success criteria, and charge to the independent review board shall be discussed for concurrence by the Principal Investigator (PI-mode only), Program Executive (SRB reviews only), Project Manager, and Review Board Chairperson, and Systems Review Manager; and distributed to all parties prior to the review. The System Review Manager is responsible for initiating this discussion. Excluding any required tailoring, projects must at a minimum meet the following criteria as part of the ORR or demonstrate an adequate path towards completion. Table 12-2 depicts the criteria for a successful ORR.

Table 12-2: ORR Success Criteria

Category	ORR Criteria
Review Process	All lifecycle milestone reviews have been successfully completed. All assigned actions have an acceptable disposition including plans to complete for work in process.
Technical Management	Systems hardware, software, personnel, and procedures are in place to support operations. Flight and ground software elements are ready to support flight and flight operations. Interfaces are checked and found to be functional.
System Design and Demonstration	The overall system characteristics and the procedures used in the system or product's operation are defined. All project and support (flight and ground) hardware, software, personnel, and procedures are ready for operations and the user documentation accurately reflects the operational state of the system.
Safety & Mission Assurance	The required approvals of the safety status and hazard assessments for flight, range, ground hardware and operations are completed. The hardware is deemed acceptably safe for flight.
Project Management	Any open remaining current risks are manageable through monitoring and/or mitigation. System design meets mission performance requirements within identified cost, schedule, and resource constraints.

12.3 Key Evaluation Factors for the Assessment of Success Criteria

Programmatic considerations shall be discussed at the ORR in sufficient detail to permit assessment of relevant review objectives.

The GSFC STD-1001-Appendix provides sample key evaluation factors often applied by individual review team members when assessing the satisfactory achievement of the established criteria.

13.0 POST-LAUNCH ASSESSMENT REVIEW (PLAR)

At the PLAR, the project demonstrates to the review panel the:

Readiness of the spacecraft systems to proceed with full, routine operations
status, performance, and capabilities of the project as evidenced from the flight operations experience since launch
Readiness to transfer responsibility from the development organization to the operations organization
Project plans and the capability to conduct the mission with emphasis on near-term operations and mission-critical events

13.1 Timing

The PLAR is conducted following the launch, typically after the early flight operations and initial checkout and prior to any Critical Event Readiness Review (CERR). When scheduling the review, the project should highlight and discuss with the review Chair any significant problem areas that may pose difficulty during the review.

13.2 Success Criteria

A review agenda, success criteria, and charge to the independent review board shall be discussed for concurrence by the Principal Investigator (PI-mode only), Program Executive (SRB reviews only), Project Manager, and Review Board Chairperson; and distributed to all parties prior to the review. The chairperson is responsible for initiating this discussion. Excluding any required tailoring, projects must at a minimum meet the following criteria as part of the PLAR or demonstrate an adequate path towards completion. Table 13-2 depicts the criteria for a successful PLAR.

Table 13-2: PLAR Success Criteria

Category	PLAR Criteria
Review Process	Liens, if any, on operations, identified as part of the ORR, have been satisfactorily disposed.
Technical Management	The mission operations capabilities, including staffing and plans, are adequate to accommodate the required flight performance.
System Design and Demonstration	The observed spacecraft and science payload performance agrees with prediction, or if not, is adequately understood so that future behavior can be predicted with confidence.
Safety & Mission Assurance	All anomalies have been adequately documented, and their impact on operations assessed. Further, anomalies impacting spacecraft health and safety or critical flight operations have been properly disposed.
Project Management	Project plans are complete for the conduct of the mission with emphasis on near-term operations and mission-critical events.

13.3 Key Evaluation Factors for the Assessment of Success Criteria

Programmatic considerations shall be discussed at the PLAR in sufficient detail to permit assessment of relevant review objectives.

The GSFC STD-1001-Appendix provides sample key evaluation factors often applied by individual review team members when assessing the satisfactory achievement of the established criteria.

14.0 CRITICAL EVENT READINESS REVIEW (CERR)

At the CERR, the project demonstrates to the review panel:

Readiness to execute the crucial activities immediately before and after the critical event
Readiness to execute the mission's critical activities during flight operations

14.1 Timing

The CERR is conducted following the launch and prior to any Critical Event activities. When scheduling the review, the project should highlight and discuss with the review Chair any significant problem areas that may pose difficulty during the review.

14.2 Success Criteria

A review agenda, success criteria, and charge to the independent review board shall be discussed for concurrence by the Principal Investigator (PI-mode only), Program Executive (SRB reviews only), Project Manager, and Review Board Chair, ; and distributed to all parties prior to the review. The review Chair is responsible for initiating this discussion. Excluding any required tailoring, projects must at a minimum meet the following criteria as part of the CERR or demonstrate an adequate path towards completion. Table 14-2 depicts the criteria for a successful CERR.

Table 14-2: CERR Success Criteria

Category	CERR Criteria
Review Process	All related peer reviews have been successfully completed with all assigned actions having an acceptable disposition.
Technical Management	The requirements for the successful execution of the critical event(s) are complete and understood and have flowed down to the appropriate levels for implementation.
System Design and Demonstration	The critical activity design complies with requirements.
Safety & Mission Assurance	The preparation for the critical activity, including the verification and validation, is thorough.
Project Management	The project (including all the systems, supporting services, and documentation) is ready to support the activity.

14.3 Key Evaluation Factors for the Assessment of Success Criteria

Programmatic considerations shall be discussed at the CERR in sufficient detail to permit assessment of relevant review objectives. The GSFC STD-1001-Appendix provides sample key evaluation factors often applied by individual review team members when assessing the satisfactory achievement of the established criteria.

15.0 DECOMMISSIONING REVIEW (DR)

At the DR, the project demonstrates to the review panel that:

The decision to terminate or decommission the system meets all applicable Agency regulations regarding safety, environmental, and health standards and regulations
The readiness of the system for safe decommissioning and disposal of system assets

15.1 Timing

The DR is conducted near the end of, or following the end of the operational life of the spacecraft.

15.2 Success Criteria

A review agenda, success criteria, and charge to the independent review board shall be discussed for concurrence by the Principal Investigator (PI-mode only), Program Executive (SRB reviews only), Project Manager, and Review Board Chairperson; and distributed to all parties prior to the review. The chairperson is responsible for initiating this discussion. Excluding any required tailoring, projects must at a minimum meet the following criteria as part of the DR or demonstrate an adequate path towards completion. Table 15-2 depicts the criteria for a successful DR.

Table 15-2: DR Success Criteria

Category	DR Criteria
Review Process	N/A
Technical Management	Safety, health, and environmental hazards have been identified. Controls have been verified.
System Design and Demonstration	The decommissioning and disposal plan is complete, approved by appropriate management, and compliant with applicable Agency safety, environmental, and health regulations. Operations plans for all potential scenarios, including contingencies, are complete and approved. All required support systems are available.
Safety & Mission Assurance	Risks associated with the disposal have been identified and adequately mitigated. Residual risks have been accepted by the required management.
Project Management	Plans for disposition of mission-owned assets (i.e., hardware, software, and facilities) have been defined and approved. Plans for archival and subsequent analysis of mission data have been defined and approved. Arrangements have been finalized for the execution of such plans. Plans for the capture and dissemination of appropriate lessons learned during the project life cycle have been defined and approved. Adequate resources (schedule, budget, and staffing) have been identified and are available to successfully complete all decommissioning, disposal, and disposition activities.

15.3 Key Evaluation Factors for the Assessment of Success Criteria

Programmatic considerations shall be discussed at the DR in sufficient detail to permit assessment of relevant review objectives.

The GSFC STD-1001-Appendix provides sample key evaluation factors often applied by individual review team members when assessing the satisfactory achievement of the established criteria.

ACRONYM LIST

C&DH	Command and Data Handling
CDR	Critical Design Review
CERR	Critical Event Readiness Review
CLA	Coupled Loads Analysis
CMC	Center Management Council
COTS	Commercial Off-The-Shelf
CPT	Comprehensive Performance Test
CPU	Computer Processor Unit
CSCIs	Computer Software Configuration Items
DR	Decommissioning Review
EEE	Electrical, Electronic and Electromechanical
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EPRP	Engineering Peer Review Plan
EPRs	Engineering Peer Reviews
ETU	Engineering Test Unit
FMEA	Failure Modes and Effects Analysis
FOR	Flight Operations Review
FOT	Flight Operations Team
FRR	Flight Readiness Review
FSW	Flight Software
FTA	Fault Tree Analysis
GFY	Government Fiscal Year
GIDEP	Government-Industry Data Exchange Program
GN&C	Guidance, Navigation and Control
GOTS	Government Off The Shelf
GPR	Goddard Procedural Requirements
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
GS	Ground Segment
GSCDR	Ground Segment Critical Design Review
GSPDR	Ground Segment Preliminary Design Review
GSRR	Ground Segment Requirements Review
GSDR	Ground Segment Definitions Review
ICDs	Interface Control Documents
GSRT	Goddard Systems Review Team
IT	Information Technology

I&T	Integration and Test
IV&V	Independent Validation and Verification
KDP	Key Decision Point
KPMP	Key Project Management Practices
KSC	Kennedy Space Center
LLIL	Limited Life Items List
LRR	Launch Readiness Review
MCR	Mission Concept Review MDR Mission Definition Review
MFRR	Mission Flight Readiness Review
MOR	Mission Operations Review
MCDR	Mission Critical Design Review
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MPDR	Mission Preliminary Design Review
MPER	Mission Pre-Environmental Review
MSPSP	Mission System Prelaunch Safety Package
MSRR	Mission System Requirements Review
NASA	National Aeronautics and Space Administration
NISN	NASA Integrated Services Network
NIST	National Institute of Science and Technology
NPR	NASA Procedural Requirement
OCE	Office of the Chief Engineer
ORR	Operational Readiness Review
PER	Pre-Environmental Review PDR Preliminary Design Review
PLAR	Post-Launch Assessment Review
PRA	Probabilistic Risk Assessment
PSA	Parts Stress Analysis
PSR	Pre-Shipment Review
QA	Quality Assurance
RF	Radio Frequency
RFA	Request for Action
S/C	Spacecraft
SDR	Systems Design Review
SIR	System Integration Review

S&MA	Safety and Mission Assurance
SPF	Single Point Failure SRB Standing Review Board
SRM	Systems Review Manager
SRP	Systems Review Plan
SRO	System Review Office
SRR	System Requirements Review
STD	Standard
S/W	Software
TBD	To Be Determined
TBR	To-Be-Resolved
ToR	Terms of Reference
TRL	Technology Readiness Level
TRR	Test Readiness Review
V&V	Verification and Validation
WBS	Work Breakdown Structure
WCCA	Worst Case Circuit Analysis

Criteria for Flight and Flight Support Systems
Key Evaluation Factors

GSFC-STD-1001-Appendix

TABLE OF CONTENTS

A Mission Concept Review (MCR) 1

B System Requirements and Definition Reviews 4

B-1 Mission-Level (MSRR/MDR) 4
B-2 Flight Element-Level (SRR/SDR) 8
B-3 Ground Segment-Level (GSRR/GSDR) 11

C Preliminary Design Reviews 15

C-1 Mission-Level (MPDR) 15
C-2 Flight Element-Level (PDR) 20
C-3 Ground Segment-Level (GSPDR) 25

D Critical Design Reviews 31

D-1 Mission-Level (MCDR) 31
D-2 Flight Element-Level (CDR) 37
D-3 Ground Segment-Level (GSCDR) 43

E Mission Operations Review (MOR) 50

F Systems Integration Review (SIR) 55

G Pre-Environmental Reviews 58

G-1 Mission-Level (MPER) 58
G-2 Flight Element-Level (PER) 62

H Flight Operations Review (FOR) 66

I Pre-Shipment Reviews 70

I-1 Mission-Level (MPSR) 70
I-2 Flight Element-Level (PSR) 74

J Operational and Mission Flight Readiness Reviews (ORR/MFRR) 78

K Post Launch Readiness Review (PLAR) 80

L Critical Event Readiness Review (CERR) 82

M Decommissioning Review (DR) 84

Appendix A: Key Evaluation Factors
Mission Concept Review (MCR)

The following list consolidates evaluation factors from NASA best practices used to assess the project's achievements toward meeting the success criteria in the development of mission systems. Key evaluation factors may be tailored to suit the needs of the individual project within the Systems Review Plan (SRP) developed per the requirements of GPR 8700.4, Integrated Independent Reviews.

Review Process:	
MCR-1	A preliminary System Review Plan (SRP) has been completed that defines the complete set of independent reviews to be conducted throughout the development lifecycle of the mission per the Goddard Procedural Requirement (GPR) 8700.4, Integrated Independent Reviews.
MCR-2	A preliminary Engineering Peer Review Plan (EPRP) has been completed that defines the review program to be conducted by the project per GPR 8700.6, Engineering Peer Reviews, and the results of which to be reported out at the subsequent element or mission-level review.
MCR-3	A draft Terms of Reference (ToR) has been developed in accordance with NPR 7120.5D requirements defining the charter of the Standing Review Board (SRB) to be appointed.
Technical Management:	
MCR-4	Mission-level assumptions and constraints are understood, defined and quantified. Science objectives are realistically achievable within the context of the mission.
MCR-5	Preliminary mission and system-level requirements are clearly defined, unambiguous, and traceable to science objectives with external systems interface requirements defined.
MCR-6	Technology dependencies are defined and understood. Timely availability is reasonable. Feasible alternative approaches for critical dependencies have been identified.
MCR-7	A requirements management approach, including To-Be-Determined (TBD) and To-Be-Resolved (TBR) tracking is defined.
MCR-8	Adequate design margins for critical resources (mass, power, data rate, etc.) are estimated.
MCR-9	Potential partnerships have been identified.
MCR-10	Potential opportunities to use commercial, academic, and other government agency sources of technology have been identified.
MCR-11	Technical planning is sufficient to proceed to phase A.
System Design and Demonstration:	
MCR-12	A high level architecture and operations concept is identified.

MCR-13	The mission system elements are sufficiently described to establish mission feasibility (e.g., spacecraft, science instruments, launch vehicle, ground operation system, ground support equipment) and are traceable to and compatible with preliminary system requirements.
MCR-14	Conceptual designs have given adequate consideration to operational, power generation and management, Electromagnetic Interference and Compatibility (EMI/EMC), Limited Life Item, contamination, radiation tolerance, and thermal environment considerations.
MCR-15	The preliminary design philosophy relative to reliability considerations and single point failures has been defined and reviewed by the appropriate decision authority.
MCR-16	Ongoing or future design related trade studies are identified and potential impact of results is understood. Selection rationale for evaluating study results is defined.
MCR-17	A conceptual system level verification approach is identified.
MCR-18	Engineering modeling and analyses have been incorporated in the conceptual system configuration where applicable.
MCR-19	Major heritage elements have been identified and their utilization for the current application appears feasible and applicable.
MCR-20	A complete scenario for mission operations as well as data processing and analysis that will satisfy mission objectives has been identified.
MCR-21	Launch and early orbit considerations have been conceptually identified.
MCR-22	Data flow scenarios exist that illustrate a data acquisition, processing, and analysis sequence that will satisfy science objectives.
Safety & Mission Assurance:	
MCR-23	Top-level safety related requirements are defined.
MCR-24	Safety management approach has been identified.
MCR-25	Consideration of safety hazards and control methodology is addressed.
Project Management:	
MCR-26	Waivers to NPR 7120.5 that have been approved, requested, or are expected to be requested, are available for review.
MCR-27	Discussions with the appropriate review authorities have been initiated and commitments to develop the System Review Plan, Terms of Reference, and Engineering Peer Review Plan have been made.
MCR-28	Roles, responsibilities, and interfaces between all participating institutions are defined.
MCR-29	Organization and staffing plans identify manpower estimates throughout the project lifecycle.
MCR-30	An assessment of potential infrastructure and workforce needs versus current plans, as well as opportunities to use infrastructure and workforce in other government agencies, industry, academia, and international organizations has been completed.
MCR-31	A preliminary risk management approach including risk identification and mitigation strategy has been identified and is acceptable.

MCR-32	Schedule estimates identify suitable mission events and task durations and are credible.
MCR-33	Conceptual acquisition strategies for proposed major procurements have been identified.
MCR-34	A credible rough cost estimate is provided and is within an acceptable cost range.
MCR-35	A draft Integrated Baseline has been developed and documented.
MCR-36	A high-level Work Breakdown Structure (WBS) consistent with the NASA standard space flight project WBS is available.

Appendix B-1: Key Evaluation Factors
Mission System Requirements and Definition Reviews (MSRR/MDR)

The following list consolidates evaluation factors from NASA best practices used to assess the project's achievements toward meeting the success criteria in the development of mission systems. Key evaluation factors may be tailored to suit the needs of the individual project within the Systems Review Plan (SRP) developed per the requirements of GPR 8700.4, Integrated Independent Reviews.

Review Process:	
MSRR/MDR-1	A System Review Plan (SRP) has been approved that defines the complete set of independent reviews to be conducted throughout the development lifecycle of the mission per the Goddard Procedural Requirement (GPR) 8700.4, Integrated Independent Reviews.
MSRR/MDR-2	An Engineering Peer Review Plan (EPRP) has been approved that defines the engineering peer review program to be conducted by the project per GPR 8700.6, Engineering Peer Reviews, and the results of which to be reported out at the subsequent element or mission-level review.
MSRR/MDR-3	All MCR (if conducted) RFAs have been closed. Any assigned RFAs from peer reviews have had suitable disposition and/or have acceptable plans for closure.
MSRR/MDR-4	Recommendations and advisories from other project or external review activity that are applicable to the subject matter of the MDR have had adequate consideration.
MSRR/MDR-5	The requirements of NPR 7120.5 and NPR 7123.1 related to the development lifecycle review success criteria and review process roles and responsibilities have been captured in the SRP.
MSRR/MDR-6	A Terms of Reference (ToR) has been approved, if required, in accordance with NPR 7120.5 specified requirements defining the charter of the appointed Standing Review Board (SRB).
Technical Management:	
MSRR/MDR-7	Project compliance with GSFC-STD-1000 "Rules for the Design, Development, Verification, and Operation of Flight Systems" is presented and any waivers, appropriate to the current project life-cycle phase, have been submitted and approved as necessary.
MSRR/MDR-8	Science objectives are clear, complete, understood, and described in terms of meaningful measurable parameters that are achievable within the context of the mission. Science assumptions and constraints have been appropriately updated as required.
MSRR/MDR-9	Science objectives have been assessed and appropriately prioritized to support the identification of potential de-scope opportunities that meet minimum success requirements.

MSRR/MDR-10	Mission and system level requirements are clearly defined, unambiguous, and traceable to science objectives with external systems interface requirements having been defined.
MSRR/MDR-11	The requirements management process is fully defined and understood. The project utilizes an acceptable process for the allocation, control, and traceability of requirements throughout all levels, including To-Be-Determined/To-Be-Resolved (TBD/TBR) tracking. (NPR 7120.5)
MSRR/MDR-12	Requirements are flowed down to the independent system elements of the mission under review (e.g., spacecraft, science instruments, launch vehicle, ground operation system, ground support equipment) and are traceable to and compatible with baseline science and mission requirements.
MSRR/MDR-13	Attainable interface requirements have been identified between independent system elements.
MSRR/MDR-14	Approaches to controlling technical activities (systems engineering, software development, verification, configuration control, etc.) have been defined.
MSRR/MDR-15	Approach for usage, control, and verification of units of measurement is defined.
MSRR/MDR-16	Long-lead procurements for Phase B have been identified and approved.
MSRR/MDR-17	Updates of major risks are identified with assigned impact and probability of occurrence. Acceptable mitigation plans and trigger events are defined. (NPR 7120.5D)
System Design and Demonstration:	
MSRR/MDR-18	A baseline mission concept (including mission de-scope options) has been sufficiently developed and documented. System configurations have been defined with sufficient depth to indicate that a feasible design approach has been selected and performance requirements will be met.
MSRR/MDR-19	The design philosophy relative to reliability considerations and single point failures has been defined and approved by the appropriate decision authority.
MSRR/MDR-20	Results of requirements trades are documented and include rationale for selected alternatives. Open trade studies are identified and potential impacts are understood.
MSRR/MDR-21	Iterations of the design since developing the initial concept, whether trade study induced or otherwise, is articulated with suitable rationale for all changes.
MSRR/MDR-22	Appropriate modeling and analytical results (e.g., performance, reliability, etc.) are available and have been considered in the mission design.
MSRR/MDR-23	Conceptual design solutions that minimize electromagnetic interference (EMI) and unwanted interaction between spacecraft electronic components and/or subsystems have been appropriately considered to ensure electromagnetic compatibility (EMC).
MSRR/MDR-24	Technology dependencies are defined and understood. Timely availability is reasonable. Workarounds and associated trigger points are defined.
MSRR/MDR-25	Use of heritage elements have been determined with rationale clearly defined and constraints identified. Current mission requirements and those of previous application(s) are compatible.

MSRR/MDR-26	The infusion of Lessons Learned and the collection of new Lessons Learned have been identified.
MSRR/MDR-27	Adequate design margins for critical resources (mass, power, data rate, etc.) are estimated.
MSRR/MDR-28	Preliminary functional flow diagrams exist. Mission critical failures have been identified. Redundancies and/or workarounds have been defined or acceptability approved.
MSRR/MDR-29	A preliminary systems level verification approach has been defined and documented.
MSRR/MDR-30	Updated data flow scenarios illustrating a data acquisition, processing, and analysis sequence that will satisfy science objectives are provided.
MSRR/MDR-31	An updated mission operations scenario as well as the data processing and analysis that will satisfy mission objectives has been identified. Updated launch and early orbit operations concepts have been identified.
Safety & Mission Assurance:	
MSRR/MDR-32	Preliminary Mission Assurance Requirements have been defined (EEE parts and materials usage, reliability analyses, quality control, problem reporting, etc.).
MSRR/MDR-33	Safety requirements are defined including hazards identification and control methodology.
MSRR/MDR-34	A safety plan has been approved that identifies all requirements, planned tailoring approaches, intended non-compliances, and schedules for all required safety data submittals. (KPMP)
MSRR/MDR-35	Orbital debris assessment in accordance with NASA Safety Standard 8719.14, Guidelines and Assessment Procedures for Limiting Orbital Debris has been defined.
MSRR/MDR-36	Pre-Mishap Plan is written and released.
Project Management:	
MSRR/MDR-37	A preliminary project plan has been developed that includes an acceptable plan for identifying and managing risks by introducing possible mitigation strategies. (NPR 7120.5D)
MSRR/MDR-38	Appropriate processes and metrics are in place to track and control cost, schedule, and technical activities throughout the remaining life-cycle.
MSRR/MDR-39	Roles, responsibilities, and interfaces between all participating institutions are clearly defined. Organization charts and staffing plans delineate functional responsibilities and relationships.
MSRR/MDR-40	Project flow has been sufficiently well defined to determine the required delivery dates and quantities of hardware and software items.
MSRR/MDR-41	Phase A work agreements have been prepared and finalized.
MSRR/MDR-42	The preliminary requirements for non-budgeted resources (facilities, capital equipment, etc.) are defined and deemed adequate. The availability of such resources has been identified and is sufficient to complete the development activities. (NPR 7120.5D)

MSRR/MDR-43	A preliminary Integrated Baseline for the formulation phase including project master schedule (with critical path and schedule reserve for Phase B) and grass-roots estimate at the task/work package level, with any development work to be conducted during formulation is identified.
MSRR/MDR-44	The project's preliminary Integrated Baseline is consistent with the NASA standard space flight project WBS and has an associated WBS dictionary.
MSRR/MDR-45	The project's preliminary integrated master schedule, preliminary life-cycle cost estimate, workforce estimates, and technical baseline/mission concept, are all consistent with the program requirements levied on the project.
MSRR/MDR-46	Appropriately detailed schedules show realistic event times as well as appropriate funded slack and are compatible with approved launch dates.
MSRR/MDR-47	The preliminary life-cycle cost estimate is based on the project's technical baseline/mission concept and preliminary integrated master schedule and uses the latest available full-cost accounting initiative guidance and practices.
MSRR/MDR-48	The preliminary life-cycle cost estimate includes reserves, along with the level of confidence estimate provided by the reserves based on a cost-risk analysis.
MSRR/MDR-49	The life-cycle cost estimate is time-phased by Government Fiscal Year (GFY) to WBS Level 2.
MSRR/MDR-50	All expected, requested, and approved waivers to NPR 7120.5 have been assessed for impact.
MSRR/MDR-51	A preliminary business case analysis for each proposed project real property infrastructure investment consistent with applicable directives and requirements has been conducted.
MSRR/MDR-52	The development of MOUs/MOAs with external partners has been initiated.
MSRR/MDR-53	Export controlled technical data that will be potentially provided to foreign partners has been identified and the development of an Export Control Plan has been initiated as required.
MSRR/MDR-54	Appropriate environmental impact assessments and control activities have been defined.

Appendix B-2: Key Evaluation Factors
Flight Element System Requirements and Definition Reviews (SRR/SDR)

The following list consolidates evaluation factors from NASA best practices used to assess the project's achievements toward meeting the success criteria in the development of specific flight elements including spacecraft, instruments, and other operational systems. Key evaluation factors may be tailored to suit the needs of the individual project within the Systems Review Plan (SRP) developed per the requirements of GPR 8700.4, Integrated Independent Reviews.

Review Process:	
SRR/SDR-1	A System Review Plan (SRP) has been approved that defines the complete set of independent reviews to be conducted throughout the development lifecycle of the mission per the Goddard Procedural Requirement (GPR) 8700.4, Integrated Independent Reviews.
SRR/SDR-2	An Engineering Peer Review Plan (EPRP) has been approved that defines the engineering peer review program to be conducted by the project per GPR 8700.6, Engineering Peer Reviews, the results of which to be reported out at the subsequent element or mission-level review.
SRR/SDR-3	All RFAs written against previous reviews have been responded to by the project and closed by the responsible review panel member serving as the author or sponsor of the RFA.
SRR/SDR-4	Recommendations and advisories from other project or external review activity that are applicable to the subject matter of the SDR have had adequate consideration.
Technical Management:	
SRR/SDR-1	Project compliance with GSFC-STD-1000 "Rules for the Design, Development, Verification, and Operation of Flight Systems" is presented and any waivers, appropriate to the current project life-cycle phase, have been submitted and approved as necessary.
SRR/SDR-2	The requirements management process is fully defined and understood. The project utilizes an acceptable process for the allocation, control, and traceability of requirements throughout all levels, including To-Be-Determined/To-Be-Resolved (TBD/TBR) tracking.
SRR/SDR-3	System-level requirements (functional and performance) are clear, complete, unambiguous, and described in terms of meaningful measurable parameters achievable within the context of the operational parameters. System requirements have been traced to top-level objectives and external systems interface requirements clearly defined. Assumptions and constraints have been identified.
SRR/SDR-4	Requirements are flowed down to the primary sub-systems of the system element under review (e.g., electrical, power, structures, software, GN&C, C&DH, propulsion, optics, thermal, instrument sensor, etc.) or lower and are traceable to and compatible with baseline requirements. Attainable interface requirements have been identified between independent sub-systems.
SRR/SDR-5	Adequate design margins for critical resources (mass, power, data rate, etc.) have been estimated.

SRR/SDR-6	A preliminary systems level verification approach has been defined and documented.
SRR/SDR-7	Approach for usage, control, and verification of units of measurement is defined.
SRR/SDR-8	List of long-lead procurements planned for Phase B has been prepared and approved.
SRR/SDR-9	Approaches to controlling technical activities (risk, systems engineering, software development, verification, configuration control, etc.) have been identified with document development initiated.
SRR/SDR-10	Major risks have been identified and/or updated with impact and probability of occurrence assessed. Associated mitigation plans and trigger events have been defined with suitable rationale.
System Design and Demonstration:	
SRR/SDR-1	A conceptual system configuration has been defined with sufficient depth to indicate a feasible design approach has been selected and functional and performance requirements will be met.
SRR/SDR-2	Iterations of the design since developing the initial concept, whether trade study induced or otherwise, are articulated with suitable rationale for all changes.
SRR/SDR-3	The design philosophy relative to reliability considerations and single point failures has been defined and approved by the appropriate decision authority.
SRR/SDR-4	Appropriate modeling and analytical results (e.g., performance, reliability, etc.) have been developed and appropriately considered in the conceptual mission design.
SRR/SDR-5	Conceptual design solutions that minimize electromagnetic interference (EMI) and unwanted interaction between electronic components and/or subsystems have been appropriately considered to ensure electromagnetic compatibility (EMC).
SRR/SDR-6	Results of requirements trades are documented and include rationale for selected alternatives. Open trade studies are identified and potential impacts are understood.
SRR/SDR-7	Technology dependencies are defined and understood. Timely availability is reasonable. Workarounds and associated trigger points are defined.
SRR/SDR-8	Use of major heritage elements have been assessed with rationale clearly defined and constraints identified. Current mission requirements and those of previous application(s) appear compatible.
SRR/SDR-9	The infusion of Lessons Learned and the collection of new Lessons Learned have been identified.
SRR/SDR-10	Preliminary functional flow diagrams exist. Mission critical failures have been identified. Redundancies and/or workarounds have been defined or acceptability approved.
Safety & Mission Assurance:	
SRR/SDR-1	Safety requirements are defined including hazards identification and control methodology.
SRR/SDR-2	Preliminary Mission Assurance Requirements have been defined (EEE parts and materials usage, reliability analyses, quality control, problem reporting, etc.).

SRR/SDR-3	Safety Plan and other S&MA Plans are written and approved that define roles, responsibilities, and scope of S&MA activities.
Project Management:	
SRR/SDR-1	Roles, responsibilities, and interfaces between all participating institutions are clearly defined. Organization charts and staffing plans delineate functional responsibilities and relationships.
SRR/SDR-2	A baseline risk management approach including risk identification and mitigation strategy is defined and approved, and has been implemented.
SRR/SDR-3	Project flow has been sufficiently well defined to determine the required delivery dates and quantities of hardware and software items and support detailed schedule development.
SRR/SDR-4	Phase A work agreements have been prepared and finalized.
SRR/SDR-5	The preliminary requirements for non-budgeted resources (facilities, capital equipment, etc.) are defined and deemed adequate. The availability of such resources has been identified and is sufficient to complete the development activities.
SRR/SDR-6	Appropriate environmental impact assessments and control activities have been initiated.

Appendix B-3: Key Evaluation Factors
Ground Segment Requirements and Definition Reviews (GSRR/GSDR)

The following list consolidates evaluation factors from NASA best practices used to assess the project's achievements toward meeting the success criteria in the development of ground segment systems. Key evaluation factors may be tailored to suit the needs of the individual project within the Systems Review Plan (SRP) developed per the requirements of GPR 8700.4, Integrated Independent Reviews.

Review Process:	
GSRR/GSDR-1	A System Review Plan (SRP) has been approved that defines the complete set of independent reviews to be conducted throughout the development lifecycle of the mission per the Goddard Procedural Requirement (GPR) 8700.4, Integrated Independent Reviews.
GSRR/GSDR-2	An Engineering Peer Review Plan (EPRP) has been approved that defines the engineering peer review program to be conducted by the project per GPR 8700.6, Engineering Peer Reviews, the results of which to be reported out at the subsequent element or mission-level review.
GSRR/GSDR-3	All RFAs written against previous reviews have been responded to by the project and closed by the responsible review panel member serving as the author or sponsor of the RFA.
GSRR/GSDR-4	Recommendations from other project or external review activity that is applicable to the subject matter of the GSDR have been adequately implemented.
Technical Management:	
GSRR/GSDR-1	Project compliance with GSFC-STD-1000 "Rules for the Design, Development, Verification, and Operation of Flight Systems" is presented and any waivers, appropriate to the current project life-cycle phase, have been submitted and approved as necessary.
GSRR/GSDR-2	Current status of compliance with NASA Software Engineering Requirements (NPR 7150.2) reflects adequate progress of activities to date and satisfactory plans for future activities. Plans are in place to submit any required waivers / deviations.
GSRR/GSDR-4	The requirements management process is fully defined and understood. The project utilizes an acceptable process for the allocation, control, and traceability of requirements throughout all levels, including To-Be-Determined/To-Be-Resolved (TBD/TBR) tracking.
GSRR/GSDR-5	Ground segment requirements are fully linked to mission requirements and are functionally allocated in a manner that permits traceability and the creation of verification matrixes.
GSRR/GSDR-6	Ground segment requirements are clearly and fully traceable to mission operations objectives.
GSRR/GSDR-7	Interface requirements with the space segment are clearly defined and fully understood for all mission phases.

GSRR/GSDR-3	The following technical management documentation is available at the proper level of maturity: Draft Ground Segment Product Plan (Ref: ISD Software Management Plan/Product Plan Template 580-TM-033-01) Draft Configuration Management Plan (may be combined with Ground Segment Product Plan) Draft Software Assurance Plan (may be combined with Ground Segment Product Plan or Flight Software Quality Assurance Plan) Draft Ground Segment Requirements Document/Detailed Mission Requirements Draft Ground Segment Interface Requirements Document (may be combined with GSRD) Draft Operations Concept Document Final Mission Threat Assessment Initial IT Risk Assessment Report Initial IT Security Plan of Actions and Milestone Document Initial Interconnection Security Agreements Initial Security Self-Assessment
GSRR/GSDR-4	Attainable interface requirements have been identified between each independent ground segment element.
GSRR/GSDR-5	Attainable requirements are flowed down to each independent ground segment element (e.g. mission operations center, ground network, instrument operations center, data processing system) or below and are traceable to and compatible with system level requirements.
GSRR/GSDR-6	Results of requirements trades are documented and include rationale for selected alternatives. Open trade studies are identified and potential impacts are understood.
GSRR/GSDR-7	Approaches to controlling technical activities (systems engineering, software development, verification, configuration control, etc.) have been defined.
GSRR/GSDR-8	Project flow has been sufficiently well defined to determine the required delivery dates and quantities of hardware and software items.
GSRR/GSDR-9	Approach to usage, control, and verification of units of measurement is defined and documented.
GSRR/GSDR-10	A preliminary systems level verification approach has been defined and documented.
GSRR/GSDR-11	Major ground segment risks are defined with impact and probability of occurrence. Acceptable mitigation plans and trigger events are defined.
System Design and Demonstration:	
GSRR/GSDR-1	Conceptual system configuration is defined with sufficient depth to indicate that a feasible design approach has been selected and requirements will be met.
GSRR/GSDR-2	Major constraints associated with flight (including the spacecraft, instrument, and launch vehicle elements) have been fully accommodated within the operations concept and reflected in the ground segment support requirements.
GSRRG/SDR-3	Preliminary functional flow diagrams exist. Mission critical failures have been identified. The design philosophy relative to redundancies, system backups, and/or workarounds has been identified, documented, and approved by the appropriate decision authority.

GSRR/GSDR-4	The infusion of Lessons Learned and the collection of new Lessons Learned have been identified.
GSRR/GSDR-5	An updated mission operations scenario including data processing and analysis to satisfy mission objectives have been identified. Launch and early orbit operations concepts have been identified.
GSRR/GSDR-6	Iterations of the design since developing the initial concept, whether trade study induced or otherwise, are articulated with suitable rationale for all changes.
GSRR/GSDR-7	Appropriate modeling and analytical results (e.g., performance, reliability, etc.) are available and have been considered in the mission design.
GSRR/GSDR-8	Results of requirements trades are documented and include rationale for selected alternatives. Open trade studies are identified and potential impacts are understood.
GSRR/GSDR-9	Technology dependencies are defined and understood. Timely availability is reasonable. Workarounds and associated trigger points are defined.
GSRR/GSDR-10	Use of heritage elements have been determined with rationale clearly defined and constraints identified. Current mission requirements and those of previous application(s) are compatible.
GSRR/GSDR-11	Adequate design margins for critical resources (data rate, memory, etc.) are estimated.
GSRR/GSDR-12	Updated data flow scenarios illustrating a data acquisition, processing, and analysis sequence that will satisfy science objectives are provided.
Safety & Mission Assurance:	
GSRR/GSDR-1	Safety requirements are defined including hazards identification and control methodology.
GSRR/GSDR-2	Definitions of top-level security requirements have been completed with references to existing security plans and procedures of institutional ground segment elements
GSRR/GSDR-3	Ground segment elements defined for mission support should have IT security requirements traceable to GSFC/NASA/NIST security standards.
GSRR/GSDR-4	Mission Threat Assessment and NIST Security Categorization have been completed
GSRR/GSDR-5	Software Assurance planning, including problem reporting, is in compliance with applicable policy, complete, and approved.
GSRR/GSDR-6	Independent Validation and Verification (IV&V) activities have been defined and are on schedule.
GSRR/GSDR-7	Preliminary Mission Assurance Requirements have been defined (COTS components and applications, EEE parts, reliability analyses, quality control, problem reporting, etc.).
Project Management:	
GSRR/GSDR-1	A baseline risk management approach including risk identification and mitigation strategy is defined and approved, and has been implemented.
GSRR/GSDR-2	Staffing plans delineate adequate assignment of current and future staff.

GSRR/GSDR-3	Roles, responsibilities, and interfaces between all participating institutions and organizations are clearly defined. The ground segment development organization chart clearly delineates functional responsibilities and relationships including software team(s) and WBS elements.
GSRR/GSDR-4	Appropriate processes and metrics are in place to track and control cost, schedule, and technical activities throughout the remaining life cycle.
GSRR/GSDR-5	Development schedules have been defined for all development activities and show key receivables, deliverables, and dependencies. The schedules have been integrated with identified operational activities and appropriately rolled-up into the project master schedule.
GSRR/GSDR-6	Schedules are appropriately detailed showing realistic event times as well as acceptable funded slack and are compatible with approved ground segments readiness and launch dates.
GSRR/GSDR-7	Measures of success for the mission are defined. Key mission objectives provide measurable requirements such as data completeness, pointing accuracy and data volume per day.
GSRR/GSDR-8	Phase A work agreements have been prepared and finalized.
GSRR/GSDR-9	The preliminary requirements for non-budgeted resources (facilities, capital equipment, etc.) are defined and deemed adequate. The availability of such resources has been identified and is sufficient to complete the development activities.
GSRR/GSDR-10	Appropriate environmental impact assessments and control activities have been initiated.

Appendix C-1: Key Evaluation Factors
Mission Preliminary Design Review (MPDR)

The following list consolidates evaluation factors from NASA best practices used to assess the project's achievements toward meeting the success criteria in the development of mission systems. Key evaluation factors may be tailored to suit the needs of the individual project within the Systems Review Plan (SRP) developed per the requirements of GPR 8700.4, Integrated Independent Reviews.

Review Process:	
MPDR-1	Planning and presentation of information at critical mission and major element milestone reviews have been rigorous; peer review results have been included in briefings; review success criteria have been adequately met; closeout of all review actions has been timely and thorough. (KPMP)
MPDR-2	A comprehensive set of Engineering Peer Reviews (EPR) has been planned and conducted on appropriate hardware and software elements per the requirements of GPR 8700.6. The EPR results and actions have been documented and communicated to the Project Manager, the Integrated Independent Review Team, and the Standing Review Board (SRB). (KPMP)
MPDR-3	Additional peer reviews have been identified as necessary and appropriately planned.
MPDR-4	All RFAs written against previous reviews have been responded to by the project and closed by the responsible review panel member serving as the author or sponsor of the RFA.
MPDR-5	Recommendations and advisories from other project or external review activity that are applicable to the subject matter of the PDR have had adequate consideration.
MPDR-6	The requirements of NPR 7120.5 and NPR 7123.1 related to the development lifecycle review success criteria and review process roles and responsibilities have been captured in the approved Systems Review Plan (SRP) per GPR 8700.4, Integrated Independent Reviews.
MPDR-7	A Terms of Reference (ToR) has been approved, if required, in accordance with NPR 7120.5D specified requirements defining the charter of the appointed SRB.
Technical Management:	
MPDR-1	Updates to project compliance with GSFC-STD-1000 "Rules for the Design, Development, Verification, and Operation of Flight Systems" have been presented and any waivers, appropriate to the current project life-cycle phase, have been submitted and approved as necessary.
MPDR-2	Requirements changes since the MSRR/MDR and associated rationale have been properly documented with flow-down updated as required.

MPDR-3	Physical and analytic integration activities for all hardware and software elements of the mission, including ground equipment and the launch vehicle, have been sufficiently planned. Test activities have been documented, including validation, calibration, and operations compatibility testing, as applicable. Documented plans and procedures to appropriately assess discrepancies and confirm adequate closeout have been developed. (KPMP)
MPDR-4	Draft integrated Payload/Launch Vehicle activity flow has been defined.
MPDR-5	Preliminary Interface Control Documents (ICDs) with external systems, as well as between system elements, have been completed. To-Be-Determined (TBD) and To-Be-Resolved (TBR) items are clearly identified with acceptable plans and schedules existing for their disposition.
MPDR-6	Verification and validation activities (analysis, inspection, and test) associated with software and hardware elements at all levels of assembly have been sufficiently planned. The proposed trending analyses for key parameters have been defined. Total and failure-free run time requirements of primary and redundant elements have been defined and deemed adequate. (KPMP)
MPDR-7	A preliminary requirements verification plan exists with provisions for referencing documented results for each requirement, including the compatibility of units of measurement as applicable.
MPDR-8	Draft environmental verification plans for components, primary systems, elements, and the all-up observatory have been developed with applicable risks identified.
MPDR-9	Science and mission operations concepts are suitably defined and operations considerations have been adequately planned. A conceptual mission timeline, from launch through disposal, exists and defines corrective actions needed for mission events that fail to occur as planned. The identification of contingency and emergency actions required of the operations team has been initiated in support of future simulation activities. (KPMP)
MPDR-10	Estimates of critical resource margins (i.e., mass, power, delta V, Computer Processor Unit (CPU) throughput and memory, etc.) have been delineated based on design maturity. Sufficient margins exist based on applicable standards. Risk mitigation strategies are defined for margins falling below applicable guidelines or best practices.
MPDR-11	The projected impacts on system performance (mass, power, software and other resources) are identified for the potential de-scopes identified to mitigate the risks of unforeseen future events.
MPDR-12	Long lead items and their acquisition plans have been identified. Any fabrication needed prior to Critical Design Review (CDR) has been identified.
MPDR-13	Equipment and facilities for the development and test of hardware and software have been identified. Facilities are available and, if needed, utilization agreements are in work.
MPDR-14	Up-to-date risk assessments with suitably defined mitigation strategies are available. All significant risks, problems, and open items are identified and tracked (including development and flight performance related items). Risk mitigation plans are appropriate and credible.
MPDR-15	Potential Launch Vehicle related risk items are identified.

MPDR-16	Draft plans are defined for launch site activities, launch & early orbit operations including planning for the involvement and training of launch site and of mission operations teams.
MPDR-17	Key technological developmental items demonstrate a Technological Readiness Level (TRL) 6 maturity.
System Design and Demonstration:	
MPDR-1	Preliminary flight and ground system performance estimates indicate a mission design expected to meet the requirements within the resource allocation. Science and mission operations concepts are suitably defined and mature for this phase of development.
MPDR-2	Comprehensive definitions of the flight and ground segment designs from the critical component and mission element-level have been developed. Materials presented on the primary elements of the mission including the observatory, ground systems, and operations concept are sufficiently mature and provide demonstrated evidence of an acceptable design solution.
MPDR-3	Results of trade studies are available and the rationale for the selected alternatives is defined. All remaining trade studies to be completed are identified and potential impacts are understood.
MPDR-4	Design concept changes since the last major mission-level review have been appropriately documented with suitable rationale provided and systems impacts identified and assessed.
MPDR-5	Lessons learned have been appropriately researched and adapted. (KPMP)
MPDR-6	Appropriate modeling and analytical results (e.g., performance, reliability, etc.) are available and have been considered in the mission design.
MPDR-7	Heritage designs have been suitably assessed for applicability. Necessary design modifications, changes in expected operating environment, and operational differences, have been appropriately analyzed and/or tested. Mission requirements have been demonstrated to be compatible with previous applications (including radiation and thermal environment, mission life-time, reliability and parts de-rating). Qualification and acceptance test plans have been fully described. Parts lists have been suitably assessed for availability.
MPDR-8	Preliminary analyses of the primary sub-systems (e.g., electrical, power, structures, GN&C, C&DH, software, propulsion, optics, thermal, instrument sensor, etc.) have been completed and summarized highlighting performance and design margin challenges. Design risks have been clearly delineated and properly factored into the risk management strategies of the project.
MPDR-9	Proper grounding architecture has been demonstrated that minimizes electromagnetic interference (EMI) and unwanted interaction between various spacecraft electronic components and/or subsystems to ensure electromagnetic compatibility (EMC).
MPDR-10	Preliminary analyses of limited life items are complete for the expected lifetime plus margins.
MPDR-11	Coupled loads analysis has been initiated with potential risk appropriately identified.
MPDR-12	Preliminary analyses of the radiation protection requirements are completed.

MPDR-13	Contamination requirements and preliminary control plans are defined.
MPDR-14	Software nominal operating scenarios have been identified, along with fault detection, isolation, and recovery strategies. Preliminary plans for Independent Verification and Validation (IV&V) have been developed. Initial software performance estimates have been assessed as acceptable.
MPDR-15	Approaches for the qualification, proto-flight, and acceptance testing of the applicable flight and ground elements have been defined as required including any special test requirements.
MPDR-16	Interleaving of environmental and functional test flow has been defined.
MPDR-17	Data flow scenarios illustrating a data acquisition, processing, and analysis sequence that satisfy science objectives have been provided.
MPDR-18	Payload-driven, Launch Vehicle first flight and mission unique items have been identified and the mission implications are understood.
MPDR-19	Preliminary identification of all mechanical and electrical Ground Support Equipment (GSE) has been completed, including launch site and mission operations unique ground systems.
MPDR-20	The overall systems design is producible.
Safety & Mission Assurance:	
MPDR-1	Personnel, facility, launch range, and mission safety have been given sufficient consideration. Safety documentation has been approved as required. (KPMP)
MPDR-2	The planning and execution of the Mission Assurance Requirements, including; quality assurance, EEE parts, materials considerations, safety, reliability, workmanship standards, and software assurance (i.e., IV&V) have been sufficiently rigorous.
MPDR-3	A comprehensive, closed-loop problem reporting and corrective action system has been implemented. (KPMP)
MPDR-4	Parts selection, de-rating, screening and qualification test criteria are defined.
MPDR-5	A safety plan has been approved that identifies all requirements, planned tailoring approaches, intended non-compliances, and schedules for all required safety data submittals. (KPMP)
MPDR-6	Preliminary hazards, controls, and verification methods have been identified and documented in a Preliminary Hazard Analysis that has been approved. All open safety issues have been identified with acceptable plans for resolution. MSPSP is planned for delivery prior to KDP C.
MPDR-7	Initial reliability analyses and assessments are complete, as appropriate, including Fault Tree Analysis (FTA), Probabilistic Risk Assessment (PRA), Failure Modes and Effects Analysis (FMEA), Single Point Failure (SPF) Assessment, and Worst Case Circuit Analysis (WCCA). Applicable results have been appropriately factored into the design. Single point failures, where retained, have reasonable supporting rationale. (KPMP)
MPDR-8	Parts Stress Analysis (PSA) requirements have been defined.
MPDR-9	Preliminary production planning and process controls (including strategy for control/verification of units of measurement) have been identified.

MPDR-10	Plans for flowing S&MA requirements to subcontractors and suppliers have been defined.
MPDR-11	Preliminary Orbital Debris Assessment Report is complete. Potential trades have been determined. End-of-life requirements and design accommodations are understood. Closed loop feedback of GIDEP Alert Disposition has been provided to the Alert Coordinator.
MPDR-12	Mishap/contingency plan is baselined. Mission Assurance plan is baselined.
Project Management:	
MPDR-1	Appropriate processes and metrics are in place to track and control cost, schedule, and technical activities throughout the remaining life-cycle.
MPDR-2	Suitable processes have been planned and implemented for managing: requirements, systems engineering, risk, configured articles, documentation, technical records, analyses, workmanship, and verification processes. (KPMP)
MPDR-3	Organization and staffing plans delineate clear responsibilities and adequate assignment of current and future staff. A suitable and workable organizational structure is in place that facilitates clear and open communication (internally and externally). (KPMP)
MPDR-4	The current and planned number, capability, and the experience levels of the people assigned are sufficient. (KPMP)
MPDR-5	De-scope plans have been completed and the associated trigger points identified to mitigate programmatic risks to the extent possible. Resulting budget and schedule impacts from the identified de-scope options have been estimated and assessed.
MPDR-6	Appropriately detailed schedules show realistic event times as well as appropriate funded slack and are compatible with approved milestone dates.
MPDR-7	Schedule addresses all Payload and Launch Vehicle inter-related activities.
MPDR-8	Cost-to-complete has adequate spending profiles and reserves, and is compatible with allocations.
MPDR-9	Waivers to NPR 7120.5 that have been approved, requested, or are expected to be requested were presented and assessed as acceptable.
MPDR-10	An Integrated Baseline has been completed for the development phase, including: project Work Breakdown Structure (WBS), resource-loaded master schedule (with critical path and schedule reserve for Phase C/D) and grass-roots estimate at the task/work package level with basis of estimates, as deemed acceptable to proceed.

Appendix C-2: Key Evaluation Factors
Flight Element Preliminary Design Review (PDR)

The following list consolidates evaluation factors from NASA best practices used to assess the project's achievements toward meeting the success criteria in the development of specific flight elements including spacecraft, instruments, and other operational systems. Key evaluation factors may be tailored to suit the needs of the individual project within the Systems Review Plan (SRP) developed per the requirements of GPR 8700.4, Integrated Independent Reviews.

Review Process:	
PDR-1	Planning and presentation of information at critical mission and major element milestone reviews have been rigorous; peer review results have been included in briefings; review success criteria have been adequately met; closeout of all review actions has been timely and thorough.
PDR-2	The review has been conducted in accordance with the approved System Review Plan (SRP) that defines the success criteria and review process requirements as specified in the Goddard Procedural Requirement (GPR) 8700.4, Integrated Independent Reviews.
PDR-3	A comprehensive set of Engineering Peer Reviews (EPR) has been planned and conducted on appropriate hardware and software elements per the requirements of GPR 8700.6. The EPR results and actions have been documented and communicated to the Project Manager, and the Goddard Systems Review Team (GSRT).
PDR-4	Additional peer reviews have been identified as necessary and appropriately planned.
PDR-5	All RFAs written against previous reviews have been responded to by the project and closed by the responsible review panel member serving as the author or sponsor of the RFA.
PDR-6	Recommendations and advisories from other project or external review activity that are applicable to the subject matter of the PDR have had adequate consideration.
Technical Management:	
PDR-1	Updates to project compliance with GSFC-STD-1000 "Rules for the Design, Development, Verification, and Operation of Flight Systems" have been presented and any waivers, appropriate to the current project life-cycle phase, have been submitted and approved as necessary.
PDR-2	Requirements changes since the SRR/SDR, if applicable, and associated rationale have been properly documented with flow-down updated as required.
PDR-3	Physical and analytic integration activities for all hardware and software elements of the system, including ground equipment (if applicable), have been sufficiently planned. Test activities have been documented, including validation, calibration, and operations compatibility testing. Documented plans and procedures to appropriately assess discrepancies and confirm adequate closeout have been developed.
PDR-4	Preliminary Interface Control Documents (ICDs) with external systems, as well as between system elements, have been completed. To-Be-Determined (TBD) and To-Be- Resolved (TBR) items are clearly identified with acceptable plans and schedules existing for their disposition.

PDR-5	Verification and validation activities (analysis, inspection, and test) associated with software and hardware elements at all levels of assembly have been sufficiently planned. The proposed trending analyses for key parameters have been defined. Total and failure-free run time requirements of primary and redundant elements have been defined and deemed adequate.
PDR-6	A preliminary verification plan exists with provisions for referencing documented results for each requirement, including the compatibility of units of measurement where applicable.
PDR-7	Draft environmental verification plans for the primary system and its components have been developed with applicable risks identified.
PDR-8	Estimates of critical resource margins (i.e., mass, power, delta V, Computer Processor Unit (CPU) throughput and memory, etc.) have been delineated based on design maturity. Sufficient margins exist based on applicable standards. Risk mitigation strategies are defined for margins falling below applicable guidelines or best practices.
PDR-9	The projected impacts on system performance (mass, power, software and other resources) are identified for the potential de-scopes identified to mitigate the risks of unforeseen future events.
PDR-10	Long lead items and their acquisition plans have been identified. Any fabrication items needed prior to the planned Critical Design Review (CDR) have been identified.
PDR-11	Equipment and facilities for the development and test of hardware and software have been identified. Facilities are available and, if needed, utilization agreements are in work.
PDR-12	Up-to-date risk assessments with suitably defined mitigation strategies are available. All significant risks, problems, and open items are identified and tracked (including development and flight performance related items). Risk mitigation plans are appropriate and credible.
System Design and Demonstration:	
PDR-1	Preliminary performance estimates indicate a system design that is expected to meet the performance requirements within the resource allocation. System design concepts are suitably defined and mature for this phase of development.
PDR-2	Complete and comprehensive definitions of the system design from the box and critical component level have been developed. Materials presented on the primary subsystems (e.g., electrical, power, structures, GN&C, C&DH, software, propulsion, optics, thermal, instrument sensor, etc.) are sufficiently mature and provide demonstrated evidence of an acceptable design solution.
PDR-3	Results of trade studies are available and the rationale for the selected alternatives is defined. All remaining trade studies to be completed are identified and potential impacts are understood.
PDR-4	Design concept changes since the last system-related review have been appropriately documented with suitable rationale provided and systems impacts identified and assessed.
PDR-5	Lessons learned have been appropriately researched and adapted.

PDR-6	Heritage designs have been suitably assessed for applicability. Necessary design modifications, changes in expected operating environment, and operational differences, have been appropriately analyzed and/or tested. System requirements have been demonstrated to be compatible with previous applications (including radiation and thermal environment, life-time, reliability and parts de-rating). Qualification and acceptance test plans specific to heritage designs and components have been fully described. Parts lists have been suitably assessed for availability.
PDR-7	Appropriate system-level modeling and analytical results (e.g., performance, reliability, etc.) are available and have been considered in the element/system design.
PDR-8	Preliminary analyses of the primary sub-systems (e.g., electrical, power, structures, GN&C, C&DH, software, propulsion, optics, thermal, instrument sensor, etc.) have been completed with sufficient detail to identify performance and design margin challenges. Design risks have been clearly delineated and properly factored into the risk management strategies of the project.
PDR-9	Preliminary definition of the flight system electrical architecture (e.g., block diagrams, integrated schematics, ICDs, engineering analyses, and specifications) has been completed.
PDR-10	Proper grounding architecture has been demonstrated that minimizes electromagnetic interference (EMI) and unwanted interaction between various spacecraft electronic components and/or subsystems to ensure electromagnetic compatibility (EMC).
PDR-11	Preliminary analyses of mechanical loads, stress, fracture control, and torque margins have been completed and demonstrate acceptable design margins or suitable design solutions.
PDR-12	Preliminary analyses of limited life items are complete for the expected lifetime plus margins.
PDR-13	Thermal environment preliminary analyses have been completed, including predicted thermal performance, and demonstrate acceptable design margins or suitable design solutions.
PDR-14	Preliminary analyses of the radiation protection requirements have been completed, and demonstrate acceptable design margins or suitable design solutions.
PDR-15	Contamination requirements and preliminary control plans have been defined.
PDR-16	Preliminary software requirements are identified, including language, structure, logic flow, Computer Processor Unit (CPU) throughput and memory loading, re-use, safety, and security.
PDR-17	Software nominal operating scenarios have been identified with fault detection, isolation, and recovery strategies properly mature for PDR.
PDR-18	Software Independent Verification and Validation (IV&V) plans have been identified.
PDR-19	Preliminary software system performance estimates have been developed with risks identified.
PDR-20	Software verification strategies have been defined including test environments.
PDR-21	Acceptable software design and development plans have been defined including lines of code estimates, number of builds, tools, and procedures.

PDR-22	Approaches for the qualification, proto-flight, and acceptance testing of the applicable systems have been defined as required including any special test requirements.
PDR-23	Plans to appropriately interleave environmental and functional test flow have been defined.
PDR-24	Identification of mechanical and electrical Ground Support Equipment (GSE) has been completed.
PDR-25	The overall systems design is producible.
Safety & Mission Assurance:	
PDR-1	Personnel, facility, and mission safety have been given sufficient consideration with updates provided since the last major system-level review. All safety documentation has been generated and approved as required.
PDR-2	A safety plan has been approved that identifies all requirements, planned tailoring approaches, intended non-compliances, and schedules for all required safety data submittals.
PDR-3	Preliminary hazards, controls, and verification methods have been identified and documented in a Preliminary Hazard Analysis that has been approved. All open safety issues have been identified with acceptable plans for resolution.
PDR-4	The planning and execution product assurance requirements including; quality assurance, EEE parts, safety, reliability, materials considerations, workmanship standards, and software assurance (i.e., IV&V) have been sufficiently rigorous.
PDR-5	Parts selection, de-rating, screening and qualification test criteria are defined.
PDR-6	Radiation tolerance requirements have been defined.
PDR-7	A comprehensive, closed-loop problem reporting and corrective action system has been implemented.
PDR-8	Initial reliability analyses and assessments are complete, as appropriate, including Fault Tree Analysis (FTA), Probabilistic Risk Assessment (PRA), Failure Modes and Effects Analysis (FMEA), Single Point Failure (SPF) Assessment, and Worst Case Circuit Analysis (WCCA). Applicable results have been appropriately factored into the design. Single point failures, where retained, have reasonable supporting rationale.
PDR-9	Parts Stress Analysis (PSA) requirements have been defined.
PDR-10	Preliminary production planning and process controls (including strategy for control/verification of units of measurement) have been identified.
PDR-11	Plans for flowing S&MA requirements to subcontractors and suppliers have been defined.
Project Management:	
PDR-1	Appropriate processes and metrics are in place to track and control cost, schedule, and technical activities throughout the remaining life-cycle.
PDR-2	Suitable processes have been planned and implemented for managing: requirements, systems engineering, risk, configured articles, documentation, technical records, analyses, workmanship, and verification processes.

PDR-3	An approved risk management process has been successfully implemented with acceptable interfaces to higher-level risk management systems as applicable.
PDR-4	Organization and staffing plans delineate clear responsibilities and adequate assignment of current and future staff. A suitable and workable organizational structure is in place that facilitates clear and open communication (internally and externally).
PDR-5	The current and planned number, capability, and the experience levels of the people assigned to the development effort are sufficient.
PDR-6	The project team has demonstrated that it actively learns from the past and contributes to future scientific, technical, and management knowledge.
PDR-7	De-scope plans have been completed and the associated trigger points identified to mitigate programmatic risks to the extent possible. Resulting budget and schedule impacts from the identified de-scope options have been estimated and assessed.
PDR-8	Appropriately detailed schedules show realistic event times as well as appropriate funded slack and are compatible with approved milestone dates.
PDR-9	Cost-to-complete has adequate spending profiles and reserves, and is compatible with allocations.

Appendix C-3: Key Evaluation Factors
Ground Segment Preliminary Design Review (GSPDR)

The following list consolidates evaluation factors from NASA best practices used to assess the project's achievements toward meeting the success criteria in the development of ground segment systems. Key evaluation factors may be tailored to suit the needs of the individual project within the Systems Review Plan (SRP) developed per the requirements of GPR 8700.4, Integrated Independent Reviews.

Review Process:	
GSPDR-1	Planning and presentation of information at critical mission and major element milestone reviews have been rigorous; peer review results have been included in briefings; review success criteria have been met; closeout of all review actions has been timely and thorough.
GSPDR-2	The review has been conducted in accordance with the approved System Review Plan (SRP) that defines the success criteria and review process requirements as specified in the Goddard Procedural Requirement (GPR) 8700.4, Integrated Independent Reviews.
GSPDR-3	A comprehensive and thorough set of engineering peer reviews and code walkthroughs has been planned and conducted on appropriate hardware and software elements of the project. Results and actions have been documented and communicated to the project manager and Integrated Independent Review Team.
GSPDR-4	Engineering peer reviews have been conducted and documented in compliance with the requirements of GPR 8700.6. All resultant RFAs have a suitable disposition. Additional peer reviews needed have been identified and appropriately planned.
GSPDR-5	All RFAs written against previous ground segment reviews have been responded to by the project and closed by the responsible review panel member serving as the author or sponsor of the RFA.
GSPDR-6	Recommendations and advisories from other project or external review activity that are applicable to the subject matter of the PDR have had adequate consideration.
Technical Management:	
GSPDR-1	Updates to project compliance with GSFC-STD-1000 "Rules for the Design, Development, Verification, and Operation of Flight Systems" have been presented and any waivers, appropriate to the current project life-cycle phase, have been submitted and approved as necessary.
GSPDR-2	Current status of compliance with NASA Software Engineering Requirements (NPR 7150.2) reflects adequate progress of activities to date and satisfactory plans for future activities. Any required waivers have been submitted.
GSPDR-3	Requirements changes since the GSRR/GSDR, if applicable, and associated rationale have been properly documented with flow-down updated as required.

GSPDR-4	Physical and analytic integration activities for all hardware and software elements of the ground system have been sufficiently planned. Test activities have been documented, including validation, calibration, and operations compatibility testing, as applicable. Documented plans and procedures to appropriately assess discrepancies and confirm adequate closeout have been developed.
GSPDR-5	Verification and validation activities (analysis, inspection, and test) associated with software and hardware elements at all levels of assembly have been sufficiently planned. The proposed trending analyses for key parameters have been defined. Total and failure-free run time requirements of primary and redundant elements have been defined and deemed adequate.
GSPDR-6	A preliminary verification plan exists with provisions for referencing documented results for each requirement, including the compatibility of units of measurement where applicable.
GSPDR-7	Requirements verification matrices have been completed demonstrating requirements traceability from the subsystem/element to the system level and throughout the software architecture.
GSPDR-8	Science and mission operations concepts are suitably defined and operations considerations have been adequately planned. A conceptual mission timeline, from launch through disposal, exists and defines corrective actions needed for mission events that fail to occur as planned. The identification of contingency and emergency actions required of the operations team has been initiated in support of future simulation activities.
GSPDR-9	A preliminary software development approach has been defined, including; build and release plan and content definition, development and test environments and tools, test strategy and plan (including test drivers and simulators, test data, and discrepancy tracking), and strategy or timeline for IV&V and Independent Technical Authority involvement, as applicable. Includes delivery and installation requirements and maintenance plan.
GSPDR-10	The following technical management documentation for the Ground Segment is available at the proper level of maturity: ▪ Ground Segment Product Plan ▪ Software Development Plan (for each mission-unique ground segment element) ▪ Ground Segment Requirements Document/Detailed Mission Requirements ▪ Ground Segment Interface Requirements Document ▪ Draft Ground Segment Design Specification ▪ Draft Subsystem/CSC Level 4 Requirements Document ▪ Draft Subsystem/CSC Level 4 Design Specification ▪ Draft Ground Segment Test Plan ▪ Operations Concept Document ▪ Draft Telemetry and Command Database Naming Convention ▪ Draft Procedure Style Guide ▪ Draft Project Data Management Plan (as applicable)
GSPDR-11	Estimates of critical resource margins have been delineated based on design maturity. Sufficient margins exist based on applicable standards. Risk mitigation strategies are defined for margins falling below applicable guidelines or best practices.

GSPDR-12	The projected impacts on system performance are identified for the potential de-scopes identified to mitigate the risks of unforeseen future events.
GSPDR-13	Long lead items and their acquisition plans have been identified. Any fabrication needed prior to Critical Design Review (CDR) has been identified.
GSPDR-14	Equipment and facilities for the development and test of hardware and software have been identified. Facilities are available and, if needed, utilization agreements are in work.
GSPDR-15	Up-to-date risk assessments with suitably defined mitigation strategies are available. All significant risks, problems, and open items are identified and tracked (including development and flight performance related items). Risk mitigation plans are appropriate and credible.
GSPDR-16	All interfaces are defined and preliminary Interface Control Documents (ICDs) with external systems (spacecraft/ground), as well as between system elements, are complete. TBDs and TBRs are clearly identified with plans and schedules existing for their disposition by GCDR.
GSPDR-17	Draft plans are defined for launch site activities, launch & early orbit operations including planning for the involvement and training of launch site and of mission operations teams.
GSPDR-18	Launch site and mission operations unique ground segments have been defined
GSPDR-19	Payload-driven first flight/mission unique items have been identified and mission implications are understood.
GSPDR-20	End-of-life requirements and design accommodations are understood.
System Design and Demonstration:	
GSPDR-1	A complete and comprehensive definition of the GS preliminary design (hardware and software) to the subsystem level was satisfactorily demonstrated.
GSPDR-2	The preliminary GS design has been adequately demonstrated to meet all baseline functional and performance requirements and supports the operations concept for all mission phases.
GSPDR-3	Adequate design margins for critical GS resources are projected including; Ground Segment Availability, Data Throughput, Data Storage, Orbit Determination Definitive and Predictive Accuracy, Science Data Capture, Science Product Availability, and Science Data Archiving.
GSPDR-4	Design concept changes since the last applicable system review have been appropriately documented with suitable rationale provided and systems impacts identified and assessed.
GSPDR-5	Commercial and Government-Off-The-Shelf (COTS/GOTS) usage has been properly identified. Customization, if required, has been planned.
GSPDR-6	Appropriate modeling and analytical results (e.g., performance, reliability, etc.) are available and have been considered in the GS design.
GSPDR-7	Results of trade studies and rationale for selected alternatives are defined. Remaining trade studies are identified and potential impacts are understood.

GSPDR-8	Trade studies to identify development facilities, development hardware and software licenses have been identified as nearing completion. Development hardware and software licenses for COTS/GOTS components needed to satisfy all mission-critical or high-risk specifications have been identified. A preliminary acquisition plan is in place. Preliminary agreements are in place of usage of development facilities.
GSPDR-9	Operations facilities have been identified including space, power, communications and networking considerations. Preliminary identification of all facility locations has been completed. Any needed facility upgrades have been identified.
GSPDR-10	Heritage designs have been suitably assessed for applicability. Necessary design modifications, changes in expected operating environment, and operational differences, have been appropriately analyzed and/or tested. System requirements have been demonstrated to be compatible with previous applications. Qualification and acceptance test plans have been fully described.
GSPDR-11	Lessons learned have been appropriately researched and adapted.
GSPDR-12	Requirements and design concept changes since the GSRR/GSDR, if applicable, and their rationale are documented.
GSPDR-13	Preliminary software requirements are identified, including language, structure, logic flow, Computer Processor Unit (CPU) throughput and memory loading, re-use, safety, and security.
GSPDR-14	Software nominal operating scenarios are identified, along with fault detection, isolation, and recovery strategies.
GSPDR-15	Software Independent Verification and Validation (IV&V) plans are identified.
GSPDR-16	Preliminary software system performance estimates indicate an acceptable design.
GSPDR-17	Software verification strategies are defined including test environments.
GSPDR-18	Software design and development plans are defined including lines of code estimates, number of builds, tools, and procedures.
GSPDR-19	Approaches for the qualification and acceptance testing of the applicable systems have been defined including success criteria. A draft ground segment test plan has been generated.
GSPDR-20	Preliminary identification of all required test tools, emulators and simulators has been completed.
GSPDR-21	Data flow scenarios illustrating a data acquisition, processing, and analysis sequence that satisfy performance objectives have been provided.
GSPDR-22	Preliminary identification of all mission operations unique ground systems has been completed.
GSPDR-23	The overall systems design is producible.
Safety & Mission Assurance:	
GSPDR-1	Personnel, facility, and mission safety have been given sufficient consideration with updates provided since the last major system-level review. All safety documentation has been generated and approved as required.

GSPDR-2	A safety plan has been approved that identifies all requirements, planned tailoring approaches, intended non-compliances, and schedules for all required safety data submittals.
GSPDR-3	Preliminary hazards, controls, and verification methods have been identified and documented. All open safety issues have been identified with acceptable plans for resolution.
GSPDR-4	The planning and execution of the applicable Product Assurance Requirements, including Software Assurance (i.e., Safety, Reliability and Quality Assurance) have been sufficiently rigorous.
GSPDR-5	A comprehensive, closed-loop problem reporting and corrective action system has been implemented.
GSPDR-6	The following technical management documentation for the GS IT Security is available at the proper level of maturity: ▪ Draft IT Security Plan ▪ Draft IT Risk Assessment Report ▪ IT Security Plan of Actions and Milestone Document (updated) ▪ Draft Interconnection Security Agreements ▪ Draft IT Security Self-Assessment
GSPDR-7	An initial set of design solutions satisfying the NIST Security Categorization for each ground segment element is identified and documented.
GSPDR-8	An initial risk assessment and selection of security controls are completed for each ground segment element.
GSPDR-9	Preliminary production planning and process controls (including strategy for control/verification of units of measurement) have been identified
GSPDR-10	Initial reliability analyses and assessments are complete, as appropriate, including Fault Tree Analysis (FTA), Probabilistic Risk Assessment (PRA), Failure Modes and Effects Analysis (FMEA), Single Point Failure (SPF) Assessment, and Worst Case Circuit Analysis (WCCA). Applicable results have been appropriately factored into the design. Single point failures, where retained, have reasonable supporting rationale.
GSPDR-11	Plans for flowing S&MA requirements to subcontractors and suppliers have been defined.
Project Management:	
GSPDR-1	Appropriate processes and metrics are in place to track and control cost, schedule, and technical activities throughout the remaining life cycle.
GSPDR-2	Suitable processes have been planned and implemented for managing: requirements, systems engineering, risk, configured articles, documentation, technical records, analyses, workmanship, and verification processes.
GSPDR-3	An approved risk management process has been successfully implemented. The GS risk process is integrated with the mission risk management process as appropriate.
GSPDR-4	All significant risks, problems, and open items are identified and tracked (including programmatic, development and performance related items). Risk mitigation plans are appropriate and credible.

GSPDR-5	Organization and staffing plans delineate clear responsibilities and adequate assignment of current and future staff. A suitable and workable organizational structure is in place that facilitates clear and open communication (internally and externally).
GSPDR-6	The current and planned number, capability, and the experience levels of the people assigned are sufficient.
GSPDR-7	The project team has demonstrated that it actively learns from the past and contributes to future scientific, technical, and management knowledge.
GSPDR-8	Resource estimates to complete the GS design have been completed. Contingency is identified consistent with the level of risk. Ground processing of unique measurements associated with new instruments contains adequate contingency corresponding to design and implementation risks.
GSPDR-9	Life-cycle cost trades (i.e., up front automation versus routine operations) have been characterized as part of the GSPDR to ensuring that the proper design is selected and developed.
GSPDR-10	Measures of progress have been developed and are appropriately tied to the test program and consistent to the complexity of the system under development.
GSPDR-11	De-scope plans have been completed and the associated trigger points identified to mitigate programmatic risks to the extent possible. Resulting budget and schedule impacts from the identified de-scope options have been estimated and assessed.
GSPDR-12	Appropriately detailed schedules show realistic event times as well as appropriate funded slack and are compatible with approved milestone dates.
GSPDR-13	Cost-to-complete has adequate spending profiles and reserves, and is compatible with allocations.

Appendix D-1: Key Evaluation Factors
Mission Critical Design Review (MCDR)

The following list consolidates evaluation factors from NASA best practices used to assess the project's achievements toward meeting the success criteria in the development of mission systems. Key evaluation factors may be tailored to suit the needs of the individual project within the Systems Review Plan (SRP) developed per the requirements of GPR 8700.4, Integrated Independent Reviews.

Review Process:	
MCDR-1	Planning and presentation of information at critical mission and major element milestone reviews have been rigorous; peer review results have been included in briefings; review success criteria have been adequately met; closeout of all review actions has been timely and thorough. (KPMP)
MCDR-2	The review has been conducted in accordance with the approved System Review Plan (SRP) that defines the success criteria and review process requirements as specified in the Goddard Procedural Requirement (GPR) 8700.4, Integrated Independent Reviews.
MCDR-3	A comprehensive set of Engineering Peer Reviews (EPR) has been conducted on appropriate hardware and software elements per the requirements of GPR 8700.6. The EPR results and actions have been documented and communicated to the Project Manager, the Goddard Systems Review Team (GSRT), and the Standing Review Board (SRB). (KPMP)
MCDR-4	Additional peer reviews have been identified as necessary and appropriately planned.
MCDR-5	All RFAs written against previous reviews have been responded to by the project and closed by the responsible review panel member serving as the author or sponsor of the RFA.
MCDR-6	Recommendations and advisories from other project or external review activity that are applicable to the subject matter of the MCDR have had adequate consideration.
MCDR-7	Updates to the Terms of Reference (ToR) have been incorporated in accordance with NPR 7120.5 specified requirements relative to the charter of the appointed SRB.
Technical Management:	
MCDR-1	Updates to project compliance with GSFC-STD-1000 "Rules for the Design, Development, Verification, and Operation of Flight Systems" have been presented and any waivers, appropriate to the current project life-cycle phase, have been submitted and approved as necessary.
MCDR-2	Requirements changes since the MPDR and associated rationale have been properly documented with the associated flow-down updated as required.

MCDR-3	Planned physical and analytic integration activities for all hardware and software elements of the mission, including ground equipment and the launch vehicle are complete. Test activities have been documented, including validation, calibration, and operations compatibility testing, as applicable. Documented plans and procedures to appropriately assess discrepancies and confirm adequate closeout precede each integration step. (KPMP)
MCDR-4	Preliminary integrated Payload/Launch Vehicle activity flow has been defined.
MCDR-5	Baseline Interface Control Documents (ICDs) with external systems, as well as between system elements, have been completed. To-Be-Determined (TBD) and To-Be-Resolved (TBR) items are clearly identified with acceptable plans and schedules existing for their disposition.
MCDR-6	The Launch Vehicle ICD has been completed or acceptable plans for finalization are available.
MCDR-7	Plans for verification and validation activities (analysis, inspection, and test) associated with software and hardware elements at all levels of assembly are complete. The trending analyses for key parameters have been defined. Total and failure-free run time requirements of primary and redundant elements have been defined and deemed adequate. (KPMP)
MCDR-8	A final requirements verification plan exists with provisions for referencing documented results for each requirement, including the compatibility of units of measurement where applicable.
MCDR-9	Preliminary environmental verification plans for components, primary systems, elements, and the all-up observatory have been developed with applicable risks identified.
MCDR-10	Science and mission operations concepts are suitably defined and operations considerations have been adequately planned and implemented. A preliminary mission timeline, from launch through disposal, exists and defines corrective actions needed for mission events that fail to occur as planned. The contingency and emergency actions required of the operations team have been identified and appropriately factored into future simulation activities. (KPMP)
MCDR-11	Estimates of critical resource margins (i.e., mass, power, pointing, delta V, Computer Processor Unit (CPU) throughput and memory, etc.) have been delineated based on design maturity. Sufficient margins exist based on applicable standards. Viable risk mitigation strategies have been defined where margins fall below applicable guidelines or best practices.
MCDR-12	The projected impacts on system performance (mass, power, software and other resources) are identified for all potential de-scopes identified to mitigate the risks of unforeseen future events.
MCDR-13	Delivery of previously identified long lead procurement items and advance fabrication efforts are proceeding on schedule. All associated technical and programmatic risks have been properly identified with rationale for acceptability of the projected impact provided.

MCDR-14	Plans for systems Integration and Test (I&T) activities, including science validation and calibration, as well as operations compatibility testing, are complete.
MCDR-15	Equipment and facilities for the development and test of hardware and software have been identified. Facilities are available and utilization agreements in place as required.
MCDR-16	Up-to-date risk assessments with suitably defined mitigation strategies are available. All significant risks, problems, and open items are identified and tracked (including development and flight performance related items). Risk mitigation plans are appropriate and credible. Risks associated with I&T have been characterized and mitigations are on track for timely closure.
MCDR-17	Potential Launch Vehicle related risk items are identified in the mission risk management system.
MCDR-18	Preliminary plans are defined for launch site activities, launch & early orbit operations including planning for the involvement and training of launch site and of mission operations teams.
MCDR-19	Future transportation methods, if applicable, are identified including environmental control and monitoring considerations. Transportation container requirements have been identified.
MCDR-20	Plans for the finalization and configuration management of remaining drawings are complete.
System Design and Demonstration:	
MCDR-1	Flight and ground system performance estimates indicate a final mission design expected to meet the requirements within the resource allocation. Science and mission operations designs are complete and suitably mature for this phase of development.
MCDR-2	Complete and comprehensive definitions of the flight and ground segment designs from critical component and mission element-level have been developed. Materials presented on the primary elements of the mission including the observatory, ground systems, and operations concept are sufficiently mature and provide demonstrated evidence of an acceptable design solution.
MCDR-3	Trade studies are complete and properly documented including analyses and the rationale for the selected alternatives. Any open trade studies are identified and with acceptable risk mitigation.
MCDR-4	Drawings for fabrication and manufacture are at sufficient levels of completion (> 80 %) or have associated risks identified with acceptable mitigation plans. The status of incomplete drawings (i.e., draft, preliminary, under review, final) and schedule for completion have been defined.
MCDR-5	Design changes since the MPDR have been appropriately documented with suitable rationale provided and systems impacts identified and assessed.
MCDR-6	Design modeling and analyses are complete with proper consideration of the documented results (e.g., performance, reliability, etc.) in the final mission design.

MCDR-7	Lessons learned have been appropriately researched, adapted, and implemented. (KPMP)
MCDR-8	Heritage designs have been successfully incorporated into the final mission design. Necessary design modifications, changes in expected operating environment, and operational differences, have been appropriately analyzed and/or tested. Mission requirements have been demonstrated to be compatible with previous applications (including radiation and thermal environment, mission life-time, reliability and parts de-rating). Qualification and acceptance test plans have been fully described. Availability of parts has been confirmed and associated risks properly assessed.
MCDR-9	Final analyses of the primary sub-systems (e.g., electrical, power, structures, GN&C, C&DH, software, propulsion, optics, thermal, instrument sensor, etc.) have been completed and summarized highlighting acceptable performance and design margins. Design risks have been clearly delineated and properly factored into the risk management strategies of the project.
MCDR-10	A grounding architecture design has been completed to minimize electromagnetic interference (EMI) and unwanted interaction between various spacecraft electronic components and/or subsystems to ensure electromagnetic compatibility (EMC).
MCDR-11	Final analyses of limited life items are complete for the expected lifetime plus margins. All required-life-testing has been completed. Where necessary, the design has been modified to accommodate results.
MCDR-12	Preliminary Coupled Loads Analysis (CLA) has been completed with potential risks appropriately identified.
MCDR-13	Thermal environment analyses have been completed, including predicted thermal performance of the observatory with demonstrated acceptable thermal characteristics.
MCDR-14	Final analyses of the radiation protection requirements are completed and documented.
MCDR-15	Contamination requirements and control plans are finalized and properly documented.
MCDR-16	Final software nominal operating scenarios are defined. Fault detection, isolation, and recovery designs are complete. Plans for Independent Verification and Validation (IV&V) have been finalized and approved. Software performance estimates have been assessed as acceptable.
MCDR-17	Build-to specifications for all hardware and software configuration items are complete.
MCDR-18	Fabrication, assembly, integration, and test plans and procedures are complete and documented.
MCDR-19	Plans for the qualification, proto-flight, and acceptance testing of the applicable flight and ground elements have been completed as required including any special test requirements.
MCDR-20	Interleaving of environmental and functional test flow has been incorporated in planned tests.

MCDR-21	Data flow design solutions that accomplish a data acquisition, processing, and analysis sequence that satisfy science objectives have been completed and documented.
MCDR-22	Payload-driven, Launch Vehicle first flight and mission unique items have been updated as appropriate and the mission implications are understood.
MCDR-23	All mechanical and electrical Ground Support Equipment (GSE) for launch site and mission operations unique ground systems have been designed.
MCDR-24	The overall systems design is producible.
Safety & Mission Assurance	
MCDR-1	Personnel, facility, launch range, and mission safety have been given sufficient consideration with updates since the MPDR. Safety documentation has been approved as required. (KPMP)
MCDR-2	The approved safety plan identifying all requirements, planned tailoring approaches, and intended non-compliances, has been successfully implemented with schedules for all required safety data submittals being adhered to as required. (KPMP)
MCDR-3	Final identification of hazards, controls, and verification methods has been appropriately documented in the Intermediate MSPSP , which has been submitted to the project and approved. Acceptable rationale for all open safety issues have been provided with suitable plans for disposition.
MCDR-4	Hazardous integration and test procedures and appropriate controls have been identified.
MCDR-5	Mission Assurance Requirements are complete and have been successfully implemented, including; quality assurance, EEE parts, safety, reliability, materials considerations, workmanship standards, and software assurance (i.e., IV&V).
MCDR-6	Parts selection, de-rating, screening and qualification testing criteria have been implemented as required, including adherence to identified radiation tolerance requirements.
MCDR-7	A comprehensive, closed-loop problem reporting and corrective action system has been implemented. (KPMP)
MCDR-8	Contamination Control Plan activities have been implemented as required.
MCDR-9	Reliability analyses and assessments are complete to the extent appropriate, including Fault Tree Analysis (FTA), Probabilistic Risk Assessment (PRA), Failure Modes and Effects Analysis (FMEA), Single Point Failure (SPF) Assessment, and Worst Case Circuit Analysis (WCCA). Applicable results based on updates since MPDR have been appropriately factored into the design.
MCDR-10	EEE Parts Stress Analysis (PSA) has been completed with satisfactory results. Non-conformances have been acceptably resolved.
MCDR-11	EEE parts and materials lists are complete, including an up-to-date Limited Life Items List (LLIL). Waivers to requirements and any special materials usages have been approved with proper consideration to mission and system requirements.

MCDR-12	Flight Software (FSW) Independent Verification and Validation (IV&V) assessments are on-track with documented results being given proper consideration during the FSW development effort.
MCDR-13	Production plans with process controls (including strategy for control/verification of units of measurement) have been completed. Applicable workmanship standards have been incorporated.
MCDR-14	Plans for flowing S&MA requirements to subcontractors and suppliers have been approved.
MCDR-15	Updated Orbital Debris Assessment Report has been submitted to NASA HQ for final review and approval. Draft end-of-life plans have been developed documenting procedural requirements.
MCDR-16	As designed parts and materials list have been approved.
Project Management:	
MCDR-1	Processes and metrics trends demonstrate successful tracking and controlling of cost, schedule, and technical activities suitable for remainder of the development life-cycle.
MCDR-2	Existing processes for managing: requirements, systems engineering, risk, configured articles, documentation, technical records, analyses, workmanship, and verification processes, have been demonstrated to be suitable for current and planned mission development activities. (KPMP)
MCDR-3	Implemented organization and staffing plans have maintained clear responsibilities and suitable staff assignments. The organizational structure continues to facilitate clear and open communications (internally and externally). (KPMP)
MCDR-4	The current and planned number, capability, and experience levels of the people assigned roles within the project are sufficient for the successful conclusion of the mission. (KPMP)
MCDR-5	The project team has demonstrated that it actively learns from the past and contributes to future scientific, technical, and management knowledge. (KPMP)
MCDR-6	All waivers to NPR 7120.5 have been generated and approved.
MCDR-7	De-scope plans have been revised as appropriate with newly defined trigger points defined to mitigate programmatic risks to the extent possible. Resulting budget and schedule impacts from the identified de-scope options have been properly estimated and assessed as acceptable.
MCDR-8	Resource loaded development schedules have been updated to reflect the current engineering development status and demonstrate acceptable event times as well as appropriate funded slack that are compatible with approved milestone dates.
MCDR-9	The master schedule addresses all updates to Payload and Launch Vehicle inter-related activities.
MCDR-10	Cost-to-complete has adequate spending profiles and reserves, and is compatible with allocations.

Appendix D-2: Key Evaluation Factors
Flight Element Critical Design Review (CDR)

The following list consolidates evaluation factors from NASA best practices used to assess the project's achievements toward meeting the success criteria in the development of specific flight elements including spacecraft, instruments, and other operational systems. Key evaluation factors may be tailored to suit the needs of the individual project within the Systems Review Plan (SRP) developed per the requirements of GPR 8700.4, Integrated Independent Reviews.

Review Process:	
CDR-1	Planning and presentation of information at major element milestone reviews have been rigorous; peer review results have been included in briefings; review success criteria have been adequately met; closeout of all review actions has been timely and thorough.
CDR-2	The review has been conducted in accordance with the approved System Review Plan (SRP) that defines the success criteria and review process requirements as specified in the Goddard Procedural Requirement (GPR) 8700.4, Integrated Independent Reviews.
CDR-3	A comprehensive set of Engineering Peer Reviews (EPR) has been conducted on appropriate hardware and software elements per GPR 8700.6. The EPR results and actions have been documented and communicated to the Project Manager and Integrated Independent Review Team.
CDR-4	Additional peer reviews have been identified as necessary and appropriately planned.
CDR-5	All RFAs written against previous reviews have been responded to by the project and closed by the responsible review panel member serving as the author or sponsor of the RFA.
CDR-6	Recommendations and advisories from other project or external review activity that are applicable to the subject matter of the CDR have had adequate consideration.
Technical Management:	
CDR-1	Updates to project compliance with GSFC-STD-1000 "Rules for the Design, Development, Verification, and Operation of Flight Systems" have been presented and any waivers, appropriate to the current project life-cycle phase, have been submitted and approved as necessary.
CDR-2	Requirements changes since the PDR and associated rationale have been properly documented.
CDR-3	Planned physical and analytic integration activities for all hardware and software elements of the system, including ground equipment are complete. Test activities have been documented, including validation, calibration, and operations compatibility testing, as applicable. Plans and procedures to assess discrepancies and confirm adequate closeout precede each integration step.

CDR-4	Plans for verification and validation activities (analysis, inspection, and test) associated with software and hardware elements at all levels of assembly are complete. The trending analyses for key parameters have been defined. Total and failure-free run time requirements of primary and redundant elements have been defined and deemed adequate.
CDR-5	A final requirements verification plan exists with provisions for referencing documented results for each requirement, including the compatibility of units of measurement where applicable.
CDR-6	Preliminary environmental verification plans for components, primary sub-systems, and the all-up element/system have been developed with applicable risks identified.
CDR-7	Estimates of critical resource margins (i.e., mass, power, pointing, delta V, Computer Processor Unit (CPU) throughput and memory, etc.) have been delineated based on design maturity. Sufficient margins exist based on applicable standards. Viable risk mitigation strategies have been defined where margins fall below applicable guidelines or best practices.
CDR-8	The projected impacts on system performance (mass, power, software and other resources) are identified for all potential de-scopes identified to mitigate the risks of unforeseen future events.
CDR-9	Delivery of previously identified long lead procurement items and advance fabrication efforts are proceeding on schedule. All associated technical and programmatic risks have been properly identified with rationale for acceptability of the projected impact provided.
CDR-10	Plans for systems Integration and Test (I&T) activities, including science validation and calibration as applicable, as well as operations compatibility testing, are complete.
CDR-11	Equipment and facilities for the development and test of hardware and software have been identified. Facilities are available and utilization agreements in place as required.
CDR-12	Up-to-date risk assessments with suitably defined mitigation strategies are available. All significant risks, problems, and open items are identified and tracked (including development and flight performance related items). Risk mitigation plans are appropriate and credible. Risks associated with I&T have been characterized and mitigations are on track for timely closure.
CDR-13	Baseline Interface Control Documents (ICDs) with external systems, as well as between system elements, are completed and approved. All TBDs and TBRs are resolved or identified on the mission risk list with acceptable rationale, plans, and schedules existing for their disposition.
CDR-14	Future transportation methods, if applicable, are identified including environmental control and monitoring considerations. Transportation container requirements have been identified.

System Design and Demonstration:	
CDR-1	System performance estimates indicate a design expected to meet the requirements within the resource allocation. Operational limits and constraints are well defined. The overall systems design is producible.
CDR-2	Complete and comprehensive definitions of the system design from the box and critical component level have been finalized. Materials presented on the primary subsystems (e.g., electrical, power, structures, GN&C, C&DH, software, propulsion, optics, thermal, instrument sensor, etc.) are sufficiently mature and provide demonstrated evidence of an acceptable design solution.
CDR-3	Trade studies are complete and properly documented including analyses and the rationale for the selected alternatives. Any open trade studies are identified and with acceptable risk mitigation.
CDR-4	Drawings for fabrication and manufacture are at sufficient levels of completion (> 80 %) or have associated risks identified with acceptable mitigation plans. The status of incomplete drawings (i.e., draft, preliminary, under review, final) and schedule for completion have been defined.
CDR-5	Design changes since the PDR have been appropriately documented with suitable rationale provided and systems impacts identified and assessed.
CDR-6	Heritage designs have been successfully incorporated into the final system design. Necessary design modifications, changes in expected operating environment, and operational differences, have been appropriately analyzed and/or tested. System requirements have been demonstrated to be compatible with previous applications (including radiation and thermal environment, mission life-time, reliability and parts de-rating). Qualification and acceptance test plans have been fully described. Availability of parts has been confirmed and associated risks properly assessed.
CDR-7	Lessons learned have been appropriately researched, adapted, and implemented as appropriate.
CDR-8	Design modeling and analyses are complete with proper consideration of the documented results (e.g., performance, reliability, etc.) in the final mission design.
CDR-9	Analyses of limited life items are complete for the expected lifetime plus margins. All required life testing is complete. Where necessary, the design has been modified to accommodate results.
CDR-10	Analyses of mechanical loads, stress, fracture control, and torque margins have been completed.
CDR-11	Thermal environment analyses have been completed, including predicted thermal performance and design margin assessments.
CDR-12	Analyses of the radiation protection requirements, including assessments of design margins have been completed. EEE parts radiation tolerance requirements have been defined.
CDR-13	Contamination analyses are finalized and Contamination Control Plans have been approved.

CDR-14	Software requirements and architecture definition is complete, including language, structure, logic flow, CPU throughput and memory loading, re-use, safety, and security. Changes since PDR have been properly identified and assessed for possible impacts.
CDR-15	Software design and management plans including database descriptions, lines of code estimates, number of builds, tools, and procedures have been demonstrated with sufficient maturity for CDR.
CDR-16	Software nominal operating scenarios are fully defined including fault detection, isolation, and recovery strategies with designs sufficiently matured for CDR.
CDR-17	Software system performance estimates are compliant with system requirements.
CDR-18	Software verification strategies are defined including test environments.
CDR-19	The Software Requirements Specification is approved. Documentation includes verification matrix mapping of the requirements to subsystems or Computer Software Configuration Items (CSCIs).
CDR-20	Build-to specifications for all hardware and software configuration items are complete.
CDR-21	Technical data information (e.g., integrated schematics, spares provisioning list, interface control documents, engineering analyses, and specifications) are complete.
CDR-22	A command and telemetry list is completed and/or a defined plan to completion is available.
CDR-23	All analyses critical to proof of design are complete with any outstanding analyses having acceptable completion dates. Any potential impacts are understood and can be accommodated.
CDR-24	Breadboard and engineering model development activities have been completed. Results are understood and have been iterated into the final design.
CDR-25	Fabrication, assembly, integration, and test plans and procedures are complete.
CDR-26	Plans for qualification, proto-flight, and acceptance testing of applicable elements and systems have been completed and approved. Interleaving of environmental and functional test flow has been appropriately defined and incorporated in the plans.
CDR-27	The identification and design of all mechanical and electrical Ground Support Equipment (GSE) have been completed, including launch site and mission operations unique ground systems.
Safety & Mission Assurance	
CDR-1	Plans for flowing S&MA requirements to subcontractors and suppliers have been approved.
CDR-2	Personnel, facility, launch site and mission safety have been given sufficient consideration with updates since the PDR. Safety documentation has been approved as required.

CDR-3	An approved safety plan has been successfully implemented that identifies all requirements, tailoring plans, and non-compliances. All safety data submittals adhere to schedule requirements.
CDR-4	Final identification of hazards, controls, and verification methods has been appropriately documented in the Intermediate MSPSP, which has been submitted and approved. The included hazardous integration and test procedures have been reviewed and associated hazard controls have been identified and implemented. Rationale for open safety issues have been provided with suitable plans for disposition.
CDR-5	Product Assurance Requirements have been successfully implemented, including; quality assurance, EEE parts, materials, safety, reliability, workmanship standards, and software assurance (i.e., IV&V). A closed-loop problem reporting and corrective action system has been implemented.
CDR-6	Parts selection, de-rating, screening and qualification testing criteria have been implemented as required, including adherence to identified radiation tolerance requirements.
CDR-7	Reliability analyses and assessments are complete to the extent appropriate, including Fault Tree Analysis (FTA), Probabilistic Risk Assessment (PRA), Failure Modes and Effects Analysis (FMEA), Single Point Failure (SPF) Assessment, and Worst Case Circuit Analysis (WCCA). Applicable results based on updates since PDR have been appropriately factored into the design.
CDR-8	EEE Parts Stress Analysis (PSA) has been completed with satisfactory results.
CDR-9	EEE parts and materials lists are complete, including an up-to-date Limited Life Items List (LLIL). Waivers to requirements have been approved with proper consideration to system requirements.
CDR-10	Software Independent Verification and Validation (IV&V) assessments have been conducted, if required, with results properly documented and considered during the software development effort.
CDR-11	Production plans with process controls (including strategy for control/verification of units of measurement) have been completed. Applicable workmanship standards have been incorporated.
Project Management:	
CDR-1	Processes and metrics trends demonstrate successful tracking and controlling of cost, schedule, and technical activities suitable for remainder of the development life-cycle.
CDR-2	Existing processes for managing: requirements, systems engineering, risk, configured articles, documentation, technical records, analyses, workmanship, and verification processes, have been demonstrated to be suitable for current and planned development activities.
CDR-3	Implemented organization and staffing plans have maintained clear responsibilities and suitable staff assignments. The organizational structure facilitates clear and open communications.

CDR-4	The current and planned number, capability, and experience levels of the people assigned roles within the project are sufficient for the successful conclusion of the development effort.
CDR-5	De-scope plans have been revised as appropriate with newly defined trigger points defined to mitigate programmatic risks to the extent possible. Resulting budget and schedule impacts from the identified de-scope options have been properly estimated and assessed as acceptable.
CDR-6	Resource loaded development schedules have been updated to reflect the current engineering development status and demonstrate acceptable event times as well as appropriate funded slack that are compatible with approved milestone dates.
CDR-7	Cost-to-complete has adequate spending profiles and reserves, and is compatible with allocations.

Appendix D-3: Key Evaluation Factors
Ground Segment Critical Design Review (GSCDR)

The following list consolidates evaluation factors from NASA best practices used to assess the project's achievements toward meeting the success criteria in the development of ground segment systems. Key evaluation factors may be tailored to suit the needs of the individual project within the Systems Review Plan (SRP) developed per the requirements of GPR 8700.4, Integrated Independent Reviews.

Review Process:	
GSCDR-1	Planning and presentation of information at critical mission and major element milestone reviews have been rigorous; peer review results have been included in briefings; review success criteria have been met; closeout of all review actions has been timely and thorough.
GSCDR-2	The review has been conducted in accordance with the approved System Review Plan (SRP) that defines the success criteria and review process requirements as specified in the Goddard Procedural Requirement (GPR) 8700.4, Integrated Independent Reviews.
GSCDR-3	Comprehensive engineering peer reviews and code walkthroughs have been conducted on appropriate hardware and software elements of the project. Results and actions have been documented and communicated to the project manager and Integrated Independent Review Team.
GSCDR-4	Engineering peer reviews have been conducted and documented in compliance with the requirements of GPR 8700.6. All resultant RFAs have a suitable disposition. Additional peer reviews needed have been identified and appropriately planned.
GSCDR-5	All RFAs written against previous ground segment reviews have been responded to by the project and closed by the responsible review panel member serving as the author or sponsor of the RFA.
GSCDR-6	Recommendations and advisories from other project or external review activity that are applicable to the subject matter of the GSCDR have had adequate consideration.
Technical Management:	
GSCDR-1	Updates to project compliance with GSFC-STD-1000 "Rules for the Design, Development, Verification, and Operation of Flight Systems" have been presented and any waivers, appropriate to the current project life-cycle phase, have been submitted and approved as necessary.
GSCDR-2	Current status of compliance with NASA Software Engineering Requirements (NPR 7150.2) reflects adequate progress of activities to date and satisfactory plans for future activities. All required waivers have been approved.
GSCDR-3	Requirements changes since the GSPDR and associated rationale have been properly documented with the flow-down of requirements updated as required.

GSCDR-4	Physical and analytic integration activities for all hardware and software elements of the ground system have been properly documented. Test activities have been documented, including validation, calibration, and operations compatibility testing, as applicable. Plans and procedures to appropriately assess discrepancies and confirm adequate closeout have been completed.
GSCDR-5	Verification and validation plans (analysis, inspection, and test) associated with software and hardware elements at all levels of assembly have been completed. The proposed trending analyses for key parameters have been documented. Total and failure-free run time requirements of primary and redundant elements have been documented and approved.
GSCDR-6	A final verification plan exists with provisions for referencing documented results for each requirement, including the compatibility of units of measurement where applicable.
GSCDR-7	Requirements verification matrices have been implemented for requirements traceability from the subsystem/element to the system level and throughout the software architecture.
GSCDR-8	Science and mission operations designs are complete with operations considerations appropriately documented. A preliminary mission timeline, from launch through disposal, exists and defines corrective actions needed for mission events that fail to occur as planned. A preliminary contingency and emergency action plan has been completed and supports future simulations.
GSCDR-9	Software development plans have been finalized and implemented, including; build and release plan and content definition, development and test environments and tools, test strategy and plan (including test drivers and simulators, test data, and discrepancy tracking), and strategy or timeline for IV&V and Independent Technical Authority involvement, as applicable. Includes delivery and installation requirements and maintenance plan.
GSCDR-10	The following technical management documentation for the Ground Segment is available at the proper level of maturity: ▪ Ground Segment Product Plan ▪ Software Development Plan (for each mission-unique ground segment element) ▪ Ground Segment Requirements Document/Detailed Mission Requirements ▪ Ground Segment Interface Requirements Document ▪ Preliminary Ground Segment Design Specification ▪ Preliminary Subsystem/CSC Level 4 Requirements Document ▪ Preliminary Subsystem/CSC Level 4 Design Specification ▪ Preliminary Ground Segment Test Plan ▪ Operations Concept Document ▪ Preliminary Telemetry and Command Database Naming Convention ▪ Preliminary Procedure Style Guide ▪ Preliminary Project Data Management Plan (as applicable)
GSCDR-11	Estimates of critical resource margins have been delineated based on design maturity. Sufficient margins exist based on applicable standards. Risk mitigation strategies are defined for margins falling below applicable guidelines or best practices.

GSCDR-12	The projected impacts on system performance resulting from potential de-scopes identified to mitigate the risks of unforeseen future events have been properly analyzed and mitigated.
GSCDR-13	Delivery of previously identified long lead procurement items and advance fabrication efforts are proceeding on schedule. All associated technical and programmatic risks have been properly identified with rationale for acceptability of the projected impact provided.
GSCDR-14	Plans for systems Integration and Test (I&T) activities, including operations compatibility testing, are complete.
GSCDR-15	Equipment and facilities for the development and test of hardware and software have been identified. Facilities are available and utilization agreements in place as required.
GSCDR-16	Up-to-date risk assessments with suitably defined mitigation strategies are available. All significant risks, problems, and open items are identified and tracked (including development and flight performance related items). Risk mitigation plans are appropriate and credible. Risks associated with I&T have been characterized and mitigations are on track for timely closure.
GSCDR-17	Baseline Interface Control Documents (ICDs) with external systems, as well as between system elements, are completed and approved. All TBDs and TBRs are resolved or identified on the mission risk list with acceptable rationale, plans, and schedules existing for their disposition.
GSCDR-18	Preliminary plans are defined for launch site activities, launch & early orbit operations including planning for the involvement and training of launch site and of mission operations teams.
GSCDR-19	Launch site and mission operations unique ground segments have been defined and documented.
GSCDR-20	Payload-driven first flight/mission unique items have been identified and mission implications are understood.
GSCDR-21	End-of-life requirements are documented and associated operational designs are complete.
System Design and Demonstration:	
GSCDR-1	A complete and comprehensive definition of the GS final design to the subsystem level has been satisfactorily demonstrated.
GSCDR-2	The final GS design has been adequately demonstrated to meet all baseline functional and performance requirements and supports the operations concept for all mission phases.
GSCDR-3	Adequate design margins for critical GS resources are projected including; Ground Segment Availability, Data Throughput, Data Storage, Orbit Determination Definitive and Predictive Accuracy, Science Data Capture, Science Product Availability, and Science Data Archiving.
GSCDR-4	Design changes since the GSPDR have been appropriately documented with suitable rationale provided and systems impacts properly identified and assessed.

GSCDR-5	Commercial and Government-Off-The-Shelf (COTS/GOTS) items have been identified and procurements have been initiated as appropriate. Customization, if required, has been documented.
GSCDR-6	Appropriate modeling and analytical results (e.g., performance, reliability, etc.) have been completed and have been appropriately considered in the final GS design.
GSCDR-7	Results of trade studies and rationale for selected alternatives are defined. Remaining trade studies are identified and potential impacts are understood.
GSCDR-8	Trade studies to identify development facilities and development hardware and software licenses have been completed. Development hardware and software licenses for COTS/GOTS components have been fully assessed and have been acquired or acquisition plans have been finalized. Required agreements for usage of development facilities are in place.
GSCDR-9	Operations facilities have been confirmed including space, power, communications and networking considerations. Identification of all facility locations has been completed and facilities upgrades have been initiated as required.
GSCDR-10	Lessons learned have been appropriately researched, adapted, and implemented as appropriate.
GSCDR-11	Heritage designs have been successfully incorporated into the final system design. Necessary design modifications, changes in expected operating environment, and operational differences, have been appropriately analyzed and/or tested. System requirements have been demonstrated to be compatible with previous applications. Qualification and acceptance test plans have been fully described. Availability of parts has been confirmed and associated risks properly assessed.
GSCDR-12	Design modeling and analyses are complete with proper consideration of the documented results (e.g., performance, reliability, etc.) in the final mission design.
GSCDR-13	Approaches for the qualification and acceptance testing of the applicable systems have been defined including success criteria. A draft ground segment test plan has been generated.
GSCDR-14	Data flow scenarios illustrating a data acquisition, processing, and analysis sequence that satisfy science objectives have been provided.
GSCDR-15	Software requirements and architecture definition are complete, including language, structure, logic flow, CPU throughput and memory loading, re-use, safety, and security. Changes since GSPDR have been properly identified and assessed for possible impacts.
GSCDR-16	Software design and management plans including database descriptions, lines of code estimates, number of builds, tools, and procedures have been demonstrated with sufficient maturity for GSCDR.
GSCDR-17	Software nominal operating scenarios are fully defined including fault detection, isolation, and recovery strategies with designs sufficiently matured for GSCDR.

GSCDR-18	Software system performance estimates have been confirmed as acceptable and compliant with mission requirements.
GSCDR-19	Software verification strategies are defined including test environments.
GSCDR-20	Software Independent Verification and Validation (IV&V) plans are approved and implemented.
GSCDR-21	The Software Requirements Specification is approved. Documentation includes verification matrix mapping of the requirements to subsystems or Computer Software Configuration Items (CSCIs).
GSCDR-22	Preliminary identification of all required test tools, emulators and simulators has been completed.
GSCDR-23	Preliminary identification of all mission operations unique ground systems has been completed.
GSCDR-24	The overall systems design is producible.
Safety & Mission Assurance:	
GSCDR-1	Personnel, facility, launch site and mission safety have been given sufficient consideration with updates since the PDR. Safety documentation has been approved as required.
GSCDR-2	An approved safety plan has been successfully implemented that identifies all requirements, tailoring plans, and non-compliances. All safety data submittals adhere to schedule requirements.
GSCDR-3	Final identification of hazards, controls, and verification methods have been appropriately documented and approved, including hazardous integration and test procedures and associated controls. Rationale for open safety issues have been provided with suitable plans for disposition.
GSCDR-4	Product Assurance Requirements have been successfully implemented including Software Quality Assurance (i.e., S/W safety, reliability, QA, IV&V). A closed-loop problem reporting and corrective action system has been implemented.
GSCDR-5	The following technical management documentation for the GS IT Security is available at the proper level of maturity: ▪ Preliminary IT Security Plan ▪ Preliminary IT Risk Assessment Report ▪ IT Security Plan of Actions and Milestone Document (updated) ▪ Preliminary Interconnection Security Agreements ▪ Preliminary IT Security Self-Assessment
GSCDR-6	A preliminary design solution satisfying the NIST Security Categorization for each ground segment element has been identified and documented.
GSCDR-7	A final risk assessment and selection of security controls have been completed for each ground segment element.
GSCDR-8	Production plans and process controls (including strategy for control/verification of units of measurement) have been finalized and implemented.

GSCDR-9	Reliability analyses and assessments are complete to the extent appropriate, including Fault Tree Analysis (FTA), Probabilistic Risk Assessment (PRA), Failure Modes and Effects Analysis (FMEA), and Worst Case Circuit Analysis (WCCA). Applicable results based on updates since GSPDR have been appropriately factored into the design.
GSCDR-10	Flight Software (FSW) Independent Verification and Validation (IV&V) assessments are on-track with documented results being given proper consideration during the FSW development effort.
GSCDR-11	Plans for flowing S&MA requirements to subcontractors and suppliers have been approved.
Project Management:	
GSCDR-1	Selected development approaches from trade-studies (i.e., up front automation versus routine operations) have been implemented with suitable rationale provided.
GSCDR-2	Processes and metrics trends demonstrate successful tracking and controlling of cost, schedule, and technical activities suitable for remainder of the development life-cycle.
GSCDR-3	Measures of progress have been developed and are appropriately tied to the test program and consistent to the complexity of the system under development.
GSCDR-4	Existing processes for managing: requirements, systems engineering, risk, configured articles, documentation, technical records, analyses, workmanship, and verification processes, have been demonstrated to be suitable for current and planned mission development activities.
GSCDR-5	Implemented organization and staffing plans have maintained clear responsibilities and suitable staff assignments. The organizational structure continues to facilitate clear and open communications (internally and externally).
GSCDR-6	The current and planned number, capability, and experience levels of the people assigned roles within the project are sufficient for the successful conclusion of the mission.
GSCDR-7	The project team has demonstrated that it actively learns from the past and contributes to future scientific, technical, and management knowledge.
GSCDR-8	De-scope plans have been revised as appropriate with newly defined trigger points defined to mitigate programmatic risks to the extent possible. Resulting budget and schedule impacts from the identified de-scope options have been properly estimated and assessed as acceptable.
GSCDR-9	An approved risk management process has been successfully implemented. The GS risk process is integrated with the mission risk management process as appropriate. All significant risks, problems, and open items are identified and tracked (including programmatic, development and performance related items). Risk mitigation plans are appropriate and credible.
GSCDR-10	Resource loaded development schedules have been updated to reflect the current engineering development status and demonstrate acceptable event times as well as appropriate funded slack that are compatible with approved milestone dates.

GSCDR-11	Cost-to-complete has adequate spending profiles and reserves, and is compatible with allocations.

Appendix E: Key Evaluation Factors
Mission Operations Review (MOR)

The following list consolidates evaluation factors from NASA best practices used to assess the project's achievements toward meeting the success criteria in the development of mission systems. Key evaluation factors may be tailored to suit the needs of the individual project within the Systems Review Plan (SRP) developed per the requirements of GPR 8700.4, Integrated Independent Reviews.

Review Process:	
MOR-1	Planning and presentation of information at critical mission and major element milestone reviews have been rigorous; peer review results have been included in briefings; review success criteria have been met; closeout of all review actions has been timely and thorough. (KPMP)
MOR-2	The review has been conducted in accordance with the approved System Review Plan (SRP) that defines the success criteria and review process requirements as specified in the Goddard Procedural Requirement (GPR) 8700.4, Integrated Independent Reviews.
MOR-3	All operations related RFAs written against previous mission or system level reviews have been responded to by the project and closed by the responsible review panel member serving as the author or sponsor of the RFA.
MOR-4	Engineering peer reviews have been conducted and documented in compliance with the requirements of GPR 8700.6. All resultant RFAs have a suitable disposition. Additional peer reviews needed have been identified and appropriately planned.
MOR-5	Recommendations and advisories from other project or external review activity that are applicable to the subject matter of the MOR have had adequate consideration.
Technical Management:	
MOR-1	Updates to project compliance with GSFC-STD-1000 "Rules for the Design, Development, Verification, and Operation of Flight Systems" have been presented. Any waivers appropriate for the current phase of the development life-cycle have been submitted and approved as necessary.
MOR-2	Ground Segment requirements are fully linked to mission requirements and are functionally allocated in a manner that permits traceability and the creation of verification matrixes.
MOR-3	Suitability of critical resource margins have been delineated based on design maturity. Sufficient margins exist based on applicable standards. Risk mitigation strategies are defined for margins falling below applicable guidelines or best practices. Management of critical resources has been demonstrated to be adequate to support mission reliability requirements.
MOR-4	Mission support requirements are fully documented and a process for identifying and tracking changes to the requirements baseline has been appropriately implemented.

MOR-5	Major constraints associated with the flight and ground segments have been fully accommodated within the operations concept and reflected in the ground system support requirements. A plan for capturing lower-level constraints and restrictions in a timely fashion has been defined.
MOR-6	A mission readiness test approach of the integrated ground system have been defined in a separate written test plan and includes Radio Frequency (RF) compatibility and network compatibility verification. Test requirements are traceable to system-level documentation and derived strictly from element-level documentation. Requirements definition is at a suitable state of maturity.
MOR-7	Intra- and inter-element test approaches are defined and scheduled.
MOR-8	Defined validation activities with the flight system (typically conducted prior to shipment of the flight system to the launch site) have been demonstrated to be adequate in both scope and number. Simulations and rehearsals using the end-to-end flight and ground system sufficiently involve the entire mission operations team. Tests include stress induced operational situations based upon anticipated and unanticipated contingencies and anomalies.
MOR-9	Sufficient test opportunities have been planned at the launch site both prior to and after integration with the launch vehicle. Testing includes validation of the space/ground interface. Adequate time periods have been allocated to accommodate regression testing to confirm resolution of anomalies.
MOR-10	Plans have been defined with acceptable levels of involvement from the Flight Operations Team (FOT) in key flight system activities such as Thermal-Vacuum testing and Comprehensive Performance Testing.
MOR-11	The approach for offline parameter trending has been defined. The data archival, retrieval, and reporting approach have been suitably detailed. Anomaly reporting is integrated into these plans.
MOR-12	The approach for documenting flight operations information has been acceptably defined, including contingencies, trending plans, and spacecraft and instrument operational constraints.
MOR-13	Spacecraft operations at the system- and subsystem-levels have been demonstrated to be well understood for the routine, special and contingency operations modes.
MOR-14	All ground system related risks have been fully defined, documented and regularly updated with credible triggers and mitigation strategies defined. Any active mitigations strategies are on track.
MOR-15	An updated risk assessment with suitably defined mitigation strategies is available.
System Design and Demonstration:	
MOR-1	The mission operations concept is complete and sufficiently documented. Areas not considered sufficient have well defined plans for completion and updating based on their current status.
MOR-2	Suitable approaches for mission planning and scheduling have been defined.

MOR-3	Typical finalized documentation made available include: detailed mission requirements, element-level requirements specifications, design specifications, Interface Control Documents (ICDs), mission readiness test plans, and a test requirements database.
MOR-4	Documents typically available in preliminary form include: Flight Operations Plan, Flight Procedures Document, Launch and Ascent Handbook, Mission Rules, Operations Agreements, Flight Operations Test Plan, Flight Operations Team Certification Plan, On-Orbit Handbook, and the Spacecraft User's Manual.
MOR-5	Mission operations plans are complete for all routine operational scenarios. Areas from which contingency operations requirements will arise have been identified.
MOR-6	Science data acquisition, processing and analysis approach have been defined with suitable plans for maintaining data throughput and integrity.
MOR-7	Preliminary plans for launch and early orbit (including deployment activities, in-orbit checkout, and communication coverage), routine science data acquisition (including health and safety monitoring as well as on-board data memory management), contingency, safe-mode, and end-of-life scenarios have been completed.
MOR-8	A flight and ground software maintenance plan has been defined.
MOR-9	The development approach for receipt of interim databases and operating procedures from flight system element providers has been defined.
MOR-10	Passive and active approaches for insight into flight system- and subsystem-level activities during integration have been defined.
MOR-11	The design and development of mission-unique ground system elements are sufficiently mature and have been demonstrated to be compliant with requirements. Designations of launch critical facilities and functions have been made.
MOR-12	The modifications of institutional ground system elements have been demonstrated to be compliant with mission requirements. Required modifications have been defined with implementation progressing at a satisfactory pace.
MOR-13	The facilities identified to host ground system elements and support simulations have been assessed as adequate, or if modifications are required, then necessary plans have been completely defined and suitable work schedules developed that meet time constraints.
MOR-14	Preliminary loading studies for institutional elements such as the Space Network, Ground Network and NASA Integrated Services Network (NISN) have been completed.
MOR-15	Lessons learned have been appropriately researched and adapted.
Safety & Mission Assurance:	
MOR-1	Final identification of hazards, controls, and verification methods have been appropriately documented and approved, including hazardous integration and test procedures and associated controls. Rationale for open safety issues have been provided with suitable plans for disposition.

MOR-2	Mission Assurance Requirements have been successfully implemented including Software Quality Assurance (i.e., Software Safety, Reliability and QA, Independent Verification and Validation [IV&V]). A closed-loop problem reporting and corrective action system has been implemented.
MOR-3	The following technical management documentation for the IT security as defined by NPR 2810.1, has been assessed to be at the proper level of maturity. Completion dates have been defined for necessary updates and for other documentation. ▪ IT Security Plan ▪ IT Risk Assessment Report ▪ IT Security Plan of Actions and Milestone Document (updated) ▪ Interconnection Security Agreements ▪ IT Security Self-Assessment
MOR-4	Personnel and physical security considerations have been defined and are compatible with all applicable requirements.
MOR-5	Mission Assurance Requirements have been implemented including Software Quality Assurance (i.e., IV&V). A closed-loop problem reporting and corrective action system has been implemented.
MOR-6	Flight Software (FSW) Independent Verification and Validation (IV&V) assessments are on-track with documented results being given proper consideration during the FSW development effort.
Project Management:	
MOR-1	Existing processes for managing: requirements, systems engineering, risk, configured articles, documentation, technical records, analyses, workmanship, and verification processes, have been demonstrated to be suitable for current and planned mission development activities. (KPMP)
MOR-2	Processes and metrics trends demonstrate successful tracking and controlling of cost, schedule, and technical activities suitable for remainder of the development life-cycle.
MOR-3	Adequate plans have been completed for the successful definition, development, verification, validation, and configuration management of all operations procedures.
MOR-4	The risk management system being implemented is fully compliant with, and appropriately linked to, the project risk management system.
MOR-5	Implemented organization and staffing plans have maintained clear responsibilities and suitable staff assignments. The organizational structure continues to facilitate clear and open communications (internally and externally). (KPMP)
MOR-6	The integration of flight system- and subsystem-level experts has been adequately planned to create a unified mission operations team.
MOR-7	Flight Operations Team (FOT) roles, responsibilities, staffing levels (including timing of and numbers during initial phase-in as well as for each mission phase), certification requirements, and training approach, are defined.
MOR-8	Plans for preparing the FOT for operations through the use of classroom training, mission simulations, flight rehearsals, and network exercises are fully defined.

MOR-9	The current and planned number, capability, and experience levels of the people assigned roles within the project are sufficient for the successful conclusion of the mission. (KPMP)
MOR-10	Waivers to NPR 7120.5 have been approved.
MOR-11	Development schedules have been defined for all development activities and integrated with operational activities and the top-level project schedule.
MOR-12	Resource loaded development schedules have been updated to reflect the current engineering development status and demonstrate acceptable event times as well as appropriate funded slack that are compatible with approved milestone dates.

Appendix F: Key Evaluation Factors
Systems Integration Review (SIR)

The following list consolidates evaluation factors from NASA best practices used to assess the project's achievements toward meeting the success criteria in the development of mission systems. Key evaluation factors may be tailored to suit the needs of the individual project within the Systems Review Plan (SRP) developed per GPR 8700.4, Integrated Independent Reviews.

Review Process:	
SIR-1	Planning and presentation of information at critical mission and major element milestone reviews have been rigorous; peer review results have been included in briefings; review success criteria have been met; closeout of all review actions has been timely and thorough. (KPMP)
SIR-2	The review has been conducted in accordance with the approved System Review Plan (SRP) that defines the success criteria and review process requirements as specified in the Goddard Procedural Requirement (GPR) 8700.4, Integrated Independent Reviews.
SIR-3	All RFAs written against the MCDR have been responded to by the project and closed by the responsible review panel member serving as the author or sponsor.
SIR-4	Engineering peer reviews have been conducted and documented in compliance with the requirements of GPR 8700.6. All resultant RFAs have a suitable disposition. Additional peer reviews needed have been identified and appropriately planned.
SIR-5	Recommendations and advisories from other project or external review activity that are applicable to the subject matter of the SIR have had adequate consideration.
SIR-6	Updates to the Terms of Reference (ToR) have been incorporated in accordance with NPR 7120.5 specified requirements relative to the charter of the appointed SRB.
Technical Management:	
SIR-1	Project updates of the compliance with GSFC-STD-1000 "Rules for the Design, Development, Verification, and Operation of Flight Systems" have been presented and any waivers, appropriate to the current project life-cycle phase, have been submitted and approved as necessary.
SIR-2	Configuration of the observatory has been defined and agreed to. All interfaces have been placed under configuration management or have been defined in accordance with an approved plan.
SIR-3	Plans for physical integration activities for all hardware and software elements of the system, including ground equipment are complete and approved. Test activities have been documented, including validation, calibration, and operations compatibility testing, as applicable. Plans and procedures to assess discrepancies and confirm adequate closeout precede each integration step.
SIR-4	Mechanical and electrical interfaces have been verified against the applicable interface control documentation.

SIR-5	Risk management documentation has been appropriately updated and highlighted; (a) the risks for Phase D with plans for the retirement of such risks prior to launch, and (b) the risks expected to remain post-launch (residual risks) with initial plans for the retirement of such risks post-launch.
System Design and Demonstration:	
SIR-1	All required elements and/or systems have been delivered for integration or have been scheduled for delivering sufficiently ahead of its associated integration activities.
SIR-2	Observatory integration plans and procedures have been completed and approved.
SIR-3	All applicable functional, element-level, system, subsystem, and qualification testing have been conducted successfully.
SIR-4	Integration facilities, including clean rooms, ground support equipment, handling fixtures, overhead cranes, and electrical test equipment, have been identified as ready and available.
SIR-5	As-built parts and materials lists approved.
Safety & Mission Assurance:	
SIR-1	Appropriate Safety and Mission Assurance (S&MA) interaction with the test facilities, launch range, and the launch vehicle organizations have been initiated.
SIR-2	Personnel, facility, launch site and mission safety have been given sufficient consideration with updates since the MCDR. Safety documentation has been approved as required for the initiation of integration and testing activities.
SIR-3	Handling and safety requirements have been documented and approved with identified updates properly scheduled for timely completion. Operations Hazard Analysis has been completed and approved, ensuring all hazards associated with integration are identified and controlled. Verification of safety controls has progressed sufficiently to warrant the start of integration.
SIR-4	Quality Assurance planning for all subsequent activities are complete and approved. The quality control organizations have confirmed readiness to support the integration effort.
SIR-5	All discrepancies (non-conformances, anomalies, failures, cannot duplicate's, etc.) identified prior to integration have been recorded and disposed in accordance with an approved plans. Any items requiring special attention or monitoring during subsequent activity have been identified and appropriate action is planned.
SIR-6	Contamination control plans and required equipment are in place and compliant with requirements.
SIR-7	All reliability analyses have been updated as appropriate.
SIR-8	All Electrical, Electronic and Electromechanical (EEE) parts and materials related acceptance screening Government-Industry Data Exchange Program (GIDEP) alert processing and qualification tests are successfully completed or associated risks have been properly identified.
SIR-9	All waivers generated to date have been identified and approved or expect to be approved.

SIR-10	Independent Verification and Validation (IV&V) activities, if required, have been completed.
Project Management:	
SIR-1	Waivers to NASA Procedural Requirement (NPR) 7120.5D that have been approved, requested, or are expected to be requested have been presented for review.
SIR-2	Support personnel have been adequately trained.
SIR-3	An Integrated Baseline for Phase D is available including; the project Work Breakdown Structure (WBS), resource-loaded master schedule (with critical path and schedule reserve for Phase D), and grass-roots estimate at the task and work package level (with basis of estimates).
SIR-4	Risk-based justifications have been completed for the level of cost, schedule, and scope reserves requested (where de-scope plan = scope reserves).
SIR-5	Documented evidence of the project's method of recording progress and reporting progress against the Integrated Baseline, and their method of maintaining configuration control of the Integrated Baseline have been demonstrated.

Appendix G-1: Key Evaluation Factors
Mission Pre-Environmental Review (MPER)

The following list consolidates evaluation factors from NASA best practices used to assess the project's achievements toward meeting the success criteria in the development of mission systems. Key evaluation factors may be tailored to suit the needs of the individual project within the Systems Review Plan (SRP) developed per the requirements of GPR 8700.4, Integrated Independent Reviews.

Review Process:	
MPER-1	Planning and presentation of information at critical mission and major element milestone reviews have been rigorous; peer review results have been included in briefings; review success criteria have been met; closeout of all review actions has been timely and thorough. (KPMP)
MPER-2	The review has been conducted in accordance with the approved System Review Plan (SRP) that defines the success criteria and review process requirements as specified in the Goddard Procedural Requirement (GPR) 8700.4, Integrated Independent Reviews.
MPER-3	All RFAs written against MCDR or SIR (if applicable) have been responded to by the project and closed by the responsible review panel member serving as the author or sponsor of the RFA.
MPER-4	Engineering peer reviews have been conducted and documented in compliance with the requirements of GPR 8700.6. All resultant RFAs have a suitable disposition. Additional peer reviews needed have been identified and appropriately planned.
MPER-5	All PER-specific materials, such as test plans, test cases, and procedures, have been available to all review team members prior to the conduct of the review.
MPER-6	Recommendations and advisories from other project or external review activity that are applicable to the subject matter of the PER have had adequate consideration.
Technical Management:	
MPER-1	Project updates of the compliance with GSFC-STD-1000 "Rules for the Design, Development, Verification, and Operation of Flight Systems" have been presented and any waivers, appropriate to the current project life-cycle phase, have been submitted and approved as necessary.
MPER-2	Requirements and flight/ground segment design changes since the CDR/SIR and rationale are documented, including changes to heritage items or their verification and qualification.
MPER-3	Configuration of the observatory has been defined and agreed to. All interfaces have been placed under configuration management or have been defined in accordance with an approved plan.

MPER-4	Integration activities for all hardware and software elements of the mission, including ground equipment have been well executed. Appropriate assessment of all applicable discrepancies and confirmation of adequate closeout has preceded each integration step. (KPMP)
MPER-5	As required, Interface Control Documents (ICDs) have been updated and approved. Resultant changes to the verification matrix have also been incorporated and approved.
MPER-6	Critical resource margins have been verified as adequate and are based on actual measured values.
MPER-7	Systems performance values have been demonstrated to be fully compliant with requirements.
MPER-8	Lessons learned have been appropriately researched and adapted.
MPER-9	Results of all hardware and software verification activities below the fully integrated flight system level have been successfully completed, including those associated with compatibility of units of measurement. The project verification matrix for documenting the results has been completed.
MPER-10	All development related risks are fully retired and any associated residual risks are approved. Risks associated with remaining activities have been defined and credible mitigations have been identified to retire risks or adequately reduce their criticality in a timely fashion.
MPER-11	Credible plans for the utilization of limited life items and consumables (e.g., cryogenic fluids, pyrotechnics, batteries, mechanisms) have been approved.
MPER-12	Sufficient operating time (including failure-free operating time) will be obtained. Critical parameters to be trended throughout the system test sequence are defined.
MPER-13	Ground handling and support equipment are qualified and available.
MPER-14	An approved and current Launch Vehicle Interface Control Document (ICD) is in place.
MPER-15	Launch vehicle related risk items have been retired. Residual risks have been identified, assessed, and accepted. First flight and mission unique items have been qualified for use.
MPER-16	Integrated payload/launch vehicle activity flow has been approved.
MPER-17	An updated coupled loads analysis has been completed.
MPER-18	Mission operations plans have been completed for all routine and contingency scenarios.
MPER-19	End-to-end operational simulations of flight and ground mission systems by Flight Operations Teams are planned and include launch and early orbit, routine science data acquisition, contingency, and end-of-life scenarios.
MPER-20	Transportation plans are fully defined. Shipping containers, handling equipment, environmental control and monitoring equipment are complete and available. Qualification activities are on track.

System Design and Demonstration:	
MPER-1	The objectives of the testing have been clearly defined and documented. Test contingency plans have been appropriately defined. A comprehensive environmental test sequence at appropriate exposure levels is planned that will complete all remaining pre-launch verification activities.
MPER-2	Adequate plans for systems performance testing during and between environmental exposures have been completed so as to ensure adequate functionality or uncover any deviations. Suitable testing of primary and redundant elements is planned.
MPER-3	All required test resources such as personnel (including a designated test director), facilities, test articles, test instrumentation, and other test enabling products have been identified and are available to support required tests.
MPER-4	Analyses of the current design are complete and demonstrate adequate margin for: (a) structural loads, (b) thermal effects, (c) radiation protection, and (d) expected lifetime of limited life items.
MPER-5	Results of Engineering Test Unit (ETU) testing since CDR or SIR (if applicable) are documented. The current design reflects the application of the results of this testing as warranted.
MPER-6	Life testing of limited life items has been completed and the design appropriately reflects results.
MPER-7	A fully successful Comprehensive Performance Test (CPT) of the integrated flight system has been completed. All discrepancies are fully explained and justify proceeding to subsequent activities.
MPER-8	Operations considerations have been adequately planned and implemented. A mission timeline, from launch through disposal, has been developed and defines corrective actions needed for mission events that fail to occur as planned. The fidelity of simulations is comprehensive and thorough and includes contingency and emergency actions by the operations team. (KPMP)
MPER-9	Planning for integrated systems test activities is complete and includes sufficient activity devoted to science validation and calibration, and operations compatibility testing.
MPER-10	Verification and validation activities (analysis, inspection, and test) associated with software and hardware elements at all levels of assembly have been well planned and executed. A verification matrix is utilized to track and confirm results and compliance with requirements. (KPMP)
MPER-11	Facility readiness reviews have been completed. Resultant actions are on track for timely completion. Handling equipment and test equipment are qualified and ready for use.
Safety & Mission Assurance:	
MPER-1	All discrepancies (non-conformances, anomalies, failures, cannot duplicate's, etc.) have been reviewed for acceptable closure and justify proceeding to subsequent activities. Any items requiring special attention or monitoring have been identified and appropriate action is planned.

MPER-2	Required safety documentation is complete with updates properly scheduled for timely completion.
MPER-3	Operations Hazard Analysis has been performed and approved. Hazards and control methods have been defined and approved. Verification of controls is on track. Procedures have been reviewed and approved ensuring adequate control of hazards.
MPER-4	Appropriate Safety and Mission Assurance (S&MA) interaction with the test facilities, launch range, and the launch vehicle organizations have been initiated.
MPER-5	All reliability analyses have been updated as appropriate.
MPER-6	Quality Assurance planning for all subsequent activities are complete and approved.
MPER-7	Contamination control plans and required equipment are in place and compliant with requirements.
MPER-8	All Electrical, Electronic and Electromechanical (EEE) parts and materials related acceptance screening Government-Industry Data Exchange Program (GIDEP) alert processing and qualification tests are successfully completed or associated risks have been properly identified.
MPER-9	All waivers generated to date have been identified and approved or expect to be approved.
MPER-10	Independent Verification and Validation (IV&V) activities have been completed.
Project Management:	
MPER-1	Organization and staffing plans delineate clear responsibilities and adequate assignment of current and future staff. The roles and responsibilities of all verification test activity personnel are defined and agreed to with all participants having undergone appropriate training.
MPER-2	Operations team staffing needs are fully defined. Staffing will be available to support simulations. Plans and training for future involvement of launch site and mission operations teams are defined.
MPER-3	Appropriately detailed schedules show realistic event times as well as appropriate funded slack and are compatible with approved launch dates.
MPER-4	All vehicle/payload interrelated activities schedules have been properly reviewed and approved.
MPER-5	Appropriate processes and metrics are in place to track and control cost, schedule, and technical activities throughout the remaining life-cycle.
MPER-6	Cost to complete have adequate spending profiles and reserves, and is compatible with allocations.

Appendix G-2: Key Evaluation Factors
Flight Element Pre-Environmental Review (PER)

The following list consolidates evaluation factors from NASA best practices used to assess the project's achievements toward meeting the success criteria in the development of specific flight elements including spacecraft, instruments, and other operational systems. Key evaluation factors may be tailored to suit the needs of the individual project within the Systems Review Plan (SRP) developed per the requirements of GPR 8700.4, Integrated Independent Reviews.

Review Process:	
PER-1	Planning and presentation of information at critical mission and major element milestone reviews have been rigorous; peer review results have been included in briefings; review success criteria have been met; closeout of all review actions has been timely and thorough. (KPMP)
PER-2	The review has been conducted in accordance with the approved System Review Plan (SRP) that defines the success criteria and review process requirements as specified in the Goddard Procedural Requirement (GPR) 8700.4, Integrated Independent Reviews.
PER-3	All RFAs written against the applicable CDR have been responded to by the project and closed by the responsible review panel member serving as the author or sponsor of the RFA.
PER-4	Engineering peer reviews have been conducted and documented in compliance with the requirements of GPR 8700.6. All resultant RFAs have a suitable disposition. Additional peer reviews needed have been identified and appropriately planned.
PER-5	All PER-specific materials, such as test plans, test cases, and procedures, have been available to all review team members prior to the conduct of the review.
PER-6	Recommendations and advisories from other project or external review activity that are applicable to the subject matter of the PER have had adequate consideration.
Technical Management:	
PER-1	Project updates of the compliance with GSFC-STD-1000 "Rules for the Design, Development, Verification, and Operation of Flight Systems" have been presented and any waivers, appropriate to the current project life-cycle phase, have been submitted and approved as necessary.
PER-2	Requirements and system/subsystem design changes since the applicable CDR and rationale are documented, including changes to heritage items or their verification and qualification.
PER-3	Configuration of the flight element or system has been defined and agreed to. All interfaces have been placed under configuration management or defined in accordance with an approved plan.

PER-4	Integration activities for all hardware and software subsystems and components, including ground equipment have been well executed. Appropriate assessment of all applicable discrepancies and confirmation of adequate closeout has preceded each integration step. (KPMP)
PER-5	As required, Interface Control Documents (ICDs) have been updated and approved. Resultant changes to the verification matrix have also been incorporated and approved.
PER-6	Critical resource margins have been verified as adequate and are based on actual measured values.
PER-7	System performance values have been demonstrated to be fully compliant with requirements.
PER-8	Lessons learned have been appropriately researched and adapted.
PER-9	Results of all hardware and software verification activities below the fully integrated flight system level have been successfully completed, including those associated with compatibility of units of measurement. The project verification matrix for documenting the results has been completed.
PER-10	All development related risks are fully retired and any associated residual risks are approved. Risks associated with remaining activities have been defined and credible mitigations have been identified to retire risks or adequately reduce their criticality in a timely fashion.
PER-11	Credible plans for the utilization of limited life items and consumables (e.g., cryogenic fluids, pyrotechnics, batteries, mechanisms) have been approved.
PER-12	Sufficient operating time (including failure-free operating time) will be obtained. Critical parameters to be trended throughout the system test sequence are defined.
PER-13	Ground handling and support equipment are qualified and available.
PER-14	Transportation plans are fully defined. Shipping containers, handling equipment, environmental control and monitoring equipment are complete and available. Qualification activities are on track.
System Design and Demonstration:	
PER-1	The objectives of the testing have been clearly defined and documented. Test contingency plans have been appropriately defined. A comprehensive environmental test sequence at appropriate exposure levels is planned that will complete all remaining pre-launch verification activities.
PER-2	Adequate plans for systems performance testing during and between environmental exposures have been completed so as to ensure adequate functionality or uncover any deviations. Suitable testing of primary and redundant elements is planned.
PER-3	All required test resources such as personnel (including a designated test director), facilities, test articles, test instrumentation, and other test enabling products have been identified and are available to support required tests.

PER-4	Analyses of the current design have been finalized and demonstrate adequate margins from the box and critical component level. Materials presented on the primary subsystems (e.g., electrical, power, structures, GN&C, C&DH, software, propulsion, optics, thermal, instrument sensor, etc.) are sufficiently mature and provide demonstrated evidence of an acceptable design solution.
PER-5	Results of Engineering Test Unit (ETU) testing since the applicable CDR are documented. The current design reflects the application of the results of this testing as warranted.
PER-6	Life testing of limited life items has been completed and the design appropriately reflects results.
PER-7	A fully successful Comprehensive Performance Test (CPT) of the integrated flight system has been completed. All discrepancies are fully explained and justify proceeding to subsequent activities.
PER-8	Planning for integrated systems test activities is complete and includes sufficient activity devoted to science validation and calibration, and operations compatibility testing.
PER-9	Verification and validation activities (analysis, inspection, and test) associated with software and hardware elements at all levels of assembly have been well planned and executed. A verification matrix is utilized to track and confirm results and compliance with requirements.
PER-10	Facility readiness reviews have been completed. Resultant actions are on track for timely completion. Handling equipment and test equipment are qualified and ready for use.
PER-11	Analyses of mechanical/structural loads, stress, fracture control, and torque margins have been updated since the applicable CDR as required and approved by the appropriate decision authority.
PER-12	Thermal environment analyses have been updated with proper approval since the applicable CDR, as required, including predicted thermal performance and design margin assessments.
PER-13	Flight software loads are complete. Changes since the applicable CDR have been properly identified and assessed for possible impacts.
PER-14	Software products have been demonstrated to have sufficient maturity for PER.
PER-15	Software nominal operating scenarios are fully defined including fault detection, isolation, and recovery strategies with designs sufficiently matured and properly simulated during testing.
PER-16	Software verification strategies are defined including test environments.
PER-17	Verification matrix mapping of the requirements to subsystems or Computer Software Configuration Items (CSCIs) has been implemented for the verification test activities.

Safety & Mission Assurance:	
PER-1	All discrepancies (non-conformances, anomalies, failures, cannot duplicate's, etc.) have been reviewed for acceptable closure and justify proceeding to subsequent activities. Any items requiring special attention or monitoring have been identified and appropriate action is planned.
PER-2	Required safety documentation is complete with updates properly scheduled for timely completion.
PER-3	Operations Hazard Analysis has been performed and approved. Hazards and control methods have been defined and approved. Verification of controls is on track. Procedures have been reviewed and approved ensuring adequate control of hazards.
PER-4	Safety and Mission Assurance (S&MA) interaction with the test facilities has been initiated.
PER-5	All reliability analyses have been updated as appropriate.
PER-6	Quality Assurance planning for all subsequent activities is complete and approved.
PER-7	Contamination control plans and required equipment are in place and compliant with requirements.
PER-8	All Electrical, Electronic and Electromechanical (EEE) parts and materials related acceptance screening Government-Industry Data Exchange Program (GIDEP) alert processing and qualification tests are successfully completed or associated risks have been properly identified.
PER-9	All waivers generated to date have been identified and approved or expect to be approved.
PER-10	Independent Verification and Validation (IV&V) activities have been completed.
Project Management:	
PER-1	Organization and staffing plans delineate clear responsibilities and adequate assignment of current and future staff. The roles and responsibilities of all verification test activity personnel are defined and agreed to with all participants having undergone appropriate training.
PER-2	Existing processes for managing: requirements, systems engineering, risk, configured articles, documentation, technical records, analyses, workmanship, and verification processes, have been demonstrated to be suitable for current and planned system development activities.
PER-3	Appropriately detailed schedules show realistic event times as well as appropriate funded slack and are compatible with approved launch dates.
PER-4	Appropriate processes and metrics are in place to track and control cost, schedule, and technical activities throughout the remaining life-cycle.
PER-5	Cost to complete have adequate spending profiles and reserves, and is compatible with allocations.

Appendix H: Key Evaluation Factors
Flight Operations Review (FOR)

The following list consolidates evaluation factors from NASA best practices used to assess the project's achievements toward meeting the success criteria in the development of mission systems. Key evaluation factors may be tailored to suit the needs of the individual project within the Systems Review Plan (SRP) developed per the requirements of GPR 8700.4, Integrated Independent Reviews.

Review Process:	
FOR-1	All RFAs written against the MOR and any operations related RFAs written against the Mission Pre-Environmental Review (MPER) have been responded to by the project and closed by the responsible review panel member serving as the author or sponsor of the RFA.
FOR-2	The review has been conducted in accordance with the approved System Review Plan (SRP) that defines the success criteria and review process requirements as specified in the Goddard Procedural Requirement (GPR) 8700.4, Integrated Independent Reviews.
FOR-3	Engineering peer reviews have been conducted and documented in compliance with the requirements of GPR 8700.6. All resultant RFAs have a suitable disposition. Additional peer reviews needed have been identified and appropriately planned.
FOR-4	Needed flight simulations have been identified and appropriately planned.
FOR-5	Independent assessment of flight simulations and Flight Operations Team (FOT) rehearsals have been conducted or planned.
FOR-6	Recommendations and advisories from other project or external review activity that are applicable to the subject matter of the FOR have had adequate consideration.
Technical Management:	
FOR-1	Project updates of the compliance with GSFC-STD-1000 "Rules for the Design, Development, Verification, and Operation of Flight Systems" have been presented and any waivers, appropriate to the current project life-cycle phase, have been submitted and approved as necessary.
FOR-2	The Mission Requirements Document is current and approved.
FOR-3	Mission support requirements documentation is current, including any changes since the MOR.
FOR-4	Ground system requirements, including any changes since MOR, are fully traceable to mission requirements. Verification results have been documented in the verification matrixes.
FOR-5	All constraints associated with flight and ground systems, including the spacecraft, instrument, and launch vehicle elements; account for any changes since MOR and have been fully accommodated.
FOR-6	Approaches for documenting flight operations information, including contingencies, trending plans, and all operational constraints are fully functional.

FOR-7	Element and system-level requirements specifications, design specifications, and Interface Control Documents (ICDs) are current and approved.
FOR-8	The data archival, retrieval, and reporting systems have been implemented and are operational.
FOR-9	The approaches for offline parameter trending have been implemented and are operational. Anomaly reporting of detected trends as defined is an integral part of the process.
FOR-10	The Mission Readiness Test Plan is current and approved with the Test Requirements Database being current and operational.
FOR-11	Sufficient test opportunities are planned at the launch site both prior to and after integration with the launch vehicle. Testing includes validation of the space/ground interface. Adequate periods have been allocated to accommodate regression testing which may be needed in order to confirm and document the acceptable resolution of anomalies.
FOR-12	Updated risk assessments with suitably defined mitigation strategies have been appropriately documented. All ground system related risk mitigations have been successfully executed. Residual risks are fully understood and have been accepted.
FOR-13	Lessons learned have been fully researched. All applicable lessons have been adapted.
System Design and Demonstration:	
FOR-1	Mission operations plans are complete for all operational scenarios and contingency situations.
FOR-2	Science data acquisition, processing and analysis approach is fully implemented.
FOR-3	The designs of mission-unique ground system elements have been verified to be compliant with requirements.
FOR-4	Approach for maintaining data throughput and integrity have been verified.
FOR-5	The approach to mission planning and scheduling has been successfully verified.
FOR-6	Scenarios for launch and early orbit, routine science data acquisition, contingency, safe-mode, and end-of-life have been verified. Specific activities include: deployments, in-orbit checkout, communication coverage, health and safety monitoring, and on-board data memory management.
FOR-7	All launch - critical operations procedures are current, verified, and approved.
FOR-8	The flight and ground software maintenance approach has been verified.
FOR-9	Databases and operating procedures from flight system element providers are current and have been appropriately incorporated into ground system operations.
FOR-10	The following documents are approved with current revisions as applicable: Flight Operations Plan, Flight Procedures Document, Launch and Ascent Handbook, Mission Rules, Operations Agreements, Flight Operations Test Plan, Flight Operations Team Certification Plan, On-Orbit Handbook, and the Spacecraft User's Manual.
FOR-11	The Mission Operations Concept document is current and approved.

FOR-12	The facilities needed to host ground system elements and support simulations have been verified.
FOR-13	Mission readiness testing of the integrated ground system has been successfully completed. All discrepancies are fully understood. Corrective actions have been fully implemented.
FOR-14	RF compatibility and network compatibility have been verified.
FOR-15	Launch critical facilities and functions have been verified as ready to provide the required mission support.
FOR-16	Required institutional ground system elements have been verified to be compliant with mission requirements.
FOR-17	Loading studies for institutional elements such as the Space Network, Ground Network and NASA Integrated Services Network (NISN) are complete. Results are compatible with mission needs.
FOR-18	Intra- and Inter-element tests have been successfully completed. All discrepancies are fully understood. Corrective actions have been fully implemented.
FOR-19	Validation activities with the flight system are adequate in both scope and number and have been completed using the launch-support Software (S/W) versions.
FOR-20	Adequate simulations and rehearsals using the end-to-end flight and ground system have been conducted or planned. They have involved the entire mission operations team and included stress induced operational situations based upon anticipated and unanticipated contingencies and anomalies.
Safety & Mission Assurance:	
FOR-1	All discrepancies (non-conformances, anomalies, failures, cannot duplicate's, etc.) have been reviewed for acceptable closure and justify proceeding to subsequent activities. Any items requiring special attention or monitoring have been identified and appropriate action is planned.
FOR-2	Required updates to documentation, such as the Information Technology (IT) documentation set required in NPR 2810.1, have been completed and approved.
FOR-3	Personnel and physical security considerations are complete and compatible with all applicable requirements.
FOR-4	Quality Assurance activity is defined and operational. Problem reporting databases reflect current status, including any discrepancies that occurred during verification and validation activities.
FOR-5	Open problem reports generated during verification and validation activities are being actively investigated and tracked with the disposition of closed problem reports fully understood.
FOR-6	Any required waivers resulting from verification and validation activities have been approved.
FOR-7	Independent Verification and Validation (IV&V) activities are complete.

Project Management:	
FOR-1	Flight Operations Team (FOT) roles and responsibilities, as currently defined, are documented and approved. Staffing levels meet current needs. Staffing needs for all future mission phases are defined with plans in place to secure the necessary staff in time to complete training prior to being placed in line with operations.
FOR-2	Existing processes for managing: requirements, systems engineering, risk, configured articles, documentation, technical records, analyses, workmanship, and verification processes, have been demonstrated to be suitable for current and planned mission development activities. (KPMP)
FOR-3	Flight system and subsystem-level experts have been effectively integrated into the FOT to form a unified team.
FOR-4	Certification and training on board staff is complete. Plans for certification and training of future staff are complete and approved.
FOR-5	Training of the FOT for operations through the use of classroom training, mission simulations, flight rehearsals, and network exercises has been planned unless otherwise planned as pre- or post-ship activity.

Appendix I-1: Key Evaluation Factors
Mission Pre-Shipment Review (MPSR)

The following list consolidates evaluation factors from NASA best practices used to assess the project's achievements toward meeting the success criteria in the development of mission systems. Key evaluation factors may be tailored to suit the needs of the individual project within the Systems Review Plan (SRP) developed per the requirements of GPR 8700.4, Integrated Independent Reviews.

Review Process:	
MPSR-1	Planning and presentation of information at critical mission and major element milestone reviews have been rigorous; peer review results have been included in briefings; review success criteria have been met; closeout of all review actions has been timely and thorough. (KPMP)
MPSR-2	The review has been conducted in accordance with the approved System Review Plan (SRP) that defines the success criteria and review process requirements as specified in the Goddard Procedural Requirement (GPR) 8700.4, Integrated Independent Reviews.
MPSR-3	All RFAs written against MPER have been responded to by the project and closed by the responsible review panel member serving as the author or sponsor of the RFA.
MPSR-4	Engineering peer reviews have been conducted and documented in compliance with the requirements of GPR 8700.6. All resultant RFAs have a suitable disposition.
MPSR-5	All PSR-specific materials such as updated system performance data, test verification reports, and risk assessments, have been available to review team members prior to the conduct of the review.
MPSR-6	Recommendations and advisories from other project or external review activity that are applicable to the subject matter of the MPSR have had adequate consideration.
Technical Management:	
MPSR-1	Project updates of the compliance with GSFC-STD-1000 "Rules for the Design, Development, Verification, and Operation of Flight Systems" have been presented and any waivers, appropriate to the current project life-cycle phase, have been submitted and approved as necessary.
MPSR-2	Physical and analytic integration activities for all hardware and software elements of the mission, including ground equipment and the launch vehicle, have been successfully executed. Appropriate assessment of all applicable discrepancies and confirmation of adequate closeout has preceded each integration step. (KPMP)
MPSR-3	All integrated flight system performance verification activities have been successfully completed.

MPSR-4	Verification and validation activities (analysis, inspection, and test) associated with software and hardware elements at all levels of assembly have been successfully executed. A verification matrix documents the results of such activity and the compliance with requirements. Trending analyses of key parameters have been conducted as planned with acceptable results. Total and failure-free run times of primary and redundant elements are consistent with plans. (KPMP)
MPSR-5	Launch site activity plan, including integrated activity with the launch vehicle, is approved and includes appropriate comprehensive system performance testing as well as end-to-end system compatibility testing.
MPSR-6	An updated risk assessment with suitably defined mitigation strategies is available. All ground system related risk mitigations have been successfully executed.
MPSR-7	The mission Orbital Debris Assessment has been approved by the appropriate decision authorities.
System Design and Demonstration:	
MPSR-1	Requirements and design changes to hardware or software since MPER and attendant rationale are documented. Mission implications and interface compatibility have been considered, and verification updates (analyses and tests) have been completed.
MPSR-2	Analyses of the current design have been completed and demonstrated adequate margin.
MPSR-3	Critical resource margin estimates remain adequate and have been based on measured values.
MPSR-4	Current calculations for systems performance have been updated as appropriate with system test results and continue to demonstrate full compliance with system requirements.
MPSR-5	Critical resource margin estimates remain adequate and have been based on measured values.
MPSR-6	All integrated environmental verification activities have been successfully completed.
MPSR-7	Documentation of the verification and validation results have been completed and confirms that the delivered system complies with the established acceptance criteria and is expected to perform as required in the predicted operational environment.
MPSR-8	Ground system verification activities required prior to shipment have been successfully completed.
MPSR-9	The certification package has been completed and includes an updated technical data package that includes all test results.
MPSR-10	All verification results have been documented in the verification matrix, including those associated with compatibility of units of measurement.
MPSR-11	Transportation plans are fully defined. Shipping containers, handling equipment, environmental control and monitoring equipment are verified and available.
MPSR-12	Launch site facilities are available and have been verified to meet requirements, including those for contamination control.

Safety & Mission Assurance:	
MPSR-1	All discrepancies (non-conformances, anomalies, failures, cannot duplicate's, etc.) have been reviewed for acceptable closure and justify proceeding to subsequent activities. Any items requiring special attention or monitoring have been identified and appropriate action is planned.
MPSR-2	Updates to the Failure Mode and Effects Analysis (FMEA), Fault Tree Analysis (FTA), and Probabilistic Risk Assessment (PRA), have been completed to reflect recent test results where applicable. (KPMP)
MPSR-3	All reliability analyses have been updated as appropriate based on documented test results.
MPSR-4	Safety and Mission Assurance (S&MA) plans with the launch facilities have been completed.
MPSR-5	Required safety documentation is complete with updates properly scheduled for timely completion.
MPSR-6	Hazard verifications and required safety documentation have been completed for launch site processing. Final MSPSP has been completed and approved and sent to Range for approval. A safety certification for flight readiness letter has been prepared and approved per Goddard Space Flight Center (GSFC) requirements. Procedures have been reviewed and approved ensuring adequate control of hazards.
MPSR-7	Quality Assurance planning for all subsequent activities are complete and approved.
MPSR-8	Contamination control plans and required equipment are in place and compliant with requirements.
MPSR-9	All Electrical, Electronic and Electromechanical (EEE) parts and materials related acceptance screening Government-Industry Data Exchange Program (GIDEP) alert processing and qualification tests are successfully completed or associated risks have been properly identified.
MPSR-10	All waivers generated to date have been approved.
MPSR-11	Independent Verification and Validation (IV&V) activities have been completed.
Project Management:	
MPSR-1	Organization and staffing plans delineate clear responsibilities and adequate assignment of current and future staff. The roles and responsibilities of all launch site activity personnel have been defined and agreed to with all participants having undergone appropriate training.
MPSR-2	Thorough management processes have been implemented for use at the launch site for functions such as: systems engineering, risk management, configuration management, documentation and technical record keeping, and verification process management. (KPMP)
MPSR-3	Operations team staffing is in place. Required personnel certifications have been approved.
MPSR-4	All risks have been fully retired. Residual risks, including those resulting from incomplete or uncertain closure of discrepancies, have been fully characterized and formally accepted by the appropriate decision authorities.

MPSR-5	Suitable processes and metrics are in place to track and control cost, schedule, and technical activities throughout the remaining life-cycle.
MPSR-6	Appropriately detailed schedules show realistic event times as well as appropriate funded slack and are compatible with approved launch dates.
MPSR-7	Cost to complete have adequate spending profiles and reserves, and is compatible with allocations.

Appendix I-2: Key Evaluation Factors
Flight Element Pre-Shipment Review (PSR)

The following list consolidates evaluation factors from NASA best practices used to assess the project's achievements toward meeting the success criteria in the development of specific flight elements including spacecraft, instruments, and other operational systems. Key evaluation factors may be tailored to suit the needs of the individual project within the Systems Review Plan (SRP) developed per the requirements of GPR 8700.4, Integrated Independent Reviews.

Review Process:	
PSR-1	Planning and presentation of information at related system-level reviews have been rigorous; peer review results have been included in briefings; review success criteria have been met; closeout of all review actions has been timely and thorough.
PSR-2	The review has been conducted in accordance with the approved System Review Plan (SRP) that defines the success criteria and review process requirements as specified in the Goddard Procedural Requirement (GPR) 8700.4, Integrated Independent Reviews.
PSR-3	All RFAs written against the PER have been responded to by the project and closed by the responsible review panel member serving as the author or sponsor of the RFA.
PSR-4	Engineering peer reviews have been conducted and documented in compliance with the requirements of GPR 8700.6. All resultant RFAs have a suitable disposition. Additional peer reviews needed have been identified and appropriately planned.
PSR-5	All PSR-specific materials such as updated system performance data, test verification reports, and risk assessments, have been available to review team members prior to the conduct of the review.
PSR-6	Recommendations and advisories from other project or external review activity that are applicable to the subject matter of the PSR have had adequate consideration.
Technical Management:	
PSR-1	Project updates of the compliance with GSFC-STD-1000 "Rules for the Design, Development, Verification, and Operation of Flight Systems" have been presented and any waivers, appropriate to the current project life-cycle phase, have been submitted and approved as necessary.
PSR-2	Physical and analytic integration activities for all hardware and software elements of the system, including ground equipment, have been successfully executed. Appropriate assessment of all applicable discrepancies and confirmation of adequate closeout has preceded each integration step.
PSR-3	All integrated flight system performance verification activities have been successfully completed.

PSR-4	Verification and validation activities (analysis, inspection, and test) associated with software and hardware elements at all levels of assembly have been successfully executed. A verification matrix documents the results of such activity and the compliance with requirements. Trending analyses of key parameters have been conducted as planned with acceptable results. Total and failure-free run times of primary and redundant elements are consistent with plans.
PSR-5	Post-shipment integration plans have been approved and includes appropriate comprehensive system performance testing as well as end-to-end system compatibility testing, as appropriate.
PSR-6	An updated risk assessment with suitably defined mitigation strategies is available. All ground system related risk mitigations have been successfully executed.
System Design and Demonstration:	
PSR-1	Requirements and design changes to hardware or software since PER and attendant rationale are documented. System implications and interface compatibility have been considered, and verification updates (analyses and tests) have been completed.
PSR-2	Analyses of the current design have been complete and demonstrate adequate margin.
PSR-3	Critical resource margin estimates remain adequate and have been based on measured values.
PSR-4	Current calculations for systems performance have been updated as appropriate with system test results and continue to demonstrate full compliance with system requirements.
PSR-5	Critical resource margin estimates remain adequate and have been based on measured values.
PSR-6	All integrated environmental verification activities have been successfully completed.
PSR-7	Documentation of the verification and validation results have been completed and confirms that the delivered system complies with the established acceptance criteria and is expected to perform as required in the predicted operational environment.
PSR-8	Ground system verification activities required prior to shipment have been successfully completed.
PSR-9	The certification package has been completed and includes an updated technical data package that includes all test results.
PSR-10	All verification results have been documented in the verification matrix, including those associated with compatibility of units of measurement.
PSR-11	Transportation plans are fully defined. Shipping containers, handling equipment, environmental control and monitoring equipment are verified and available.
PSR-12	Post shipment integration facilities are available and have been verified to meet requirements, including those for contamination control.

Safety & Mission Assurance:	
PSR-1	All discrepancies (non-conformances, anomalies, failures, cannot duplicate's, etc.) have been reviewed for acceptable closure and justify proceeding to subsequent activities. Any items requiring special attention or monitoring have been identified and appropriate action is planned.
PSR-2	Updates to the Failure Mode and Effects Analysis (FMEA), Fault Tree Analysis (FTA), and Probabilistic Risk Assessment (PRA), have been completed to reflect recent test results where applicable.
PSR-3	All reliability analyses have been updated as appropriate based on documented test results.
PSR-4	Safety and Mission Assurance (S&MA) plans with the integration facilities have been completed.
PSR-5	Required safety documentation is complete with updates properly scheduled for timely completion.
PSR-6	Final MSPSP has been completed and approved and sent to Range for approval. Hazard verifications and required safety documentation have been completed for post-shipment processing. Procedures have been reviewed and approved ensuring adequate control of hazards.
PSR-7	Quality Assurance planning for all subsequent activities are complete and approved.
PSR-8	Contamination control plans and required equipment are in place and compliant with requirements.
PSR-9	All Electrical, Electronic and Electromechanical (EEE) parts and materials related acceptance screening Government-Industry Data Exchange Program (GIDEP) alert processing and qualification tests are successfully completed or associated risks have been properly identified.
PSR-10	All waivers generated to date have been approved.
PSR-11	Independent Verification and Validation (IV&V) activities have been completed, as applicable.
Project Management:	
PSR-1	Organization and staffing plans delineate clear responsibilities and adequate assignment of current and future staff. The roles and responsibilities of all post-shipment integration activity personnel have been defined and agreed to with all participants having undergone appropriate training.
PSR-2	Thorough management processes have been implemented for use at the post-shipment processing site for functions such as: systems engineering, risk management, configuration management, documentation and technical record keeping, and verification process management.
PSR-3	All risks have been fully retired. Residual risks, including those resulting from incomplete or uncertain closure of discrepancies, have been fully characterized and formally accepted by the appropriate decision authorities.

PSR-4	Suitable processes and metrics are in place to track and control cost, schedule, and technical activities throughout the remaining life-cycle.
PSR-5	Appropriately detailed schedules show realistic event times as well as appropriate funded slack and are compatible with approved launch dates.
PSR-6	Cost to complete have adequate spending profiles and reserves, and is compatible with allocations.

Appendix J: Key Evaluation Factors
Operational and Mission Flight Readiness Reviews (ORR/MFRR)

The following list consolidates evaluation factors from NASA best practices used to assess the project's achievements toward meeting the success criteria in the development of mission systems. Key evaluation factors may be tailored to suit the needs of the individual project within the Systems Review Plan (SRP) developed per the requirements of GPR 8700.4, Integrated Independent Reviews.

Review Process:	
ORR-1	Planning and presentation of information at critical mission and major element milestone reviews have been rigorous; peer review results have been included in briefings; review success criteria have been met; closeout of all review actions has been timely and thorough. (KPMP)
ORR-2	The review has been conducted in accordance with the approved System Review Plan (SRP) that defines the success criteria and review process requirements as specified in the Goddard Procedural Requirement (GPR) 8700.4, Integrated Independent Reviews.
ORR-3	All RFAs written against the MPSR have been responded to by the project and closed by the responsible review panel member serving as the author or sponsor.
ORR-4	Engineering peer reviews have been conducted and documented in compliance with the requirements of GPR 8700.6. All resultant RFAs have a suitable disposition.
ORR-5	Recommendations and advisories from other project or external review activity that are applicable to the subject matter of the ORR/MFRR have had adequate consideration.
ORR-6	Updates to the Terms of Reference (ToR) have been incorporated in accordance with NPR 7120.5 specified requirements relative to the charter of the appointed SRB.
Technical Management:	
ORR-1	An operations handbook has been completed and approved.
ORR-2	Personnel training has been provided to the users and operators on the correct operational procedures for the system.
ORR-3	Operational contingency planning has been accomplished, and all personnel have been trained.
ORR-4	Certification has been received that flight operations can safely proceed with acceptable risk.
ORR-5	The system and support elements have been confirmed as properly configured and ready for flight.
ORR-6	Interface compatibilities and functions have been properly verified.
ORR-7	All operational supporting and enabling products (e.g., facilities, equipment, documents, and updated databases) that are necessary for the nominal and contingency operations have been tested and delivered/installed at the site(s) necessary to support operations.
System Design and Demonstration:	
ORR-1	The system state supports a launch "go" decision based on go/no-go criteria.

ORR-2	Flight segment all-up system development activity is complete and flight configured.
ORR-3	Readiness of mission operations system has been verified and is available for continued launch processing.
ORR-4	Mission operations plans have been completed and approved for all routine and contingency scenarios. Mission simulations of all operational scenarios, including contingency situations, have been successfully completed.
ORR-5	All flight and ground segment systems verification activities have been completed with results documented in a verification matrix, including those associated with compatibility of units of measurements.
ORR-6	Adequate end-to-end operational simulations of flight and ground mission systems have been completed by the actual operations team.
ORR-7	All validation testing has been completed.
ORR-8	Test failures and anomalies from validation testing have been resolved and the results incorporated into all supporting and enabling operational products.
ORR-9	Network compatibility demonstrations have been successfully completed.
ORR-10	Flight failures and anomalies from previously completed flights and development efforts have been resolved and the results incorporated into all supporting and enabling operational products.
ORR-11	Mission end-of-life scenarios are fully approved or have plans for approval for launch in 30 days.
Safety & Mission Assurance:	
ORR-1	All discrepancies (non-conformances, anomalies, failures, cannot duplicate's, etc.) are fully understood with corrective actions completed. Plans and preparations for any required follow-on actions are completed. All waivers have been approved.
ORR-2	Hazard verifications and required safety documentation is complete. A safety certification for flight readiness letter has been prepared and approved per Goddard Space Flight Center (GSFC) requirements.
Project Management:	
ORR-1	The project's activities to date are in compliance with applicable directives and guidance (e.g., Project Plan, Program Plan, NASA Headquarters and Center policies, etc).
ORR-2	The Integrated Baseline for Phase E development, including the project Work Breakdown Structure (WBS), resource-loaded master schedule, and grass-roots estimate at the task/work package level with basis of estimates has been completed.

Appendix K: Key Evaluation Factors
Post Launch Readiness Review (PLAR)

The following list consolidates evaluation factors from NASA best practices used to assess the project's achievements toward meeting the success criteria in the development of mission systems. Key evaluation factors may be tailored to suit the needs of the individual project within the Systems Review Plan (SRP) developed per the requirements of GPR 8700.4, Integrated Independent Reviews.

Review Process:	
PLAR-1	The review has been conducted in accordance with the approved System Review Plan (SRP) that defines the success criteria and review process requirements as specified in the Goddard Procedural Requirement (GPR) 8700.4, Integrated Independent Reviews.
PLAR-2	Recommendations and advisories from other project or external review activity that are applicable to the subject matter of the PLAR have had adequate consideration.
PLAR-3	Updates to the Terms of Reference (ToR) have been incorporated in accordance with NPR 7120.5 specified requirements relative to the charter of the appointed SRB.
Technical Management:	
PLAR-1	Significant changes to procedures, interface agreements, software, and staffing have been properly documented.
PLAR-2	Plans for future development and testing activities have been documented and approved.
System Design and Demonstration:	
PLAR-1	The launch vehicle performance assessment and mission implications, including launch sequence assessment, early propulsive maneuver results, and launch operations experiences with lessons learned, have been completed.
PLAR-2	The observed spacecraft and science instrument performance, including instrument calibration plans and status, has been suitably documented and assessed.
PLAR-3	Experiences with mission operations and the ground data system, including tracking and data acquisition support and spacecraft telemetry data analysis, have been documented and assessed.
PLAR-4	Documentation has been appropriately updated, including any updates originating from the early operations experience.
PLAR-5	Status and impacts to minimum mission requirements have been assessed as acceptable.
Safety & Mission Assurance:	
PLAR-1	In-flight anomalies and the responsive actions taken, including any autonomous fault protection actions taken by the spacecraft or any unexplained spacecraft telemetry, including alarms, have been documented.

Project Management:	
PLAR-1	The mission operations organization, including staffing, facilities, tools, and mission software (e.g., spacecraft analysis, and sequencing), has been available as needed with updates and modifications being planned and approved as specified in the existing plans.

Appendix L: Key Evaluation Factors
Critical Event Readiness Review (CERR)

The following list consolidates evaluation factors from NASA best practices used to assess the project's achievements toward meeting the success criteria in the development of mission systems. Key evaluation factors may be tailored to suit the needs of the individual project within the Systems Review Plan (SRP) developed per GPR 8700.4, Integrated Independent Reviews.

Review Process:	
CERR-1	The review has been conducted in accordance with the approved System Review Plan (SRP) that defines the success criteria and review process requirements as specified in the Goddard Procedural Requirement (GPR) 8700.4, Integrated Independent Reviews.
CERR-2	Recommendations and advisories from other project or external review activity that are applicable to the subject matter of the PLAR have had adequate consideration.
CERR-3	Updates to the Terms of Reference (ToR) have been incorporated in accordance with NPR 7120.5 specified requirements relative to the charter of the appointed SRB.
Technical Management:	
CERR-1	Critical event activity requirements and constraints have been defined and documented with an acceptable change control process in place.
CERR-2	A critical event operations plan, including planned uplinks and criticality, has been completed.
CERR-3	Operations staff has been implemented with an appropriate mix of experienced and new personnel.
CERR-4	Test plans have been reviewed for completeness and appropriateness of test environment. Plans and strategy have been assessed against lessons learned from experienced personnel.
CERR-5	Contingency and anomaly plans and procedures have been implemented with proper operations staff training and familiarization.
System Design and Demonstration:	
CERR-1	Critical event activity sequence designs, including key trades and selection rationale, have been completed.
CERR-2	Fault protection strategy updates have been defined, verified, and implemented for critical events.
CERR-3	An operations team training plan and readiness report has been completed and assessed. A spacecraft readiness report has been completed and assessed.
CERR-4	Open items and plans for disposition have been defined and risks assessed. Residual risks associated with the critical event have been appropriately assessed with rationale for acceptance.

Safety & Mission Assurance:	
CERR-1	Sequence verification (testing, walk-throughs, and peer review) and critical activity validation have been completed. The critical event simulation environment is of requisite fidelity.
Project Management:	
CERR-1	A project-wide, integrated plan and schedule for accomplishing all significant activities has been implemented. Activities are compliant with project requirements with an achievable schedule for remaining work.

Appendix M: Key Evaluation Factors
Decommissioning Review (DR)

The following list consolidates evaluation factors from NASA best practices used to assess the project's achievements toward meeting the success criteria in the development of mission systems. Key evaluation factors may be tailored to suit the needs of the individual project within the Systems Review Plan (SRP) developed per the requirements of GPR 8700.4, Integrated Independent Reviews.

Review Process:	
DR-1	The review has been conducted in accordance with the approved System Review Plan (SRP) that defines the success criteria and review process requirements as specified in the Goddard Procedural Requirement (GPR) 8700.4, Integrated Independent Reviews.
DR-2	Recommendations and advisories from other project or external review activity that are applicable to the subject matter of the DR have had adequate consideration.
DR-3	Updates to the Terms of Reference (ToR) have been incorporated in accordance with NPR 7120.5 specified requirements relative to the charter of the appointed SRB.
Technical Management:	
DR-1	A disposal plan has been developed and approved including the background for decommissioning and disposal and the associated requirements.
System Design and Demonstration:	
DR-1	Plans are in place for decommissioning, disposal, and any other removal from service activities.
DR-2	Current system capabilities and limitations are defined and understood.
DR-3	For off-nominal operations, all contributing events, conditions, and changes to the originally expected baseline are described.
DR-4	If hardware is to be recovered from orbit: a. Return site activity plans have been defined and approved. b. Required facilities are available and meet requirements, including those for contamination control, if needed. c. Transportation plans are defined and approved. Shipping containers and handling equipment, as well as contamination and environmental control and monitoring devices, are available.
Safety & Mission Assurance:	
DR-1	Safety, environmental, and any other constraints are described.
DR-2	All personnel have been properly trained for the nominal and contingency procedures.
Project Management:	
DR-1	Resources are in place to support decommissioning and disposal activities, plans for disposition of project assets, and archival of essential mission and project data.