

**This directive remains effective until
Revision C is approved.**

Glenn Procedural Requirements

GLPR 7123.36B

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COMPLIANCE IS MANDATORY

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Responsible Office: L/Research and Engineering Directorate Engineering Review Board (ERB) Procedure

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Change History

Change	Date	Description/Comments
Basic	5/14/09	New directive that describes the Engineering Review Board (ERB) process and outlines responsibilities for the entire ERB cycle, from the original request for an ERB, through final recording and archiving of the ERBs results.
A	6/28/11	Rewrite per increased experience and integration between Engineering and Space Flight Project Management using the formal Management Steering Group inspection process. Added a flow to reflect the ERB plan process and improved the interface with the Project Change Board (PCB) at the end of the process. Updated content per input from Center-wide review, removed the PCB activity at the end, and put a reference to forward the ERB recommendation to the project upon completed tasks in this process.
Change 1	4/11/12	Changed the responsible organization from DT/Chief Engineer Office to D/Engineering Directorate (on front cover). Added distribution statement on page 4.
Change 2	1/16/14	Reinserted the ERB Comment Gathering Tool in Appendix D.3
Change 3	5/13/14	Changed the responsible organization from Code D/Engineering Directorate to Code L/Research and Engineering Directorate.
Change 4	4/21/16	An extension was granted per GLW 1410.1-15 – changed the expiration date from June 28, 2016 – June 28, 2017. Updated appendices numbering in conformance with NPR 1400.1.
Change 5	5/2/2017	A second extension was granted per GLW 1410.1-19 – changed the expiration date from June 28, 2017 – June 28, 2018.
B	02/27/2019	This revision includes updates to align with the latest Agency and Center policies. The number of “shall” statements have been reduced, particularly in areas where “will” statements or expected outcomes were sufficient. Prescriptive instructions were also reduced. The compliance matrix appendix was deleted, as it was not utilized in practice. Forms in the appendices were deleted and replaced with instructions on where to obtain them.

Preface

P.1 Purpose

The purpose of this document is to establish the process and requirements at the NASA Glenn Research Center (GRC) for conducting Engineering Review Boards (ERBs).

P.2 Applicability

a. The requirements of this Glenn Procedural Requirement (GLPR) apply in all modes of program and project implementation for those deliverables for which GRC is responsible. This includes when the effort is contracted (i.e. “buy” approach), when the effort is a shared responsibility of GRC and a partner, or when the effort is implemented in an “in-house” (i.e. “make” approach) mode.

b. The term “project” in the context of this document refers to any specific investment having defined requirements. These may range from NASA Procedural Requirement (NPR) 7120.5 and NPR 7120.8 defined programs or projects to tasks managed through other NASA Centers. The term project also includes specific institutional initiatives within engineering.

c. For existing projects, the requirements of this document are applicable to the project’s current phase, as of the effective date of this GLPR, and to phases yet to be completed.

d. This GLPR may also be applied to institutional initiatives within engineering in which engineering management requires a rigorous review due to the cost, scope, or complexity of the initiative.

e. In this directive, all mandatory actions (i.e., requirements) are denoted by statements containing the term "*shall*." The terms "may" or "can" denote discretionary privilege or permission, "should" denotes a good practice and is recommended but not required, "will" denotes expected outcome, and "are/is" denotes descriptive material.

f. In this directive, all document citations are assumed to be the latest version unless otherwise noted.

P.3 Authority

NPR 7123.1, NASA Systems Engineering Processes and Requirements

P.4 Applicable Documents

a. NASA Policy Directive (NPD) 1000.0, NASA Governance and Strategic Management Handbook

b. GLP 1120.1, NASA John H. Glenn Research Center Technical Authority Implementation Plan

c. GLPR 1280.1, Glenn Research Center Quality Manual

P.5 Measurement/Verification

a. The GRC Chief Engineer Office may conduct annual assessments of projects to verify compliance with this document. Compliance will be determined by reviewing the archived artifacts required by this procedure.

b. Independent internal and external audits of this procedure may also be performed as defined in the GLPR 1280.1, Glenn Research Center Quality Manual.

P.6 Cancellation

This procedure cancels GLPR 7123.36A, Engineering Review Board (ERB) Procedure, dated June 28, 2011.

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Janet L. Watkins
Associate Director

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Chapter 1. Introduction

1.1 Rationale and Benefit

a. The NASA Glenn Research Center (GRC) uses Engineering Review Boards (ERBs) as a key process in implementing the NASA Technical Authority (TA) governance model. ERBs are used to establish technical positions, waiver/deviation approvals, or recommendations, and help ensure sufficient technical rigor with independent assessment. ERBs support full and open discussion of issues, including alternative and divergent views including a path for formal Dissenting Opinions. Diverse views are to be fostered and respected in an environment of integrity and trust with no suppression or retribution. In assessing a decision or action, a member has three choices: agree, disagree but be willing to fully support the decision, or disagree and raise a Dissenting Opinion. For disagreements that rise to the level of importance that warrant a specific review and decision by a higher level of management, the Dissenting Opinion process as described in GLP 1120.1, GRC Technical Authority Implementation Plan, may be utilized.

b. ERBs are used to formally review significant technical actions and products, to provide an in-depth systems design engineering approach to such actions and products prior to accomplishment, and to ensure consistent application of policies, guidelines, processes, standards, and requirements. There are two types of ERBs: Project ERBs that fulfill the technical assessment processes required by NPR 7123.1, NASA Systems Engineering Processes and Requirements (such as peer reviews or other technical assessments); and, Institutional ERBs, which engineering management uses to address issues outside the scope of projects. The result of an ERB can be decisional when related to Engineering TA requirements and products, or advisory when related to Programmatic Authority requirements and products. The results of an ERB covering Programmatic Authority scope is a recommendation to a project control board. Regardless of the authority source of content being reviewed, the Dissenting Opinion process is available to any individual with significant concerns regarding a decision they disagree with and are unwilling to support. Institutional ERB results are submitted as a recommendation to engineering management.

c. The benefit of this procedure is to establish a standard and repeatable institutional process with clear roles and responsibilities for forming, convening, and recording ERBs for all GRC project or engineering institutional activities. An ERB is a technical review of a specific technical problem or product, and is not intended to replace milestone reviews defined in NPR 7123.1, such as a Systems Requirement Review (SRR), Preliminary Design Review (PDR), Critical Design Review (CDR), etc.

1.1.1 Procedure Overview

Significant technical actions and products in development proceed through a sequence of stages as they advance from concept to finished product. These advances are referred to as “levels of development.” Technical reviews are done after each level of development to (1) check design maturity, (2) review technical risk, and (3) determine whether to proceed to the next level of development. ERBs can be used to facilitate and reach technical conclusions or choices needed to support milestone reviews.

1.2 Records

1.2.1 Records Management

Each project will establish and maintain a repository of project records and products accessible by project staff and associated stakeholders. Record management procedures are typically defined in a project's Configuration and Data Management (CDM) Plan. For project ERBs, the outputs of this procedure shall be maintained in the project defined CDM system. For Institutional ERBs, the outputs of this procedure shall be maintained in the corresponding organization's records.

1.2.2 Inputs

Project Systems Engineering Management Plan (SEMP) (draft or baseline) or initial project plan or engineering management direction.

1.2.3 Outputs

- a. The ERB plan.
- b. Updates to SEMP.
- c. Engineering decision or recommendation.

1.2.4 Metrics Used to Measure Process Effectiveness

- a. Metrics may be gathered for this process to indicate the effectiveness of this process, and provide direction on how the process could be improved.
- b. The Project Chief Engineer (PCE), or designee, gathers metrics and submits to the responsible office "Point of Contact" listed in the GRC Business Management System (BMS).
- c. The responsible office will use the metrics to identify areas of improvement.

Chapter 2. Roles and Responsibilities

2.1 General

The roles and responsibilities in this GLPR are described below. A key role of the ERB members is to support NASA governance as defined in NPD 1000.0, by providing technical review independent of Programmatic Authority. Technical Authorities are a key part of NASA's overall system of checks and balances and provide independent oversight of programs and projects in support of safety and mission success. Independent technical experts for the defined ERB topic are to be included on the board as determined by the ERB Chair.

2.2 Requestor/Engineer

a. The ERB Requestor/Engineer is the responsible engineer overseeing a specific project or institutional activity that identifies technical content warranting independent engineering review. The Requestor/Engineer may also be assigned by the project leadership to bring a technical topic forward for ERB review. The Requestor/Engineer prepares and presents all ERB materials for the ERB activities.

b. The responsibilities of the Requestor/Engineer include, requesting an ERB to convene, preparing the ERB technical briefing packages and presentation materials, assessing and consolidating ERB member comments prior to the ERB presentation, presenting the ERB materials and recommendations, and respond to action items from ERB.

2.3 Discipline Lead Engineer (DLE)

a. At GRC, Discipline Lead Engineers (DLEs) serve as independent subject matter experts and are delegated engineering discipline TA for specific areas. DLEs are responsible for ensuring quality discipline products by providing input to help formulate and review the ERB recommendation based on their expertise and experience.

b. DLEs may serve as board members or provide technical support during an ERB, as requested by the ERB Chair. An ERB may require multiple DLEs depending on the technical content being reviewed.

c. DLEs also serve as branch chiefs and oversee the work of engineers within their organization. The DLE of the Requestor/Engineer is responsible for reviewing the ERB materials for accuracy and completeness prior to the Requestor/Engineer submitting to the ERB Chair.

d. DLEs requested to support an ERB may delegate representation to an expert within their organization, provided the delegate is independent of the project team.

2.4 ERB Chair

a. A key responsibility of the ERB Chair is to ensure ERBs support full and open discussion of issues, including alternative and divergent views including a path for formal Dissenting Opinions. Diverse views are to be fostered and respected in an environment of integrity and trust with no suppression or retribution. The ERB Chair is the final arbiter of disagreements, decisions, or recommendations of the ERB. However, the Dissenting Opinion process is available for any individual with significant concerns that is unwilling to support a decision.

b. The PCE will serve as the ERB Chair for all ERB activities within a project. For smaller projects where no PCE has been designated, the Project Lead Engineer (PLE) will have the role of the ERB

Chair. However, TA decisional items, such as waiver/deviation approvals to TA requirements, shall be approved by a formally delegated TA (e.g. a DLE that is the branch chief of the PLE). For institutional engineering initiatives, an ERB Chair will be assigned by engineering management.

c. The responsibilities of the ERB Chair include reviewing/dispositioning project ERB requests; assessing technical content of the ERB information prior to scheduling the ERB; convening and presiding over the ERB; identifying and assigning actions required to close the ERB; identifying Dissenting Opinions; and closing the ERB and determining the final position. The ERB Chair will consider all inputs from the ERB membership by polling the board prior to making a final disposition.

d. For project ERBs, the ERB Chair represents the ERB recommendation at the Project Control Board (PCB), and also serves as the engineering representative on decisions made at the PCB. For institutional ERBs, the ERB Chair represents the ERB recommendation to engineering management.

2.5 ERB Members

a. ERB members are voting participants to a particular ERB. For projects, the board consists of two parts. A core set of permanent members and additional discipline specific members depending on the topic being addressed for a particular ERB. The minimum permanent members include the PCE (as Chair), Chief Safety and Mission Assurance (SMA) Officer (CSO), and the Lead Systems Engineer (if there is one). The PCE may define other permanent project or external members to provide consistent representation throughout the project lifecycle. The permanent membership will be specified in the ERB Plan. While a board may include project technical staff or leadership (such as the Lead Systems Engineer), the majority of the board and emphasis should be members independent of the project. Permanent members may delegate this responsibility when necessary, but only for individual ERBs, and not for the duration of the project.

b. Other ERB Members will be selected by the Chair depending on the technical discipline(s) and expertise required to effect sound engineering decisions, and to assure that all aspects of the ERB request have been considered. Other members are typically DLEs but may also include engineering leads, other technical experts or institutional representation.

c. The responsibilities of ERB members include reviewing ERB materials, identifying issues, submitting comments, attending ERB meetings, participating in recommendations and dispositions, and elevating Dissenting Opinions if necessary.

2.6 ERB Participants

Additional ERB participants can be invited to attend the ERB meetings for informational purposes or to provide supplementary information, but are not voting members of the board. See Table for a list of potential ERB participants.

Table A—Potential ERB Participants

a. Project Manager	n. Power
b. Discipline Lead Engineer (s)	o. Propulsion
c. System Engineer(s)	p. Mechanisms
d. NASA Engineering and Safety Center	q. Flight Dynamics
e. Safety and Mission Assurance	r. Thermal
f. Other Project Chief Engineers	s. Command and Data Handling
g. Manufacturing Representative	t. Software
h. Integration	u. Communication and Tracking
i. Configuration Management	v. Any additional support required from outside the Project Engineering Offices
j. Test and Verification	w. Launch Processing and Operations Engineer or alternate
k. Production and Assembly	
l. Operations (Ground and Flight)	
m. Structures	

2.7 Project Manager (PM)

The Project Manager (PM) may request an ERB for any technical area needing higher technical scrutiny, or to facilitate project decision-making on technical options. The PM may participate in the ERB presentations and should identify programmatic constraints or considerations that may influence technical decision weighting. The PM is responsible for evaluating and dispositioning ERB recommendations through the PCB or as defined in the project plan.

2.8 ERB Secretary

The ERB secretary is assigned by the ERB Chair and will administer ERB procedures and actions, and serve as recorder at ERB meetings. For simple topics or smaller projects the ERB Chair may act as the ERB Secretary. Responsibilities of the ERB secretary include coordinating and assisting with ERB logistics (see Appendix E. Engineering Review Board (ERB) Logistics Plan (Reference Only)); distributing the ERB agenda and meeting schedule; distributing the ERB package to board members prior to the ERB meeting and providing a comment gathering tool (see Appendix D. ERB Comment Gathering Tool for an example); documenting ERB attendance, roll call votes, and meeting minutes; distributing minutes to board members after approval; and ensuring ERB records are maintained in the project defined CDM system.

Chapter 3. Procedure

3.1 ERB Formulation

This procedural document provides a process flow and templates for conducting and documenting the ERB activity for specific engineering products. Formulating the ERB is guided by the program/project SEMP and this procedural document. Once the ERB is formulated, the subsequent processes can be iterated without re-formulating.

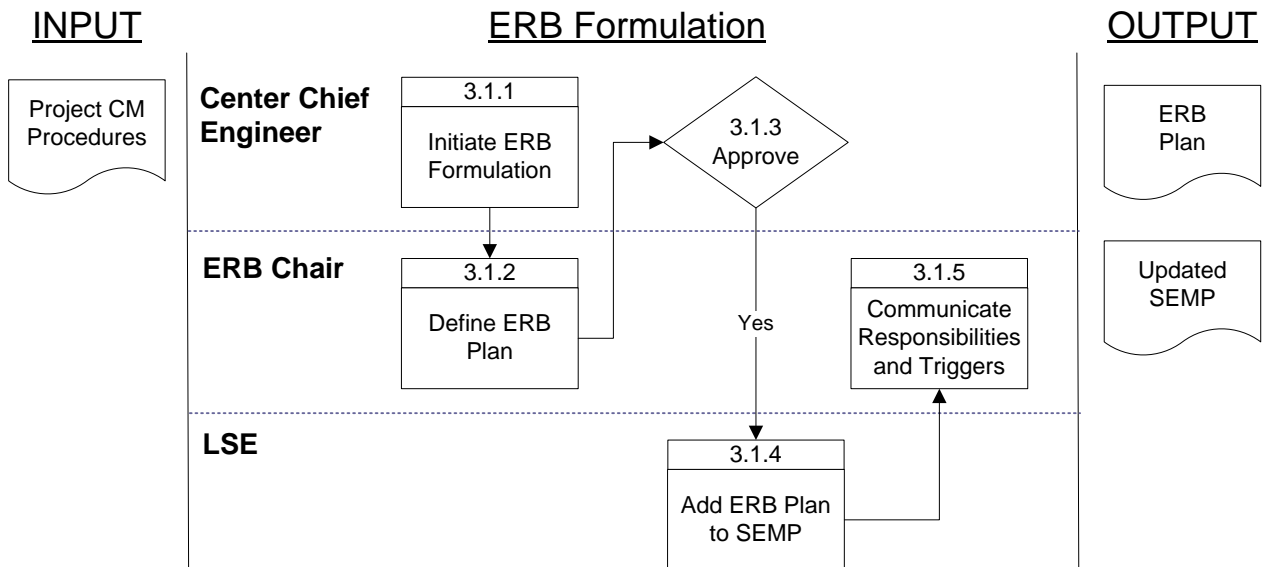


Figure 3.1 – Formulation Activities

3.1.1 Initiate ERB Formulation

- a. For each project requiring engineering support, the Center Chief Engineer (CCE) will provide the authority to charter by assigning responsibility to the appropriate PCE; this PCE is responsible for defining the plan, running the ERB per this procedure, and filling the role of the ERB Chair.
- b. For institutional ERBs, the ERB Chair will be assigned by engineering management.

3.1.2 Define ERB Plan

- a. The project ERB Chair *shall* define the ERB plan for inclusion in the project SEMP or other project records (e.g. if a project SEMP does not exist).

(1) Projects need to define the ERB plan once at the beginning of the project lifecycle, and should review it at the major project milestones (e.g. SRR, PDR, CDR, etc.).

- b. The project ERB Chair will document the following detail for the project ERB plan:

(1) Identify permanent ERB members, and describe the criteria for inviting other ERB members and participants.

(2) Document ERB ground rules and formats (agenda format, data package content, templates, etc.).

(3) Define how and when the Dissenting Opinion process as described in GLP 1120.1 is used.

(4) Describe engineering management reporting requirements and expectations (e.g., Engineering Management Board (EMB) and Safety and Mission Assurance Management Board (SMB) reporting) including standard and nonstandard reporting.

(5) Identify ERB meeting expectations for approved ERBs. This includes if regular standing ERB meetings are expected, or define the protocol to set up ad hoc meetings.

(6) Define the relationships with other organizational reviews. Other organizational reviews conducted by SMA and NASA Engineering and Safety Center could provide input to an ERB, or the disposition of the ERB could be input to the other organizational reviews. These relationships are typically documented in the technical assessment plan.

c. The project ERB Chair should include the list of minimum ERB triggers in the plan. Minimum ERB triggers should be tailored based on project size and complexity and may include items such as:

(1) Establishment of, and changes to, the project technical baseline that require PCB approval due to impacts on cost, schedule, technical risk, or performance.

(a) Requirement changes (baseline, add, modify, delete).

(b) Impact across multiple Work Breakdown Structures (e.g., system/subsystem/component design, operations, analysis cycle/trade study results, etc.).

(c) Safety impacts (redundancy, criticality, handling, etc.).

(d) Interface changes.

(2) Engineering products required to satisfy entrance/success criteria for project reviews prior to the work product moving into a milestone review or approval cycle.

(a) Controlled documents only.

(b) Not required for draft and preliminary documents.

(3) Deviations and waivers to requirements/standards.

(4) SEMP and Technical Review Plans.

(5) Proposals for new work.

(6) Additionally, chief engineers can convene an ERB on other topics at their discretion.

d. For Institutional ERBs, the ERB Chair will define and document (as required) the ERB plan in conjunction with engineering management.

3.1.3 Approve

The CCE will review the ERB plan for completeness and consistency and approve the plan or return to the ERB Chair with recommended modifications. This can be done informally or as requested by the CCE.

3.1.4 Add ERB Plan to Project SEMP or Other Records

a. For project ERBs, the LSE will add the defined ERB plan to the project SEMP or other project records.

b. Some projects may perform ERBs in the early stages of the project lifecycle prior to having the SEMP. In these cases, the ERB plan is provided to the project to be included in the project records.

3.1.5 Communicate Responsibilities and Triggers

- The ERB Chair should communicate the ERB plan to the project core team members and describe what triggers an ERB.
- The ERB Chair should provide a copy of the ERB plan, when requested, to establish a common understanding of how ERBs are identified, managed, and closed.

3.2 Request and Perform ERB

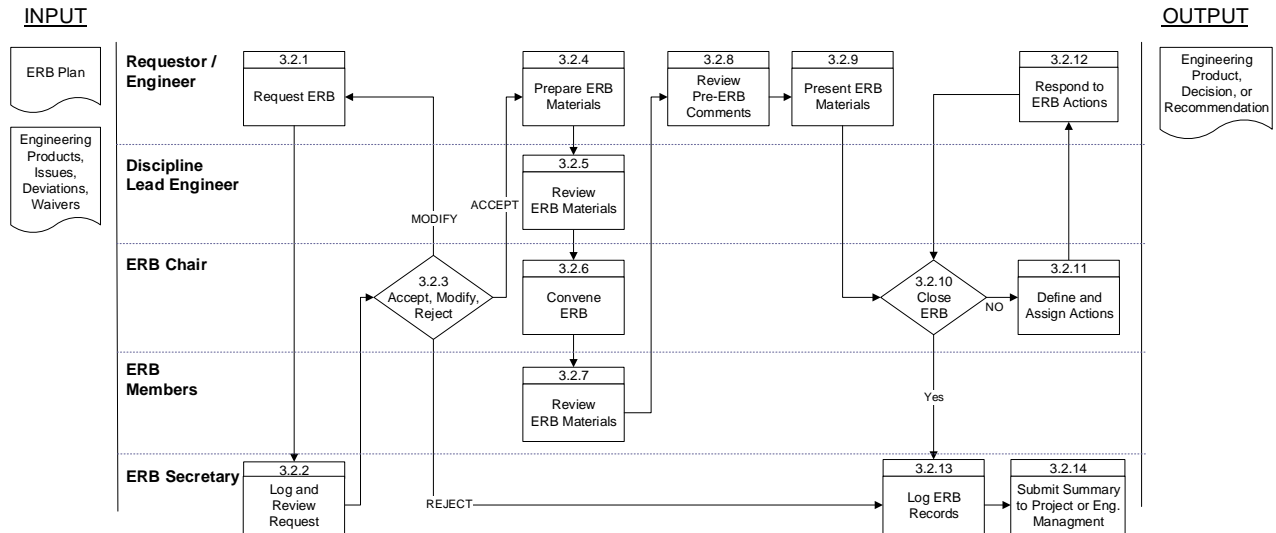


Figure 3.2 – Request and Perform Activities

3.2.1 Request ERB

- The Requestor/Engineer will request an ERB using the designated ERB Request Form (see Appendix C, ERB Forms).
- The Requestor/Engineer should clearly define the goal and scope of the ERB in the, “Reason for ERB,” section of the request form.
- Use the list of minimum ERB triggers documented in the ERB plan. If the requested ERB does not fit into one of these triggers, additional justification may be required.
- The completed ERB request is submitted to the ERB Secretary.

3.2.2 Review and Log ERB Request

- The ERB Secretary will log all project ERB requests into the designated system, and assign an ERB number in sequence (not applicable to institutional ERBs).
- The ERB Secretary will determine the project task number, if applicable. This task number should correspond to the project Integrated Master Schedule task number or other project WBS used to control the project (not applicable to institutional ERBs).
- The ERB Secretary will review the ERB request form for correctness and completeness prior to submitting to the ERB Chair for review.

3.2.3 Review ERB Request

- a. The Chair reviews the ERB request for technical merit and either accepts, accepts with modification, or rejects the request.
- b. If the Chair accepts with modification, the Chair may update the request to include the modifications, or return the request to the Requestor/Engineer for updating prior to signing the request.
- c. If the Chair rejects the request, the Chair will provide rationale for the disposition.
- d. The Chair will sign the ERB request and submit it to the ERB Secretary for further processing and/or records management.
- e. If the Requestor/Engineer disagrees with the decision a Dissenting Opinion may be elevated or the Requestor/Engineer's DLE may elevate a Dissenting Opinion as defined in GLP 1120.1.

3.2.4 Prepare ERB Material

- a. The Requestor/Engineer gathers all necessary artifacts and exhibits.
- b. The Requestor/Engineer or the ERB secretary will initiate the ERB summary form (see Appendix C, ERB Forms).
- c. The Requestor/Engineer creates a presentation in which the format must:
 - (1) Define the problem.
 - (2) Discuss the evaluation method and results.
 - (3) Objectively identify a range of potential solutions along with cost, schedule, and risk impact data for each solution.
 - (4) Provide recommendations along with any associated risk which should be considered for adoption into the project risk matrix.

3.2.5 Review ERB Materials

The DLE of the Requestor/Engineer should review the ERB materials for quality and completeness prior to the ERB Chair scheduling and convening the ERB. If the materials are judged ready by the DLE, the engineer will inform the ERB Chair that the ERB can be convened, and provide review materials for distribution.

3.2.6 Convene ERB

- a. The Requestor/Engineer will coordinate with the ERB Chair and ERB Secretary to determine a date that provides sufficient time for ERB members to review the material before the meeting.
- b. If the ERB is of low complexity or time sensitive in nature, the Chair may coordinate with the PM to perform the ERB concurrently with a PCB. A joint ERB/PCB requires participation of both board's members with votes polled and recorded according to each boards plan or charter.
- c. The ERB Chair will:
 - (1) Schedule the ERB (date and place).
 - (2) Define ERB members required to support the ERB as well as any other participants.
 - (3) Publish and distribute the agenda.

- (4) Determine a deadline for board member review comments to be submitted.
 - (5) For project ERBs, the PM is notified of the review and may attend or send a representative. For institutional ERBs, engineering management is notified of the review.
- d. The ERB Secretary will support the Chair in coordinating logistics and distributing materials. Appendix E, ERB Logistic Planning Guide, is provided to assist the ERB Secretary and ERB requestor in planning and running the ERB session.

3.2.7 Review ERB Materials

- a. The ERB secretary will distribute the ERB meeting notification/schedule/agenda, ERB review materials, and comment gathering tool to the ERB members (noting the deadline for comment submission).
- b. The ERB participants will review the ERB materials, and provide comments to the ERB Secretary prior to the deadline.
- c. The ERB Secretary will submit comments to the ERB Chair and Requestor/Engineer.

3.2.8 Review ERB Comments

- a. The Requestor/Engineer should review and organize comments received from the ERB members to improve the efficiency of the ERB. Comments should be grouped into similar topics or themes.
- b. The Requestor/Engineer should disposition all comments and obtain concurrence/reclama, as appropriate.
- c. The Requestor/Engineer should summarize the comments, and prepare the ERB presentation materials accordingly.

3.2.9 Present ERB Materials

- a. The Requestor/Engineer presents the ERB materials.
- b. During the ERB presentation, the Requestor/Engineer will address the comments that were identified during the ERB review.
- c. During the session the ERB secretary will:
 - (1) Record meeting notes.
 - (2) Document all action items including owners and due dates.
 - (3) Create a “parking lot” of unanswered questions and review them at the end of the session.
 - (4) Capture and record any candidate project risks that result from the decision made.
 - (5) Record all Dissenting Opinions, voiced or written.

3.2.10 Close ERB

- a. The ERB Chair will consider all inputs from the ERB members and participants prior to making a final disposition. Prior to closure the Chair will:
 - (1) Review the list of actions and determine if any require closure prior to closing the ERB or if the actions are acceptable to be processed as forward work. The Chair will identify action owners and due dates.

(2) Review any agreed modifications to the Requestor/Engineer's recommended action that were identified during the presentation.

b. The Chair will poll the ERB members for concurrence with the proposed recommendation (including any agreed modifications recorded above). In making decisions, board members have three choices: agree, disagree but be willing to fully support the decision, or disagree and raise a Dissenting Opinion. During polling members will indicate concurrence, or non-concurrence with rationale. If a board member non-concurs they will indicate if they are willing to fully support the decision if it is approved.

c. The final decision on ERB recommendations and/or decisions are made by the ERB Chair.

d. After issuing a final decision, the ERB chair will request if any member or participant wants to elevate a Dissenting Opinion. Dissenting Opinions *shall* be recorded as part of the formal ERB records and reported to the EMB and/or SMB. Dissenting opinions will be documented in the ERB minutes and/or ERB summary form (Appendix C).

e. The Chair will solicit identification of any new candidate risks associated with the ERB.

f. If the ERB Chair closes the ERB, the ERB Chair *shall* complete and approve the ERB summary form (Appendix C), and submit the recommendation to the ERB Secretary for recording in the project CDM system or submission to engineering management.

g. If the ERB Chair does not close the ERB, the ERB minutes will record the rationale for the ERB remaining open, and identify which actions must be completed in order to either close the ERB, or reconvene the ERB for closure.

3.2.11 Actions are Defined and Assigned

a. The ERB Chair will define issues and actions required to close the ERB or to be processed as forward work.

b. The ERB Chair will assign the defined actions to the appropriate engineer.

c. The ERB secretary records all actions, assigned owners, and due dates for each action.

3.2.12 Evaluate Responses to Actions

The Requestor/Engineer or action assignee will submit responses to ERB actions to the ERB Chair for review by the date agreed to during the ERB. The ERB Chair can approve the responses, or request another ERB to review the responses.

3.2.13 Log ERB Records

a. The ERB Secretary *shall* submit the ERB recommendation, ERB presentation materials, and Chair approved ERB Summary form for logging in the project CDM system.

b. For Institutional ERBs, the ERB recommendation will be forwarded to engineering management.

3.2.14 Submit ERB Results for Project or Engineering Management Consideration

a. The ERB results are submitted to the PM for evaluation and disposition, typically via the PCB or as defined in the project plan. Regardless of the authority source of content being reviewed, the Dissenting Opinion process is available to any individual with significant concerns regarding a decision they disagree with and are unwilling to support.

- b. The PM may request additional supporting material needed to make a project decision, such as assessment of cost impacts, schedule, technical requirements, risk, etc.
- c. For institutional ERBs, recommendations will be presented to engineering management for review and implementation.

Chapter 4. Process Tailoring and Process Improvement

4.1 General

- a. Tailoring of this process may be performed based on size, cost, risk, complexity, or other factors of the project under consideration. For instance, the Engineering TA of a low cost NPR 7120.5 Class-D project may streamline application of this GLPR and use it as guidance with specific application determined by the PCE on an as needed basis. The tailored approach of this GLPR *shall* be specified in the project SEMP and approved by the delegated Engineering TA. If a stand-alone SEMP is not generated for the project, the tailored ERB approach may be included in alternate project records, provided the Engineering TA approval is formally recorded (e.g. including tailoring a consolidated Project Plan/SEMP to which the Engineering TA is an approver signatory).
- b. All users of this GLPR should assess the activities and resulting products to determine if any improvements are warranted. Process improvement suggestions should be forwarded to the BMS point of contact for this GLPR for consideration in future updates. Project lessons learned sessions or other knowledge capture activities may also be used to identify improvements to this process.

Appendix A. Definitions

Discipline Lead Engineer (DLE). The DLE is the subject matter expert, in a specific discipline or related discipline, who executes the Technical Authority with respect to those discipline principles that are applied to any specific program or project.

Engineering Management Board (EMB). Chaired by the Director of Research and Engineering, the purpose of this board is to resolve engineering and technical issues that fall under the responsibility of the Research and Engineering Directorate including, but not limited to, those issues related to implementation of the Center's Space Flight Projects, Aeronautics Projects, and Engineering Technical Authority. See the GRC BMS for the official charter.

Milestone Review. These reviews are defined in NPR7123.1 (e.g. SRR, PDR, CDR, etc.) and are conducted to provide an overall assessment of the development progress of the entire system, evaluate risks and risk handling measures, and verify completion of milestone events and activities.

Peer Review. This is an independent evaluation by internal or external subject matter experts who do not have a vested interest in the work product under review. Peer reviews can be planned, focused reviews conducted on selected work products by the producer's peers to identify defects and issues prior to that work product moving into a milestone review or approval cycle.

Project Chief Engineer (PCE). The PCE is the subject matter expert in a specific system or related family of systems. The PCE executes the technical authority for the assigned program, project, or element at the Center. The PCE will serve as the single point of contact for the execution of the technical authority process.

Project Lead Engineer (PLE). At GRC, the title of PLE might be substituted for PCE within lower level projects, or elements that are considered of significance enough to require a designated lower level equivalent of the PCE. Organizationally, PCEs will be part of the GRC Chief Engineers Office, whereas PLE, as well as DLEs, will reside in their home organization.

Responsible Engineer. The responsible engineer is responsible for requesting, planning, and facilitating the ERB. This Engineer is responsible for the technical design and the technical findings and recommendations. They can be from any discipline within the GRC Research and Engineering Directorate responsible for technical designs required to satisfy requirements defined by programs/projects.

Safety and Mission Assurance Management Board (SMB). Chaired by the Director of Safety and Mission Assurance, the purpose of this board is for ensuring sound Safety and Mission Assurance and Occupational Health practices, standards, policies, and procedures are implemented for GRC programs and projects, and for assuring safe operations and a healthy work environment. The SMB is responsible for facilitating resolution of issues, including, but not limited to, implementing and overseeing SMA Technical Authority. See the GRC BMS for the official charter.

Significant Technical Actions and Products. Examples of significant technical actions and products include: Requirements documents, trade study reports, significant studies position papers, architecture definition that affect other subsystems, and/or design review packages.

Technical Assessment. An approach and means to measure progress against plans and technical requirements, as well as satisfaction or criteria for entering or exiting a major technical event within a system life cycle phase.

Technical Assessment Process. One of the systems engineering technical management processes; the technical assessment process measures technical progress and the effectiveness of various technical plans and requirements, and monitors progress against those plans.

Technical Authority (TA). Part of NASA's system of checks and balances that provides independent oversight of programs and projects in support of safety and mission success through the selection of individuals at delegated levels of authority. These individuals are the Technical Authorities. Technical Authority delegations are formal and traceable to the Administrator. Technical Authorities are responsible for controlling technical requirements and approving any deviations, waivers, or changes from such requirements at the level commensurate with their authority.

Technical Authority (TA) Requirements. A subset of institutional requirements invoked by the Office of Chief Engineer, Office of Safety and Mission Assurance, and Office of the Chief Health and Medical Officer documents (e.g., NPRs or technical standards cited as program or project requirements) or contained in Center institutional documents. These requirements are the responsibility of the office or organization that established the requirement unless delegated elsewhere.

Technical Baseline. A specification or product that has been formally reviewed and agreed upon, that thereafter serves as the basis for further development, and that can be changed only through formal change control procedures. Any document or a set of such documents that has been formally designated and fixed at a specific time during the life cycle of a configuration item. Any agreement or result designated and fixed at a given time, from which changes require justification and approval.

Technical Review. A technical review is an event at which the progress of the technical effort is assessed relative to its governing plans and technical requirements. Technical reviews are key decision events used to measure technical progress and maturity in system development, as well as to assess various programmatic issues. As such, they are an important oversight tool and are used to review and evaluate the state of the system and the program, redirecting activity after the review, if found necessary.

Appendix B. Acronyms

BMS	Business Management System
CCE	Center Chief Engineer
CDM	Configuration and Data Management
CDR	Critical Design Review
CM	Configuration Management
CSO	Chief Safety and Mission Assurance Officer
DLE	Discipline Lead Engineer
EMB	Engineering Management Board
ERB	Engineering Review Board
GLP	Glenn Procedure
GLPR	Glenn Procedural Requirement
GRC	Glenn Research Center
LSE	Lead Systems Engineer
NPD	NASA Policy Directive
NPR	NASA Procedural Requirement
PCB	Project Control Board
PCE	Project Chief Engineer
PDR	Preliminary Design Review
PLE	Project Lead Engineer
PM	Project Manager
SEMP	Systems Engineering Management Plan
SMA	Safety and Mission Assurance
SMB	Safety and Mission Assurance Management Board
SRR	Systems Requirement Review
TA	Technical Authority
WBS	Work Breakdown Schedule

Appendix C. Engineering Review Board Forms

C.1 GRC ERB Request and Summary forms, GRC2012 and GRC2013, will be maintained by the GRC Chief Engineer Office and updated on an as needed basis.

C.2 These forms are available on the NASA Electronic Forms site at <https://nef.nasa.gov/> by entering the form number in the search box.

C.3 Project Chief Engineers may tailor these forms to suit project needs, provided the equivalent minimum information on the original form is included in the project tailored form. If tailored, the forms should be given a project unique number, annotated that they were derived from the standard form, and maintained by the Project.

Appendix D. ERB Comment Gathering Tool

The ERB Comment Gathering tool should be created using a simple Microsoft Excel spreadsheet with these following columns. This spreadsheet can be distributed to the reviewers prior to the ERB and consolidated by the responsible engineer or ERB chair prior to the ERB.

Example of an Engineering Review Board (ERB) Comment Gathering tool.

Document Number		Document Title		Date Review Opened		Expected Close Date					
Evaluator Information										Author Disposition	
Comment Number	Evaluator's Name	Evaluator's Organization	Page / Section	Requirement Number	Comment Type	Severity	From Text	To text (or Finding)	Rationale	Comment Disposition	Disposition Comments
<i>Sequential Number</i>		<i>e.g., DT, DPS, MIO, etc</i>	<i>e.g., P.12 and/or Section 3.1.2.b</i>	<i>If applicable</i>	<i>- Wrong - Missing - Extra - Typo - Grammar - Question</i>	<i>- Major - Minor - Editorial</i>	<i>Para phrase the text being challenged</i>	<i>Add recommended text changes</i>	<i>Describe the reason for the change</i>	<i>- Accept - Accept with Mod - Duplicate/Combine - Reject - Withdrawl - Open</i>	<i>Author to provide insight why the comment was dispositioned th way it was</i>
1											
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Appendix E. Engineering Review Board (ERB) Logistics Plan (Reference Only)

ERB Logistics Planning Guide	ERB No.: <i>ERB-YY-num</i>
Reference Guide Only	Task No.:

Initiator to complete this section

ERB Title:
ERB Presenter:
<input type="checkbox"/> Request submitted and approved <input type="checkbox"/> ERB scheduled <input type="checkbox"/> Participants identified and notified <input type="checkbox"/> Meeting facilities identified and scheduled <input type="checkbox"/> Identify meeting scribe, usually the ERB secretary <input type="checkbox"/> Necessary presentation equipment identified and reserved <input type="checkbox"/> Whiteboards, easels, markers, post-it notes, <input type="checkbox"/> Proximity to other necessary resources/facilities <input type="checkbox"/> Refreshments orders, if applicable <input type="checkbox"/> ERB package defined and presentation created; format must: Define the problem, discuss the evaluation method and results, identify the solutions and provide recommendations including cost and schedule impact data. <input type="checkbox"/> Artifacts created and copies made <input type="checkbox"/> Summary sheet created