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ASSESSMENT OF THE NASA FLIGHT ASSURANCE REVIEW PROGRAM

August 1983

Prepared for
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546
under Contract NASW-3787

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TECHNICAL REPORT

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by

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ABSTRACT

ARINC Research Corporation conducted a three-month assessment of the National Aeronautics and Space Administration (NASA) Flight Assurance Review Program to develop minimum standard guidelines for flight assurance reviews. We evaluated more than 70 documents from eight NASA centers and NASA Headquarters to determine current design review practices and procedures. On the basis of that analysis, we identified six reviews as being the recommended minimum. We analyzed and synthesized the practices and procedures used at the different centers to incorporate the most effective ones into the minimum standard review guidelines. We defined guidelines in terms of procedures, personnel and responsibilities, review items/data checklist, and feedback and closeout.

This report presents the results of our assessment. It identifies and describes the six reviews recommended and presents the minimum standard guidelines developed for flight assurance reviews. It also presents observations and conclusions for further improving the NASA review and quality assurance process.

SUMMARY

Under Contract NASW-3787, ARINC Research Corporation conducted an assessment of the National Aeronautics and Space Administration (NASA) Flight Assurance Review Program to develop minimum standard guidelines for flight assurance reviews. We identified six reviews as being the recommended minimum, and analyzed and synthesized the practices and procedures used at the different NASA centers to be incorporated into the review guidelines.

To conduct the assessment, we performed four tasks:

- Task 1 - Collect and Analyze Data from Centers
- Task 2 - Develop a Matrix of Flight Review and Certification Practices
- Task 3 - Select the Best Practices
- Task 4 - Develop Guidelines for NASA-Wide Practices

During our assessment, we identified the following six reviews as being the recommended minimum for the Flight Assurance Review Program:

- Preliminary Requirements Review
- Preliminary Design Review
- Critical Design Review
- Preshipment Review
- Design Certification Review
- Flight Readiness Review

We defined the minimum standard guidelines for the NASA Flight Assurance Review Program in terms of the following items:

Procedures

The method of convening the Review Board or Team, the selection of the Board or Team members, and a general description of the activities of the Board or Team.

Personnel and Responsibilities

Because titles vary from center to center, personnel are described in terms of management level and technical competence rather than by title. Responsibilities of persons and groups of persons (such as Review Board or Team members) are related to the Review Board or Team component (i.e., cognizant manager, chairman, etc.).

Review Items/Data Checklist

A compilation of matters to be considered by the Review Board or Team for each of the six reviews.

Feedback and Closeout

A process that begins with the identification of a problem or concern and continues through the disposition of all action items, in keeping with the basic objective of providing assurance to NASA management that the requirements of a program or project are satisfied.

The minimum standard review guidelines were developed from a synthesis of the practices and procedures of the NASA centers so that they can be applied to as many projects and programs as possible. Three of the preceding items (procedures, personnel and responsibilities, and feedback and closeout) are common to all Review Board or Team reviews; the review item data checklist is unique to each of the six reviews.

As a result of our assessment, ARINC Research made the following observations:

- The NASA centers conduct many different reviews to ensure the quality and safety of end items.
- The practices and procedures used in conducting reviews follow similar patterns.
- The terminology used varies somewhat from center to center.
- The detailed documented descriptions of review practices and procedures vary greatly from center to center. Personnel must rely on referenced documents to provide the detail lacking in some of the documents supplied for this study.

- Documents from individual centers do not always clearly describe an in-depth review process; it was often necessary to refer to a number of documents to obtain confidence that the review process has the necessary depth and includes all of the necessary elements.

- Few of the documents supplied indicate an in-depth feedback and closeout process.

- Some of the documents do not describe procedures of the Review Board or Team or a review item/data checklist.

- There was little documentation supplied describing the decision process for determining payload classifications (A, B, C, or D), or for determining the differences in the reviews for each classified payload.

- Most reviews are conducted by the persons directly associated with the end item under review.

- The Review Board chairman is generally directly associated with the program or project under review.

- The review descriptions do not indicate how upper-level Review Boards or management are advised of action-item closeouts, leading to the assumption that a closeout stops at the level at which it was approved.

- The review descriptions do not indicate a process for moving open action items to a higher-level review.

- The review practices and procedures of the Department of Defense (DoD) and the Federal Aviation Administration (FAA) do not offer significant areas of improvement to NASA.

On the basis of these observations, we reached the following conclusions:

- A standard format for review practices and procedures, including standard terminology, should be used by all centers.

- A procedure should be devised and implemented for advising a central office at Headquarters of improvements to the standard review practices and procedures so that all centers can be kept fully informed.

- Minimum standard review guidelines promulgated by a central office at Headquarters should be structured in a manner that allows each center flexibility in interpreting the standards to meet diverse mission requirements.

- A procedure should be devised and implemented for advising a central office at Headquarters of changed review practices and procedures to meet specific mission requirements.

- The chairman of the Review Board or Team should be selected first for management ability and second for technical competence; the chairman should not be directly associated with the program or project under review.

- The number of persons on the Review Board or Team (including the chairman) should be an odd number, and should be the minimum number necessary to satisfy technical requirements of the program or project under review. The majority of the members should be persons not directly associated with the program or project under review.

- Members of Review Board or Team should be selected for their technical competence and ability to communicate effectively.

- An approval process should be developed for all changes made under the standard flight-critical change program. Approval by a minimum of two persons should be required for changes of the lowest classification, and approval of a formal review board should be required for changes of the highest level of criticality.

- Each review should begin with a summary of action items from the previous review together with a short statement of the current disposition of each action item.

- A specific standard procedure should be developed to evaluate the qualification of components, subassemblies, or assemblies on the basis of previous applications or similarity to another component, subassembly, or assembly.

- The history of similar systems, components, subassemblies, or assemblies should be reviewed at the PDR or CDR so as to identify areas of needed concentrated analysis or review to take advantage of data regarding previous failures or problem areas.

- When a design change is approved, it may be necessary to review all subsequent changes related to the approved change or made to accommodate the approved change.

- One-person reviews or change approval should be avoided.

- Standard procedures and methods should be developed for reviewing and certifying software. The procedures should include criteria for identifying the requirements for recertification of software based on either hardware or software changes.

- The minimum standard review guidelines presented in this report should be considered for implementation as a NASA management instruction.

- The minimum standard review guidelines presented in this report should be used as working papers to solicit comments from all centers before the guidelines are officially published. A number of iterations may be necessary to consolidate and coordinate comments from the centers into the final document.

- An independent third party review may be required for Class A payloads if the Review Board guidelines do not provide the required freedom of action which should be expected when the chairman and over half of the Review Board are not associated with the project under review.

ARINC Research Corporation recommends that the conclusions detailed above be considered in the implementation of the minimum standard guidelines for the NASA Flight Assurance Program.

CONTENTS

CONTENTS
(continued)

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

One of the functions of the Office of the Chief Engineer of the National Aeronautics and Space Administration (NASA) is to provide integrated technical and management focus on policies throughout NASA concerning design certification reviews of all NASA programs. To fulfill this function, the Office began to collect information from the individual NASA centers describing the design review processes used. A preliminary analysis of the collected information showed that each center has established its own practices and procedures for design reviews. Different reviews are conducted at different centers and, where there are similar reviews at two or more centers, different implementation practices are used. Because of these differences, it was determined that a more detailed study of the information supplied was required. ARINC Research Corporation was contracted to conduct an assessment of the practices and procedures used at the different centers, select the most effective ones, synthesize them into a set of standard review processes, and develop recommended guidelines for their implementation.

1.2 OBJECTIVES

The primary objective of the effort was to develop guidelines for minimum standard review procedures applicable across all NASA activities. The primary objective was to be obtained through completion of two interim objectives:

- Evaluate the existing critical flight program review practices and procedures followed by the various NASA centers.

- Select the most effective practices and procedures used in each step of the review process.

1.3 DESCRIPTION OF TASKS

The Statement of Work set forth four tasks for the study. They are described in the following subsections.

1.3.1 Task 1 - Collect and Analyze Data from Centers

The Office of the Chief Engineer supplied documents from the various NASA centers showing current review procedures. The objective of Task 1 was to analyze the procedures to determine practices followed, data used in each review, feedback processes, and the nature of the action item review process.

Each review process was to be charted to compare the various steps and decision paths followed at each center, and the charts were to be reviewed with the cognizant NASA technical monitor. In addition, a glossary of terms used by the different centers was to be compiled to provide a basis for establishing common definitions for the practices to be followed.

1.3.2 Task 2 - Develop a Matrix of Flight Review and Certification Practices

The information from Task 1 was to be used to develop matrices for the various center reviews showing all of the steps followed, including personnel involved; review items/data and analysis required; referenced NASA standards, instructions, bulletins, or other documents; and any decisions made and possible outcomes. Upon completion of Task 2, a letter report was to be prepared documenting the current practices.

1.3.3 Task 3 - Select the Best Practices

Following development of the matrices, the most effective practices were to be reviewed with NASA and selected in three steps, as follows:

- Define the steps in the review and design certification process to be recommended.
- Review the matrices to select the best practices applicable.
- Develop a new matrix for the standard process.

1.3.4 Task 4 - Develop Guidelines for NASA-Wide Practices

The results of Task 3 were to be expanded into practices applicable throughout NASA for conducting flight assurance reviews. The expanded review practices were then to be documented as minimum standard review guidelines, defined in terms of:

- Procedures
- Personnel and responsibilities
- Review items/data checklist
- Feedback and closeout

In addition, any requirements for new instructions, directives, or quality assurance guidelines were to be identified.

1.4 ORGANIZATION OF THE REPORT

Chapter Two of this report presents the study approach, describing the analysis of the current review practices and procedures and the process by which the minimum standard review guidelines were developed. Chapter Three presents the minimum standard guidelines for flight assurance reviews. Chapter Four presents the observations and conclusions resulting from this study. Appendix A is a glossary of terms; Appendix B lists the documents reviewed; Appendix C lists other documents referenced by the documents reviewed; Appendix D presents descriptions of current review practices; and Appendix E presents a discussion of the applicability of the minimum standard guidelines to payload classifications A, B, C, and D.

CHAPTER TWO

ASSESSMENT APPROACH

2.1 INTRODUCTION

For our review of current review practices and procedures, the NASA Office of the Chief Engineer supplied more than 70 documents from eight centers and NASA Headquarters. A list of those documents is presented as Appendix B to this report. In general, all the centers described similar reviews such as the Preliminary Design Review (PDR) and the Critical Design Review (CDR), but the detailed descriptions of the practices and procedures varied greatly from center to center. The differences are probably not as great as they appear, however, because many of the documents reference other documents (not supplied) that may include additional procedural details. The documents reviewed provided us with sufficient data to develop guidelines for agency-wide reviews.

2.2 ANALYSIS OF CURRENT PRACTICES AND PROCEDURES

We analyzed the supplied documents in four steps.

We first read each document and developed an annotated flow chart for each review described. Figure 2-1 is a sample flow chart. We also prepared a list of terms (Appendix A) and a list of other documents referenced in the documents under study (Appendix C).

The second step was the development of a matrix that showed, for each described review, procedures, personnel and responsibilities, review items/data checklist, and feedback and closeout. Figure 2-2 is a sample matrix. Each matrix was headed by the title and purpose of the review, and keyed to the applicable NASA center and document. The appropriate sections from the document under study were copied and pasted in the indicated matrix column (see Appendix D).

In the third step, we identified six reviews as being the recommended minimum for the flight assurance review program:

- Preliminary Requirements Review (PRR)

- Preliminary Design Review (PDR)

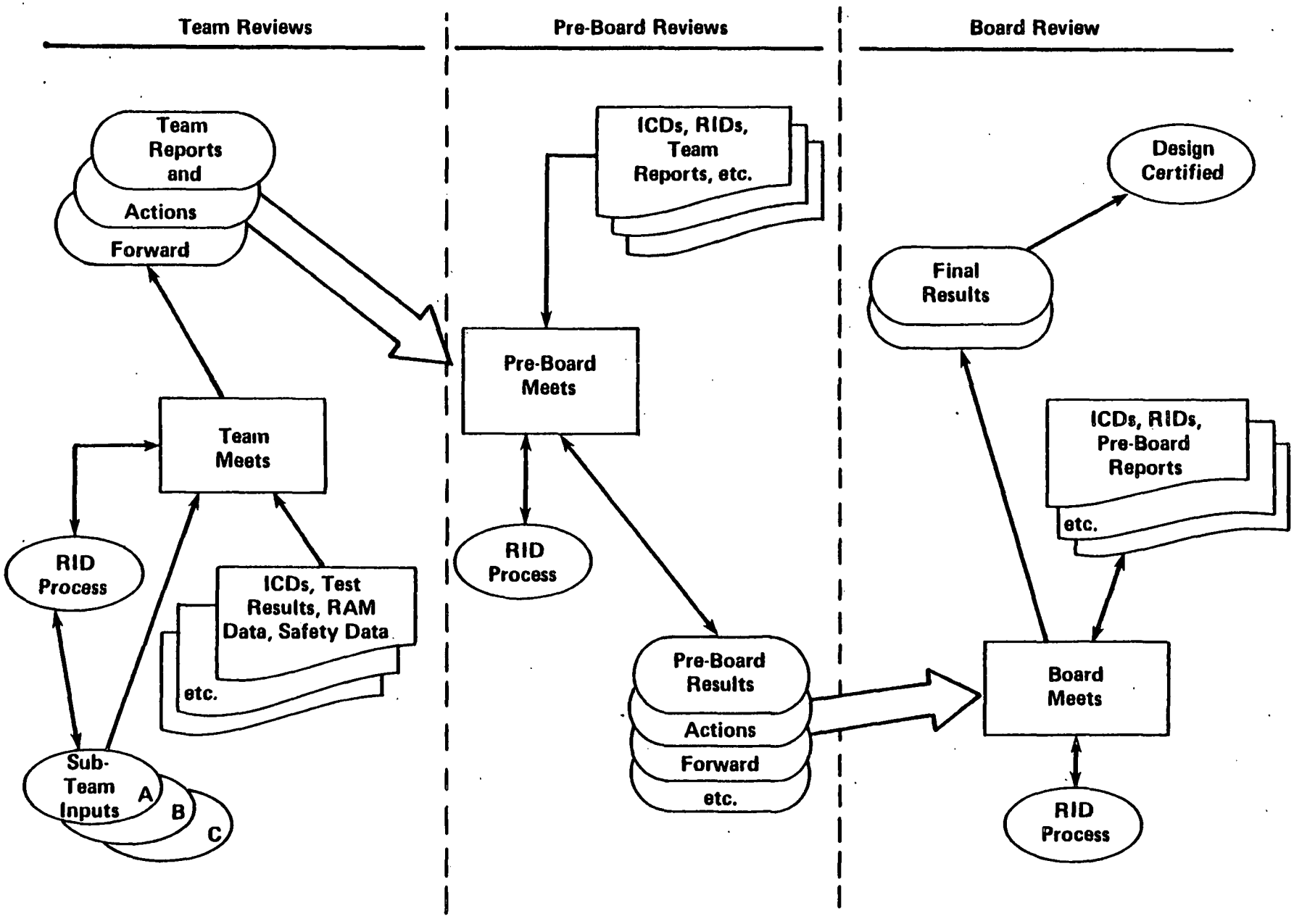

Figure 2-1. SAMPLE REVIEW FLOW CHART

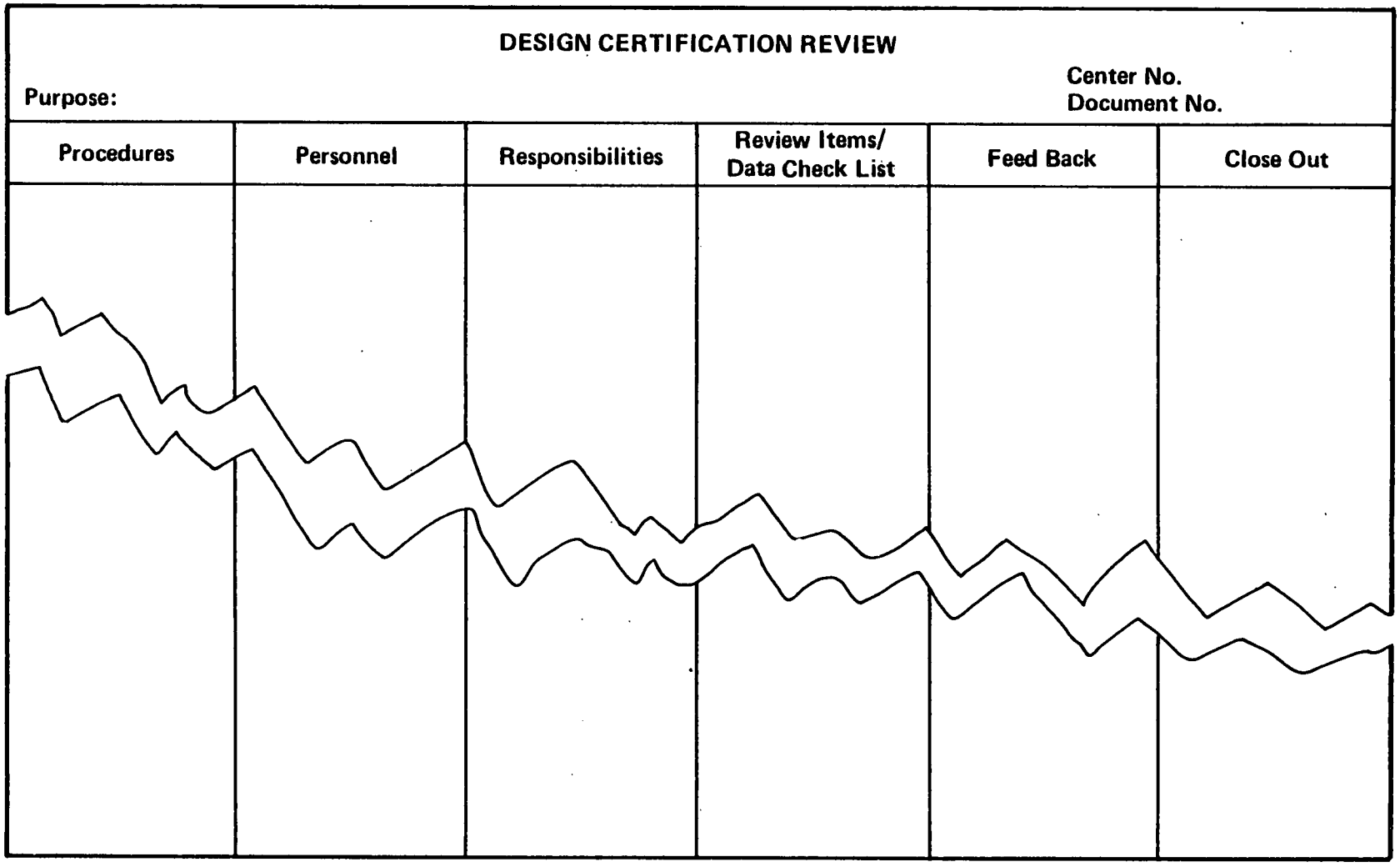

Figure 2-2. SAMPLE REVIEW MATRIX

- Critical Design Review (CDR)

- Preshipment Review (PSR)

- Design Certification Review (DCR)

- Flight Readiness Review (FRR)

We prepared a consolidated matrix for each of these reviews from the matrices developed in Step 2. Figure 2-3 illustrates the matrix form. In addition to reviewing the NASA documents, we also analyzed both Department of Defense (DoD) and Federal Aviation Administration (FAA) design review documents and interviewed persons familiar with the DoD and FAA review procedures to determine if any practices and procedures were applicable to NASA.

Finally, we analyzed the six consolidated matrices and the prepared flow charts to establish the following:

- Purpose of each of the six reviews

- Procedures to be followed in setting up or convening the Review Board or Team

- The personnel involved and their responsibilities in the review process

- A comprehensive review items/data checklist for each of the six reviews

- A feedback and closeout process common to all reviews

Our original purpose had been to select the best review practices and procedures from among those described. In our analysis, we found that this was not evident. Practices and procedures of the various centers were similar, however, and some were described in more detail than others which resulted in the assembly of composite practices and procedures which appeared to be most effective in terms of NASA-wide guidelines.

2.3 DEVELOPMENT OF MINIMUM STANDARD GUIDELINES

To develop the minimum standard guidelines for the six reviews, we studied the six consolidated matrices -- one for each type of review. The guidelines for each type of review were also related to the standard payload classifications. (Payload classifications are described in Section 3.5.)

DESIGN CERTIFICATION REVIEW							
Review Areas	Center 1	Center 2	Center 3	Center 4	Center 5	Center 6	Center 7
Procedures							
Personnel							
Responsibilities							
Review Item/ Data Checklist							
Feedback							
Closeout							

Figure 2-3. CONSOLIDATED REVIEW MATRIX

The procedures for convening a Review Board or Team were defined as being common to all reviews. Personnel and responsibilities of the Review Board or Team were also considered to be common to all reviews. A third area of commonality was the feedback and closeout process, the main purpose of which is to inform all personnel of the disposition of all action items established during the review process.

The review items/data checklist was determined to be unique to each type of review. The checklists were compiled from the various lists of items and data to be reviewed as described in the documents supplied.

CHAPTER THREE

MINIMUM STANDARD GUIDELINES FOR THE NASA FLIGHT ASSURANCE REVIEW PROGRAM

3.1 INTRODUCTION

Our analysis of documents from various NASA centers indicated that a number of similar reviews are conducted throughout the agency. Although the processes and terminology used vary from center to center and, in some cases, within the same center, reviews with similar titles are conducted in somewhat similar fashion. We found this similarity to be sufficient for the development of agency-wide review guidelines.

The minimum standard review guidelines described in this chapter are intended to serve as an aid in establishing an agency-wide Flight Assurance Review Program. The basic objective of the program is to provide assurance to management that a design satisfies the specified requirements for operations, hardware and software end items, and systems for all mission stages, from original definition through successful flight.

The Flight Assurance Review Program consists of a series of design reviews, during which applicable technically competent persons convene to determine whether an end item meets specified requirements. The objectives of the review program include the following:

- To evaluate whether a design meets the specified end item requirements.
- To evaluate whether a design meets the specified requirements of an assembly of end items and of a total system end item.
- To identify problems and devise solutions to problems identified for all mission stages, from original definition through flight, including the areas of design, production, assembly, tests, and operations.
- To evaluate the effects that proposed design and configuration changes have on performance.

- To evaluate the designed operational capabilities of an end item in terms of state-of-the-art technology.

- To determine whether specifications satisfy mission requirements.

- To determine whether the design of an end item is optimized within its specified functional requirements.

- To determine the effect that a change in end item design has on the baseline configuration.

The design reviews are conducted by Review Board or Teams. Section 3.2 describes the levels of Review Boards.

3.2 LEVELS OF REVIEW BOARDS

The Review Board can operate on any of several levels, depending on the complexity, criticality, and visibility of the program, project, system, or task under review. The Level I review, the highest level of review, is conducted by an associate administrator at NASA Headquarters as a total system review; the Level II review is conducted at the cognizant center management level as a program review; the Level III review is conducted as the project management level as a project review; and Level IV review is conducted at the task management level as an operations, hardware, or software end item review.

3.3 MINIMUM STANDARD REVIEW GUIDELINES

In determining the minimum standard guidelines for the Flight Assurance Review Program, we defined each review in terms of procedures, personnel and responsibilities, review items/data checklist, and feedback and closeout. All of these areas except review items/data checklist are generic to each of the six reviews identified; the review items/data checklist is unique to each review. The four areas are addressed in the following subsections. Guidelines for procedures, personnel and responsibilities, and feedback and closeout are presented in Sections 3.3.1 through 3.3.3, respectively. Section 3.3.4 briefly describes the six reviews and presents the review items/data checklist guidelines for each.

3.3.1 Procedures

Procedures include the method of convening the Review Board, the selection of Board members, and a general description of the activities of the Review Board.

3.3.1.1 Convening of Review Board

Figure 3-1 illustrates the organization of the Review Board. A Review Board should be convened by the convening authority which is the in-line management at least one level above the program or project under review. The responsibilities of the convening authority should include the following:

- Prepare and issue a Review Board charter identifying the purpose, scope, objectives, and authority of the Review Board.
- Identify the specific functions of the Review Board.
- With the assistance of the cognizant manager, select a Review Board chairman.
- Review agenda and schedule.
- Review Board conclusions and recommendations.
- Approve or reject Board conclusions and recommendations.

The convening authority should be assisted by the cognizant manager of the program, project, system, or task under review. The cognizant manager should assist the convening authority and support the Review Board as follows:

- With the concurrence of the convening authority, recommend the Review Board chairman.
- With the assistance and concurrence of the Review Board chairman, recommend the Review Board members.
- Assist the Review Board chairman in the development of the review agenda in accordance with the charter.
- Ensure that the review item/data package adequately supports the Review Board charter.
- Prepare a description of how action item disposition will be handled for the convening authority.
- Monitor the status of action items and report closeouts to the convening authority.
- Approve and impose the generated action items.

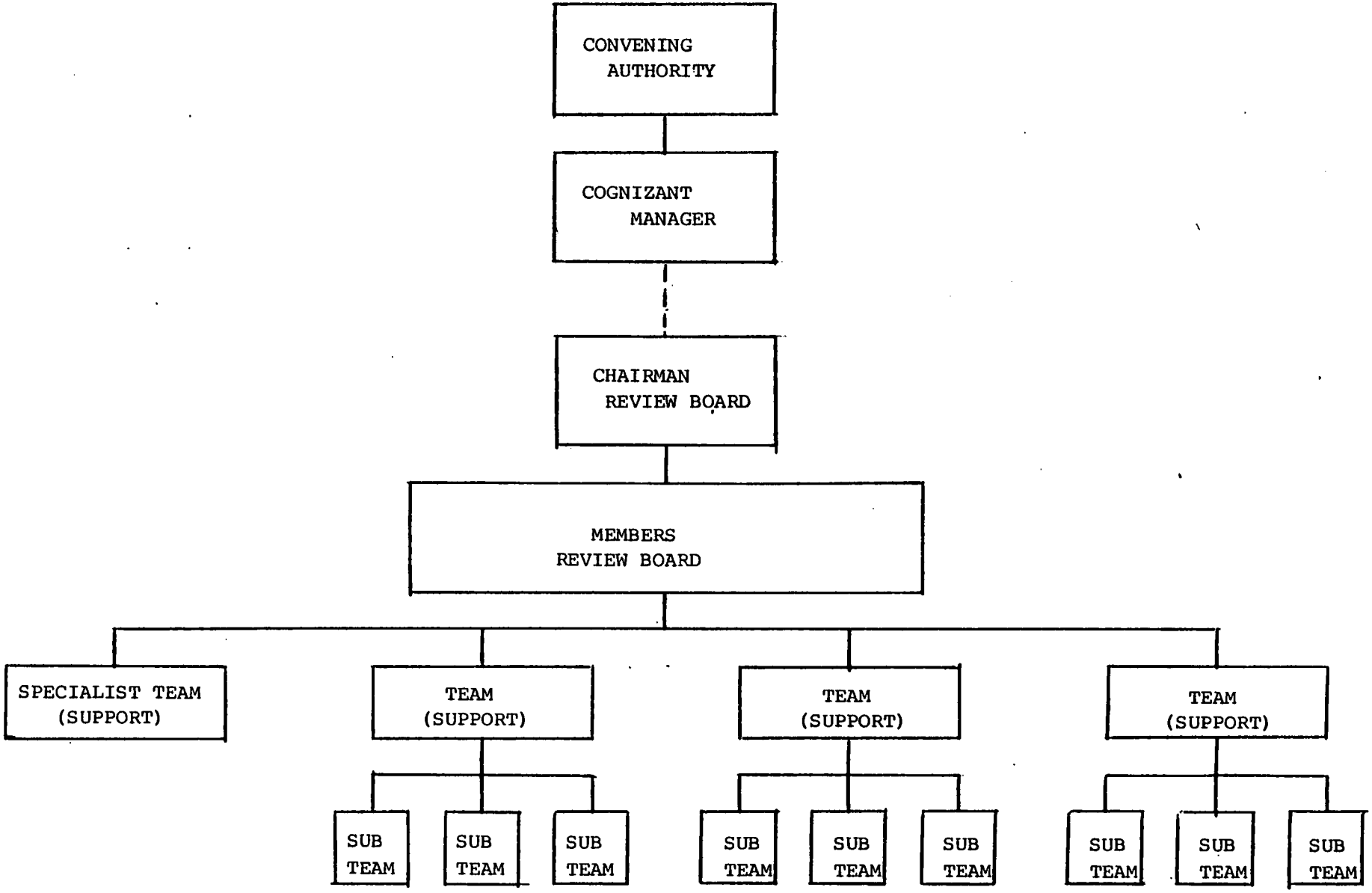

Figure 3-1. REVIEW BOARD ORGANIZATION

3.3.1.2 Membership of Review Board

The Review Board chairman selected must have the technical competence to understand the general technical aspects of the program, project, system, or task under review. Most important, he or she should have the ability to maintain a favorable review climate by fostering free discussion. It is preferable that the chairman not be directly associated with the program, project, system or task under review in order to eliminate any tendency toward bias.

Board members should be selected on the basis of their individual technical capabilities regarding the review subject(s), so that the collective capabilities and disciplines will satisfy the review objectives. Preferably, the members should have broad experience in different projects. In the event that a permanent Review Board is established to function over an extended period, additional "standby" members should be selected for their recognized capabilities in the required specialities and should be rotated as appropriate.

The number of Review Board members should not exceed the minimum necessary to encompass all the required disciplines under review. The majority of the Review Board, including the chairman, should be members who are not directly associated with the program, project, system, or task under review.

The Review Board often will be supported by teams and subteams directly involved in the review subject(s). In some cases the Review Board will require the support of a specialist team, which may be assembled from the NASA center, from other centers, or from outside NASA. Often it may be most effective if the specialist team is composed mainly of individuals who have the necessary technical knowledge but are not directly associated with the program, project, system, or task under review.

3.3.1.3 Activities of Review Board

As previously stated, the purpose of the Review Board is to approve an end item and to provide to NASA management and contractors assurance that the most satisfactory design has been selected, that an end item has been produced to meet the specified requirements, or that an end item is ready for flight. The Review Board is convened for a single purpose or for multiple purposes, as required by its charter. Input to and output from the Review Board consists of a systemized and disciplined set of documents as well as oral presentations describing concerns, problems, requests for actions, and the disposition of action items.

Input to the Review Board may include a few requests for action, review items, or concerns, or it may constitute a large number of items. The initial input document should be a single-page form describing each request for action, review item, or concern with supporting documentation. The document should be delivered as a review package to the Board, the convening authority, and the cognizant manager in advance of the scheduled meeting. All personnel should review the review package before the meeting.

Action items constitute a significant output of the Review Board. Action items are documented on a standardized form and assigned, with the assistance of the cognizant manager, to an assignee for action. The assignee may accept or reject the action item, but in either case the standardized form must be completed and returned to the Review Board with supporting documentation and data as required.

The deliberations of the Review Board should be conducted in an open forum during which all considerations (approval or rejection) of request for action or review items and concerns are voiced and recorded. The audience should be free to comment. The conclusions of the Review Board, whether arrived at unanimously or by consensus, should be documented, together with the Board minutes and any dissenting opinion, for the record and for distribution to the convening authority, cognizant manager, and Board.

3.3.2 Personnel and Responsibilities

Inasmuch as the members of the Review Board are selected on the basis of their collective capabilities and disciplines, the persons assigned need not be the leading authorities in their respective specialities. However, it is important that the collective technical competency of the Review Board be comparable to that which produced the design under review. It is also important that the Board include the participation of as many individuals as possible that are not directly associated with the program or project under review. Further, the Board must be able to effectively communicate its deliberations. Therefore, the Review Board must include the proper mix of personnel with the technical skills and communications capability to effectively document the results of the review.

In addition to being responsible for directing program or project management's attention to design deficiencies, the Review Board must ensure that a favorable climate exists, including adequate time for preparation, and that the review procedures provide for free discussion. The Review Board must not establish a climate that would tend to penalize a person presenting "bad news."

The specific responsibilities of each component of the Review Board are as follows:

- Convening Authority
  - -- Confirm the classification of the payload end item.
  - -- With the assistance of the cognizant manager, select the review board chairman.
  - -- Issue the charter describing the purpose, scope, and authority of the review.
  - -- Report the findings of the Board to the next-level review as appropriate, including a summary of action item dispositions.
  - -- Approve the cognizant manager's response to the Review Board report.
  - -- Transmit the summary of action item dispositions and open action item documentation and data to the next-level review.
- Cognizant Manager
  - -- Recommend candidates for Review Board chairman to the convening authority.
  - -- With the assistance of the chairman select the Review Board members.
  - -- Contribute to the development of the Review Board charter.
  - -- Ensure that the review package is adequate and distributed on schedule.
  - -- Support the Review Board chairman in developing the review agenda.
  - -- Recommend to the convening authority disposition of the findings and recommendations of the Board.
  - -- Approve and assign the action items that are generated.
  - -- Prepare for the convening authority's approval the written response to the Board's report, including how action items will be handled.
  - -- Monitor the status of action items and report the closeout of action items to the convening authority.

- Review Board Chairman

  -- With the assistance of the cognizant manager, establish a Review Board agenda to meet the charter requirements, including all information relevant to the charter.

  -- Assist the cognizant manager in the selection of the Review Board members.

  -- Specify the date and location of review meetings.

  -- Appoint a secretary.

  -- Chair the review and keep the discussion open, on the subject, and on schedule.

  -- Convene the Review Board as required to deliberate, and to arrive at findings and recommendations.

  -- Develop, where necessary, a consensus of findings of the Board, including an assessment of the risk associated with problem areas; develop recommendations for action.

  -- Ensure that a written report of findings, including recommendations for actions, is submitted on a timely basis to the convening authority, with a copy to the cognizant manager.

  -- Approve action item closeout before distribution to Board members.

- Review Board Members

  -- Become familiar with the documentation and presentation material and with the objectives and criteria for assessment and evaluation before the review.

  -- Participate in all scheduled meetings and contribute to the fulfillment of the objectives of the Review Board.

  -- Assist in developing a disposition for the material reviewed, make recommendations for action, and contribute to the Review Board report.

- Review Board Secretary

  -- Record comments of the Board members.

  -- Assist the chairman in preparing the Board report.

  -- Maintain a file of all Board actions, including closeout memoranda.

- Review Board Secretary (continued)

  -- Forward action items to Action Item Control and assignee(s).

  -- Provide signature approval of the Board report and prepare any minority report.

- Presenters to the Review Board

  -- Assemble the data package for the review, including appropriate documents, and provide handouts of the oral presentation material and supplementary data as required.

  -- Make the oral presentation and respond to questions.

  -- Assist the cognizant manager in defining action items.

  -- Follow up on and respond in writing to action items assigned.

Action Item Control may be an assigned individual, a group of individuals, or a permanent organization, depending on the complexity of the program, project, system, or task under review. The responsibilities of Action Item Control are as follows:

- Assign and maintain action item control numbers for each action item.

- Maintain the action item and disposition file.

- Distribute numbered action items to related action assignees.

- Prepare an action item summary report showing action item number, action item description, disposition, and closeout (or open), and distribute it to the convening authority, cognizant manager, Review Board members, and action assignee before the next Review Board meeting.

3.3.3 Feedback and Closeout

The major purpose of the feedback and closeout process is to ensure that the convening authority, cognizant manager, Review Board chairman, and members are kept fully apprised of the status of all closed and open action item reports (also called Review Item Disposition or RID reports). Figure 3-2 illustrates the feedback and closeout process.

The convening authority convenes the Review Board on the basis of action item requests, problems, and concerns brought to his or her attention. In continuing the Review Board, the convening authority approves or rejects Review Board actions and approves/certifies Review Board reports to the next-level review. The Cognizant Manager is kept fully apprised of all activities of the convening authority and Review Board and supports both as required. The cognizant manager may return a rejected request for action, problem, concern, open or closed action item to the convening authority or the Review Board for review.

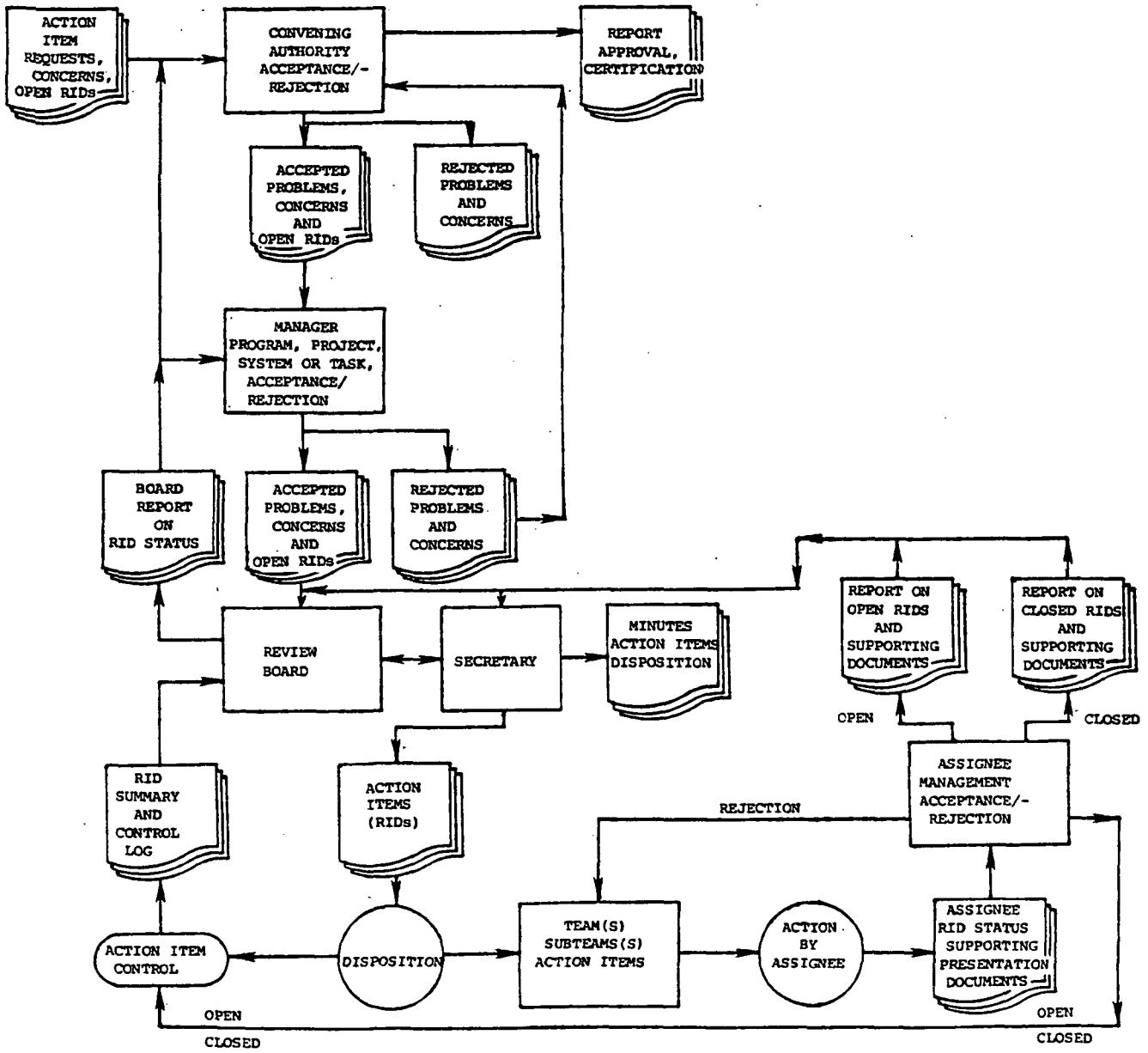

Figure 3-2. FEEDBACK AND CLOSEOUT FLOW CHART

The Review Board chairman, by direction to the secretary, documents all Board actions and sends copies to all members, the convening authority, and the cognizant manager. The action item (RID) output of the Review Board is sent to Action Item Control and is assigned to the appropriate team or subteam for action with the concurrence of appropriate management. The assignee(s) within the team or subteam document the actions taken and inform Action Item Control and assignee management, who in turn issue open and closed RID reports, with supporting documentation, to the Review Board. This process continues in a loop until all RIDs are closed, or until the convening authority determines that remaining open items must be elevated to another convening authority for a higher-level Review Board.

The feedback and closeout process is a fundamental audit trail of action item requests, problems, concerns, and potential problem areas. Each center should develop specific procedures and implementation directives that clearly define the handling and disposition of open and closed RIDs to ensure that the action items are treated properly and that mechanisms are established to ensure sufficient visibility of the results of the disposition of the items.

3.4 FLIGHT ASSURANCE REVIEWS AND REVIEW ITEMS/DATA CHECKLISTS

The review items/data checklist consists of matters to be considered by Review Board for each review. As explained previously, the checklists are unique to each of the six reviews identified. The following subsections present a brief description of the reviews, together with the review items/data checklist for each. Individual reviews may be modified by charter to meet the requirements of the program, project, system, or task under review.

3.4.1 Preliminary Requirements Review (PRR)

The purpose of the PRR is to establish the requirements of and the conceptual approaches to meeting the requirements of the program, project, system, or task. The PRR lays the groundwork for ensuing reviews and establishes the following:

- Confirmation of the payload classification as A, B, C, or D (see Section 3.5)
- Verification of the configuration concepts and requirements
- Verification of the mission objectives
- Qualification of the conceptualized approach
- Approval of the requirements baseline for program or project
- Confirmation that the functional requirements for the system and subsystem are responsive to the end-item objectives and constraints

PRR purposes (continued)

- End item suitability of the selected configuration by reference to preliminary drawings and study reports
- Expected suitability of the end item baseline configuration to meet the required schedule
- Feasibility and development tests required to select and substantiate design approaches

The PRR review items/data checklist includes the following:

- Statement of mission objectives
- Analyses of mission requirements
- Preliminary preferred requirements
- Functional analyses
- Preliminary interface requirements
- Support agreements
- Preliminary reliability and quality assurance requirements
- Scientific requirements
- Concept drawings and sketches
- Block and logic diagrams
- Costs and schedules
- Design-concept documentation
- General test requirements
- Preliminary study reports
- Heritage analyses

3.4.2 Preliminary Design Review (PDR)

The purpose of the PDR is to establish the design and ensure that it meets the program, project, system, or task end item baseline requirements. The PDR process includes approval of the basic design approach, confirmation of the design requirements, and evaluation of the progress and technical adequacy of the design approach. Further, it determines whether the selected design approach is compatible with the end item.

The PDR review items/data checklist includes the following:

- Status of PRR action items
- Final functional requirements
- Analyses for compliance with functional requirements and specifications
- Analyses of suitability of inherited designs and hardware
- Environmental design requirements
- Interface design requirements
- Design parameters, restraints, and constraints
- Block diagrams
- Single-point failures analyses
- List of preliminary parts, materials, and processes
- Plan and schedule for hardware and software development (including verification tests on analyses to be performed)
- Software standards to be applied
- Experiment performance analysis
- Preliminary data management flow and reduction plans
- Plans for safety, reliability, and quality assurance compliance
- Plans for spares provisioning
- Requirements and plans for support equipment
- Plans for preliminary operations
- Schedules and status of the project, including cost and technical developments
- Design optimization analyses
- Plans and controls documentation
- Design traceability

3.4.3 Critical Design Review (CDR)

The purpose of the CDR is to verify, when the design of an end item is essentially complete, the suitability of the design in meeting the specified requirements, and to determine whether the end item is ready for manufacture.

The CDR determines whether the designed end item is compatible with the specified requirements, and verifies that the design conforms to the requirements established at the PDR and updated to the time of the CDR. During the CDR, the integrity of the design is verified through review of analytical and test data and the system capability is established through reference to all system engineering documentation. The CDR approves or rejects all released drawings or drawings ready for release.

As a result of the CDR, the design baseline is established, end item specifications are updated, and specific end item designs are accepted for release for fabrication.

The CDR review items/data checklist includes the following:

- Status of PDR action items
- Assessment of hardware and software inheritance
- Test and performance specifications
- Prototype test results
- Design mechanization and analysis
- Design trade-offs and alternatives considered
- Detailed interfaces and cable configurations
- Detailed analysis of failure modes
- Analyses of safety and human factors
- Maintainability, repairability, operability, and reliability considerations
- Schedule and resource plans
- Man-machine interfaces
- Training plans
- Conformance of the design to the functional requirements
- Differences between the system and subsystem performances in relation to the performances estimated at the Preliminary Design Review

CDR review items/data checklist (continued)

- Detailed design parameters, restraints, and constraints
- Interface details and agreements
- Weight and power
- Detailed circuit drawings
- Electronic parts classification
- Screening specifications
- List of nonelectronic parts, materials, and processing
- List of purchased devices
- Materials and processing specifications
- Identification and traceability of materials and specifications
- Electronic and mechanical parts stress analysis results
- Worst-case analysis of end-item failure
- Conformance to environmental design requirements
- Details of design, construction, and electronics packaging
- Quality assurance plans and procedures
- Manufacturing plans
- Configuration control plans (hardware and software)
- Documentation status
- Flow plan and schedule status (hardware and software)
- Problem/failure reporting system
- Failure modes and effects analysis
- Preliminary test plans
- Developmental and detailed test results
- Qualification and acceptance test plans
- Calibration plan
- Data management plan

CDR review items/data checklist (continued)

- Formal and informal report plans
- Final design verification plans
- Constraints and precautions for initial user handling or operation
- Spares provisioning
- Requirements for support equipment
- Flight operations approach
- Schedule and cost status
- Risk assessment

3.4.4 Preshipment Review (PSR)

The purpose of the PSR is to verify that testing is complete with no unresolved problems, to evaluate the readiness of the end item for delivery, and to verify the readiness of ground-based facilities and the integrated flight team.

The PSR review items/data checklist includes the following:

- Status of previous action item closeouts
- Current approved drawings and specifications, and adequate definition of the end item, including approved specification changes and waivers
- Status and documentation of the end item, including all interface documentation, to ensure that the latest changes have been incorporated in affected hardware
- Status of test documentation and determination (by review of the test results) of the adequate and proper testing of the end item
- Documentation to determine the status of the problem/failure report and evaluate its total impact, particularly with respect to risk for the mission
- Documentation of the quality assurance history of the end item to ensure that necessary inspections have been performed and that all discrepancies have been properly closed out
- Requirements and plans for shipping and handling
- Verification of compliance with safety requirements
- Status and acceptability of the deliverable end-item data package
- Risk assessment

3.4.5 Design Certification Review (DCR)

The purpose of the DCR is to ensure that the end item has reached design and developmental maturity through reexamination of the requirements in light of NASA goals and to certify that the entire system design meets those requirements. The DCR is always a Level I review, is chaired by an Associate Administrator, and includes all aspects of the program -- hardware and software, ground and flight operations, and personnel (e.g., training, risk/contingency, and safety). The DCR assesses and certifies the design of a hardware or software end item or a space vehicle for flight worthiness and flight safety, and assesses and certifies the design of the launch complex, the mission control center, the space flight network, and launch instrumentation for the associated mission.

The DCR review items/data checklist includes the following:

- Status of previous action items
- Item change data
- Analysis and test documentation
- Reliability documentation
- Analyses of safety and human factors
- Specified requirements derived from mission objectives
- Analysis of previous failures and incidents
- Verification of physical and functional configuration
- Validation of analytical models of the equipment and system
- Validation of the thermal-control design
- Review of hazards control
- Checklist of a safety systems and subsystem including the following:
  - -- Electrical
  - -- Materials
  - -- Mechanical
  - -- Pressure
  - -- Propulsion

DCR review items/data checklist (continued)

  - -- Pyrotechnics
  - -- Structures
  - -- Cautions and warnings
  - -- Environmental control
  - -- Cryogenics
  - -- Hydraulics
  - -- Optics
  - -- Human factors
- Training of ground flight personnel
- Operational plans and status
- Mission rules
- Results and status of verification planning, testing, and analysis for the total system and associated ground support systems
- Deviations from baseline configuration
- Configuration inspection documentation

3.4.6 Flight Readiness Review (FRR)

The purpose of the FRR is to assess the overall readiness of the total system and the flight, including readiness to achieve all flight objectives.

The FRR review items/data checklist includes the following:

- Status of previous action item closeouts
- Status of vehicle and launch support facilities, systems, equipment, range support, launch commit criteria, and personnel training
- Reports on residual hazards and problems
- Status of operation and maintenance instructions
- Verification of completion of documentation, including the following:
  - -- Structures

FRR review items/data checklist (continued)

  - -- Dynamic coupling
  - -- Integrated vehicle control capability
  - -- Staging
  - -- Pyrotechnics
  - -- Safe mission termination
  - -- Radio frequency transmissions
  - -- Weight and center-of-gravity control
  - -- Baseline mission capability
  - -- Payload support requirements
  - -- Ground support equipment and facility safety design
  - -- Ground operations control and monitor capability
  - -- Hydraulic power capability
  - -- Emergency egress design capability (as applicable)
  - -- Landing station capability
  - -- Range safety system
  - -- Communications and tracking

- Configuration changes since the previous review
- Hardware and software anomalies
- Limited-life components, life remaining, and age life/time cycle
- Status of logistics readiness (spares support)
- Identification of actual hardware shortages and open work items
- Assessment of safety, reliability, and quality assurance
- Identification of problems that may constrain the flight
- Failures/incidents and accidents reports

3.5 PAYLOAD CLASSIFICATIONS

The Review Board's charter should include the classification of any payload under review. The classification should be determined on the basis of NASA Management Instruction NMI 8010.1, Classification of NASA Space Transportation System (STS) Payloads. That document states the classification of payloads as follows:

- Class A: Minimum Risk. Payloads for which a minimum risk approach is clearly dictated by prohibitively high cost of the consequences of failure, or by an unacceptable combination of costs and intangible factors associated with failure.

- Class B: Risk/Cost Compromise. Payloads for which an approach characterized by reasonable compromise between minimum risks and minimum costs is appropriate due to the capability to recover from in-flight failure by some means that is marginally acceptable, even though it involves significantly high costs and/or highly undesirable intangible factors.

- Class C: Economically Reflyable or Repeatable. Payloads for which reflight or repeat flight is planned as a routine back-up in the event of in-flight soft failure, and reflight or repeat flight costs are low enough to justify limiting qualification and acceptance testing to end-item environment screening. (In addition to whatever is required for STS safety and compatibility and payload functional testing.) There is no significant intangible or tangible impact of soft failure except the cost of repair and reflight, or repeat flight which can be estimated with reasonable confidence and can be directly related to flight-reliability enhancement costs. Therefore, a decision criteria of minimum total expected cost is appropriate and practical.

- Class D: Minimum Single Attempt Cost. Payloads that have objectives worth achieving at a cost not-to-exceed the amount required for a single low-cost attempt where formal verification requirements are limited to those necessary for safety and compatibility.

A specific payload should be classified as A, B, C, or D as early as the payload project definition, but no later than the Preliminary Requirements Review. Early classification of the payload is necessary to properly apply the NMI 8010.1 requirements. Proper application of the classification is required to ensure that the end item (payload) will meet the design specifications at the lowest cost consistent with the stated level of confidence for the specific end item.

Headquarters Program Offices are responsible for assigning the initial payload classifications, and field installations are responsible for recommending classifications for payloads and payload assemblies and subassemblies within their area of responsibility. Because NMI 8010.1 is highly project-oriented, it is appropriate for each center to review this management instruction in light of individual mission or project responsibilities. Appendix E presents a discussion of the applicability of the minimum standard guidelines to payload classifications A, B, C, and D.

CHAPTER FOUR

OBSERVATIONS AND CONCLUSIONS

4.1 OBSERVATIONS

As a result of our assessment, ARINC Research made the following observations:

- The NASA centers conduct many different reviews to ensure the quality and safety of end items.

- The practices and procedures used in conducting reviews follow similar patterns.

- The terminology used varies somewhat from center to center.

- The detailed documented descriptions of review practices and procedures vary greatly from center to center. Personnel must rely on referenced documents to provide the detail lacking in some of the documents supplied for this study.

- Documents from individual centers do not always clearly describe an in-depth review process; it was often necessary to refer to a number of documents to obtain confidence that the review process has the necessary depth and includes all of the necessary elements.

- Few of the documents supplied indicate an in-depth feedback and closeout process.

- Some of the documents do not describe procedures of the Review Board or Team or a review item/data checklist.

- There was little documentation supplied describing the decision process for determining payload classifications (A, B, C, or D) and determining the differences in the scope of the reviews for each classified payload.

- Many reviews are conducted by the persons directly associated with the end item under review.

- The Review Board chairman is generally directly associated with the program or project under review.

- The review descriptions do not indicate how upper-level Review Boards or management are advised of action item closeouts, leading to the assumption that a closeout stops at the level at which it was approved.

- The review descriptions do not indicate a process for moving open action items to a higher-level review.

- The review practices and procedures of the DoD and FAA do not offer significant areas of improvement to NASA.

4.2 CONCLUSIONS

On the basis of our observations, we reached the following conclusions:

- A standard format for review practices and procedures, including standard terminology should be used by all centers.

- A procedure should be devised and implemented for advising a central office at Headquarters of improvements to the standard review practices and procedures so that all centers can be kept fully informed.

- Minimum standard review guidelines promulgated by a central office at Headquarters should be structured in a manner that allows each center flexibility in interpreting the standards to meet diverse mission requirements.

- A procedure should be devised and implemented for advising a central office at Headquarters of changed review practices and procedures to meet specific mission requirements.

- The chairman of the Review Board or Team should be selected first for management ability and second for technical competence; the chairman should not be directly associated with the program or project under review.

- The number of persons on the Review Board or Team (including the chairman) should be an odd number, and should be the minimum number necessary to satisfy the technical requirements of the program or project under review. The majority of the members should be persons not directly associated with the program or project under review.

- Members of the Review Board or Team should be selected for their technical competence and ability to communicate effectively.

- An approval process should be developed for all changes made under the standard flight-critical change program. Approval by a minimum of two persons should be required for changes of the lowest classification, and approval of a formal Review Board should be required for changes of the highest level of criticality.

- Each review should begin with a summary of action items from the previous review together with a short statement of the current disposition of each action item.

- A specific standard procedure should be developed to evaluate the qualification of components, subassemblies, or assemblies on the basis of previous applications or similarity to another component, subassembly, or assembly.

- The history of similar systems, components, subassemblies, or assemblies should be reviewed at the PDR or CDR so as to identify areas of needed concentrated analysis or review to take advantage of data regarding previous failures or problem areas.

- When a design change is approved, it may be necessary to review all subsequent changes related to the approved change or made to accommodate the approved change.

- One-person reviews or change approval should be avoided.

- Standard procedures and methods should be developed for reviewing and certifying software. The procedures should include criteria for identifying the requirements for recertification of software based on either hardware or software changes.

- The minimum standard review guidelines presented in this report should be considered for implementation as a NASA management instruction.

- The minimum standard review guidelines presented in this report should be used as working papers to solicit comments from all centers before the guidelines are officially published. A number of iterations may be necessary to consolidate and coordinate comments from the centers into the final document.

- An independent third party review may be required for Class A payloads if the Review Board guidelines do not provide the required freedom of action which should be expected when the chairman and over half of the Review Board are not associated with the project under review.

ARINC Research Corporation recommends that the conclusions detailed above be considered in the implementation of the minimum standard guidelines for the NASA Flight Assurance Program.

APPENDIX A

GLOSSARY OF TERMS

A glossary of standard terms should be included as an integral part of the minimum standard guidelines for the Flight Assurance Review program.

GLOSSARY OF TERMS

AA-STS:	Associate Administrator, Space Transportation System
Acceptance:	The act of an authorized representative of the Government by which the government assents to its ownership of existing and identified articles or approves specific services rendered as partial or complete performance of the contract.
Acceptance Test:	The environmental, electrical, mechanical, functional, and other tests that payloads, spacecraft, subsystems, instruments, and components scheduled for flight must pass before launch. These tests are planned to approximate the expected flight conditions. They are designed to detect nonconformances in material and workmanship.
Accident/Incident:	An unplanned event that results in personnel fatality or injury or damage to or loss of equipment, environment, public property, or private property or that could result in an unsafe situation or operational mode. An accident refers to a major event whereas an incident is a minor event or episode that could lead to an accident.
Action Assignee:	The individual or group given the responsibility for completing a specific action item.
Action Item:	A specifically defined problem or set of problems requiring resolution as determined by a review board or review team.
ADP:	Acceptance Data Package
Aerospace Ground Equipment:	All equipment required on the ground to make an aerospace system operational in its intended environment.
AGE:	Aerospace Ground Equipment
ALT:	Approach and Landing Test

Analysis:	A process used in lieu of, or in addition to, testing to validate compliance of an item to specification requirements. The techniques include the use of analytical models in systems engineering analysis, statistics and qualitative analyses, safety analyses, computer and hardware simulations, and analog modeling.
Article:	A unit of hardware or any portion thereof required by the contract.
Assembly:	A functional subdivision of a component, consisting of parts or subassemblies that perform functions necessary for the operation of the component as a whole (e.g., regulator assembly, power amplifier assembly, gyro assembly, primary structure, boom, and solar array).
AR:	Acceptance Review
ASE:	Airborne Support Equipment
Associate Contractor:	The contractor who under direct contract to NASA performs work excluded from the principal contract. The associate contractor is responsible to the principal contractor for technical integration of the (sub) system and must coordinate technical developments and requirements in a timely and organized manner. The associate contractor is directly responsible to NASA for administrative and contractual matters.
ASSY:	Assembly
ATE:	Automatic Test Equipment
Baseline Configuration:	The documented and approved design concept or arrangement of components as established at a given point in the procurement cycle for systems or equipment.
Block Diagram:	A line drawing with block outlines to designate units or functional groups for general arrangement studies, functional explanation, product familiarization, etc. within a system, set, or item.

Breadboard:	An assembly of preliminary circuits or parts used to prove the feasibility of a device, circuit, system, or principle without regard to the final configuration or packaging of the parts.
CAR:	Configuration and Acceptance Review; Corrective Action Request.
Cargo:	Everything contained in the shuttle payload bay, plus other equipment located elsewhere in the orbiter that is payload-unique and not carried in the standard baseline orbiter weight budget, including payloads and payload support equipments.
Catastrophic Hazard:	A hazard with the potential for personnel injury or resulting loss of life or for preventing the safe return to Earth of an orbiter vehicle.
CCB:	Configuration Control Board
CCP:	Configuration Control Panel
CDDT:	Countdown Demonstration Test
CDR:	Critical Design Review
CEI:	Contract End Item
Certificate of Flight Worthiness:	The principal record at key milestone events of an end item's progress. Certification of flight worthiness provides the means by which centers, center end item contractors and NASA Using Sites certify to end item configuration and design drawings and specifications, availability and disposition of required documentation and compatibility of end item configuration, launch and orbit operations documentation.
Certificate of Safety Compliance:	A formal documented approval through the safety assessment procedure. Includes a statement that all safety requirements of NHB 1700.7 have been met or, if not, what waivers are applicable.

Certification:	The approval of an end item, assembly of parts, soft-ware or system confirming that the specification requirements have been met in all respects.
Checklist:	A list of procedures or items summarizing the activities required for an operator or technician to perform his duties; a condensed guide; an on-the-job supplement to more detailed job instructions.
CI:	Configuration Inspection
CITE:	Cargo Interface Test Equipment
COFR:	Certification of Flight Worthiness
COFW:	Certification of Flight Readiness
Cognizant NASA Installation:	That major organizatioal unit of NASA which has direct technical and managerial responsibility for the system under contract.
Component:	A combination of parts, subassemblies, or assemblies, usually self-contained, which performs a distinctive function in the operation of the overall equipment; a "black box"
Conceptual Phase:	That period in the system life cycle which usually terminates with publication of a specific operational requirement.
Configuration:	The technical and physical description required to fabricate, test, accept, operate, maintain, and logistically support systems or equipment.
Configuration Control:	The systematic definition, evaluation, coordination and disposition of each proposed change, deviation, or waiver, and the implementation of each approved change in the configuration of a Program/Project/EI after formal establishment of the configuration identification.

Configuration Control Board: The functional body within a Program/Project/EI office responsible for directing the implementation of baselines, and the review and disposition of all changes, deviations, or waivers to these baselines.

Configuration Inspection: The last of the formal baseline reviews in which the manager conducts an audit of his CEI to determine that the "as-built" documentation is in accordance with its release engineering, to approve the CEI specification and to establish the product configuration baseline.

Configuration Management: A discipline applying technical administrative direction and surveillance to:

Identify and document the technical requirements of a Program/Project/EI.

Control changes/deviations/waivers to these technical requirements.

Record and report change processing and implementation status.

Construction Analysis: An internal inspection for assessing design, workmanship, assembly, and any other processing associated with fabrication of the part.

Contractor: Any person, partnership, company, or corporation (or any combination of these) which is a party to a contract with the United States Government.

Countdown Demonstration Test - Dry: A dress rehearsal, with flight crew participation, of the Lauch Countdown operations excluding external tank propellant loading opertions.

Countdown Demonstration Test - Wet:	A full dress rehersal of the launch countdown operations including cryogenic propellant loading of the external tank. Test normally terminates at the time for Space Shuttle Main Engine (SSME) ignition. Flight crew does not participate from the vehicle.
CR:	Configuration Review
Critical Design Review:	A formal technical evaluation of the detailed design of an end item or series of end items to assure that the detailed design meets the specified requirements for the end item or end items. This evaluation may be conducted in one review or a series of phased reviews as appropriate for the complexity of the end item(s).
Critical Hazard:	A hazard with the potential for resulting in damage to equipment or for requiring use of contingency or emergency procedures.
CRR:	Cargo Readiness Review
DAR:	Deviation Approval Request
DE:	Design Engineering
DCR:	Design Certification Review
DDT&E:	Design, Development, Test and Evaluation
Design Certification Review:	A formal comprehensive evaluation of all hardware and software end items and elements of a system to assure and certify that the overall system and the system sub elements meet the design requirements and are satisfactory for accomplishment of a safe and successful mission.
Design criteria:	Standards upon which a design is based.
Design Review:	A systematic, technically oriented and documented evaluation of spacecraft, experiments, end items and unique support equipment by a team of specialists.

Design Review Program:	A systematized and disciplined application of the broad technical competence of the contractor and the customer to a product. The program is intended to improve the product and to provide assurance to contractor and customer management, by formalized documentation of the decision logic, that the most satisfactory design has been selected to meet the program requirements.
Design Specification:	A document prescribing criteria to be satisfied in designing a particular component, subsystem, or system (or part). Typical criteria include performance requirements under specified environments, interface requirements, size, weight, ruggedness, safety margins, derating factors, and apportioned reliability goal (with definition of failure)
Designated Representative:	An individual (such as a NASA plant representative), firm (such as an assessment contractor), or Government agency designated and authorized by NASA to perform a specific function(s) relative to the contractor's reliability effort; e.g., monitor-ship, assessment, and design review participation and/or approval of certain documents or actions.
Detail Drawing:	Delineates information to describe an item and shall include materials, finish, tolerances, and other requirements as applicable.
Deviation:	A specific authorization, granted before the fact, to depart from a particular requirement of specifications or related documents.
DR:	Disposition Record
Drawing Departure Authorization:	A form completed by the contractor and submitted for each noncompliance condition which requires a departure from the design requirements set forth in the contractual Interface Control Document

DRT:	Design Review Team
DWG:	Drawing
EC:	Engineering Change
E&D:	Engineering Development
EI:	End Item
Emergency:	Any condition that can result in crew injury or threat to life and that requires immediate corrective action, including predetermined crew response.
End Item:	A space system or any of its principal system or subsystem elements; for example, launch vehicle, spacecraft, ground support system, propulsion engine, CEI or guidance system. Also, articles covered by major subcontracts where NPC 200-2 is invoked by the NASA installation or by a system prime contractor. Also, articles which will be delivered directly to a Government installation or provided as GFP to a contractor.
Engineering Change:	An authorized modification to a baseline.
Engineering Change Proposal:	The method by which a contractor submits a proposed change to a configuration baseline for complete assessment by the procuring activity.
Engineering Drawing:	A verifiable engineering delineation setting forth pictorial or descriptive language representations or combinations thereof. Drawings solely for contractor's processes or plant facilities are not included.
Equipment:	A separate item designed either to provide an individual service or function as a self-contained unit, or to perform a service or function when used in conjunction with other devices.
ESMC:	Eastern Space and Missile Center
ET:	External Tank

ETR:	Eastern Test Range
Experiment:	An action or a process undertaken to confirm or disprove an existing theory and to obtain data leading to the development of new theories.
FAL:	First Approach and Landing
Facility:	Any fixed installation; e.g., test stand or launch platform, which is part of a program/project. This includes Real Property Installed Equipment (RPIE).
FCB:	Flight Certification Board
FCF:	First Captive Flight
Feasibility Study:	The phase during which studies are made of a proposed item or technique to determine the degree to which it is practicable, adviseable, and adaptable for the intended purpose.
FEC:	Field Engineering Change
Field Engineering Change:	The method for expediting make fit/make operable changes at NASA Using Sites.
Flight Readiness Firing:	A 20-second firing of the Space Shuttle Main Engines (SSMEs) in a near Shuttle flight configuration on the launch pad, with a scheduled cutoff prior to Solid Rocket Booster (SRB) ignition and liftoff, to be conducted (one-time-only) as part of the CDDT.
Flight Readiness Review:	The last major evaluation prior to a launch conducted as a consolidated review of the hardware, software, operational and support elements to assure readiness to begin the mission. The result of this evaluation, shortly before launch, is a positive certification of flight readiness by both government and contractor.
FMCF:	First Manned Captive Flight
FMEA:	Failure Modes and Effects Analysis

FRF:	Flight Readiness Firing
FRR:	Flight Readiness Review
GFE:	Government Furnished Equipment
GFP:	Government Furnished Property
GMI:	Goddard Management Instruction
GOR:	Ground Operations Review
Ground Support Equipment:	Nonflight equipment, implements, and devices required for the handling, servicing, inspection, testing, maintenance, alignment, adjustment, checking, repairing, and overhauling of an operational end time or a subsystem or component part thereof. This may include equipment required to support another item of GSE.
GSE:	Ground Support Equipment
GSFC:	Goddard Space Flight Center
H&SEO:	Health and Safety Engineering Office
Hazard:	The presence of a potential-risk situation caused by an unsafe act or condition.
ICD:	Interface Control Drawing
Installation Drawing:	Shows general configurations, attaching hardware, and information to locate, position, and mount an item relative to fixed points and to other items.
Interface:	The point or area where a relationship exists between two or more parts, systems, programs, persons, or procedures wherein physical and functional compatibility is required.
Interface drawing:	The engineering drawing which graphically or descriptively displays the conditions of the interface which exist between assemblies.

Integration:	The process of assuring that the major elements of a program be conceived, designed, assembled, tested, operated, and documented in such a manner as to be compatible with each other and to satisfy the program objectives.
JG:	JSC Ground Systems
JPL:	Jet Propulsion Laboratory
JSC:	Johnson Space Center
KMI:	Kennedy Management Instruction
KPD:	Kennedy Program Directive
KSC:	Kennedy Space Center
LaRC:	Langley Research Center
LeRC:	Lewis Research Center
Launch Integrity Team:	Review team composed of high-level representatives of the prime contractor, or the integration contractor and the major associates, to review each Launch Vehicle prior to the customer flight-readiness review.
Launch Vehicle:	The part of the space vehicle which furnishes the propulsion and guidance during the inital part of the trajectory to provide the prescribed velocity, position, and attitude required for injection into the desired trajectory. Launch vehicles are commonly called boosters and consist of two or more propulsive stages.
LIT:	Launch Integrity Team.
LHB:	Langley Handbook
LMI:	Langley Management Instruction
L-2 Day:	Launch Minus 2 Days
LO:	Launch Operations

LRR:	Launch Readiness Review
LRU:	Line Replaceable Unit
LVP:	Launch Vehicle Project
Man-Rated Space Vehicle:	Space vehicles for manned flight which have achieved the standards of performance and reliability previously established as reasonably acceptable for this class of equipment.
MATCO:	Material Analysis Tracking and Control
MCR:	Master Change Record
Milestone:	Any significant event in the design and development of a space system or in the associated program or project which is used as a control point for measurement of progress and effectiveness or for planning or redirecting future effort.
Mission:	The performance of a coherent set of investigations or operations to achieve program goals.
Mission Task:	The specified purpose for which a device must perform.
MMM:	Marshall Management Manual
MMI:	Marshall Management Instruction
Modification:	An identified, approved and contractually authorized change to systems/equipment and spares already accepted by the Government.
Modification Instructions:	A form initiated by the contractor to be used as a checklist for modification kit completeness and to serve as instruction for accomplishment of the modification.
MR:	Material review disposition
MRB:	Material Review Board
MSFC:	Marshall Space Flight Center

NASA:	National Aeronautics and Space Administration
National Aeronautics and Space Administration	Civilian agency with research and development jurisdiction in aeronautical and space activities, except those activities peculiar to and primarily associated with the development of weapons systems and military operations.
NDE:	Non-Destructive Evaluation
NHB:	NASA Handbook
NMI:	NASA Management Instruction
Nonstandard Part:	One for which no published standard or specification exists
Normal STS Mission Phases:	All portions of the mission to be performed by the STS, excluding STS abort and emergency landing.
NSS:	NASA Safety Standard
NSSDC:	National Space Science Data Center
O&C:	Operations and Checkout
O&M:	Operations and Maintenance
OFT:	Orbital Flight Test
OHA:	Operations Hazards Analysis
OMD:	Operation and Maintenance Documentation
OMI:	Operation and Maintenance Instruction
Operational:	Equipment for which all research and development has been completed with achievement of performance objectives.
Operational Phase:	The period from acceptance by the user of the first operating unit until disposition of the system equipment. The operational phase overlaps the acquisition phase.

Operations and Maintenance Instruction:	Organized step-by-step procedural information specifying methods of operating and maintaining flight hardware and support equipment. OMIs are used in the performance of day-to-day operations and maintenance tasks.
OPO:	Orbiter Project Office
OPR:	Office of Planning and Review
OSTS:	Office of Space Transportation Systems
OV:	Orbiter Vehicle
PAD:	Project Approval Document
Part:	One piece or two or more pieces joined together which are not normally subject to disassembly without destruction.
PASS:	Planning and Scheduling System
Payload:	A specific complement of instruments, space equipment, and support hardware and software carried into space by one shuttle flight to achieve specific objectives (not considered part of the basic STS itself).
Payload Bay:	The 15-foot diameter by 60-foot long enclosed volume within the orbiter, designed to carry carriers, payloads, payload-support equipment, and associated mounting hardware.
Payload Elements:	Instruments, support equipment, software, or other individual payload items that are subsets of an integrated cargo complement.
PDP:	Program Development Plan
PDR:	Preliminary Design Review
PERT:	Program Evaluation and Review Technique

Piggyback Experiment:	An experiment which rides along with the primary experiment on a space-available basis without interfering with the mission of the primary experiment.
PIP:	Payload Integration Plan
PM:	Program Management
Preliminary Design Reviews:	A formal technical evaluation of the proposed design approach to an end item. It is conducted prior to the detailed design or very early in the detailed design phase to asure that the engineering approach is acceptable. As a general rule this evaluation is conducted when the design layouts are 95% completed and the detailed design is 10% completed.
Program:	A related series of undertakings designed to accomplish a broad scientific or technical goal. Attainment of such long-range goals may be accomplished by implementation of specific projects.
Program Evaluation and Review Technique:	Method of charting events and obtaining predicted performance in accordance with a schedule.
Program/Project Requirements Review:	The first of the major baseline reviews, in which the Program/Project Manager assures that the mission objectives and technical requirements of his specification are fully understood and can be met based on the concepts selected for each EI/major element and that the Program/Project Requirements Baseline is established.
Project:	A scheduled undertaking, within a program, which may involve the research and development, design, construction, and operation of system and associated hardware, or hardware only, to accomplish a scientific or technical objective.

PRR:	Preliminary Requirements Review
PSO:	Project Safety Officer
QA:	Quality Assurance
QAI:	Quality Assurance Instructions
Qualification Tests:	Tests intended to demonstrate that the design will function within performance specifications under simulated conditions more severe than those expected from ground handling, launch, and orbital operations. Their purpose is to uncover deficiencies in design and method of manufacture. They are not intended to exceed design safety margins or to introduce unrealistic modes of failure.
R&QA:	Reliability and Quality Assurance
Released Engineering:	The current and total set of approved drawings and specifications which have been completed for a product and formally recorded. It is centrally controlled and, upon release, represents the engineering requirement to which all contractor disciplines applicable to that product must adhere in order to meet contract requirements.
Retrofit:	The incorporation of an engineering change in accepted or in-service items.
RID:	Review Item Disposition
RPIE:	Real Property Installed Equipment
RR:	Requirements Review
SAA:	Systems Assurance Analysis
Safety:	Freedom from chance of personnel injury or fatality and damage to or loss of equipment or property.

Safety Analysis:	A process used in lieu of, or in addition to, testing to validate compliance of an item to specification requirements. The techniques include the use of analytical models in systems engineering analyses, safety analyses, statistics and qualitative analyses, computer and hardware simulations, and analog modeling.
Safety Critical:	Systems or subsystems whose inadvertent operation or failure to operate results in either a critical or catastrophic hazard.
Schematic Diagram:	A diagrammatic drawing that shows function symbols with interconnections to illustrate circuit operation. It does not necessarily identify physical location of components or connections between them.
SFP:	Single Failure Point
Single Failure Point:	A single element of hardware, where failure would lead directly to loss of life, vehicle, or mission. When safety considerations dictate that an abort be initiated when a redundant element fails, the element is also considered a SFP.
Space Shuttle:	The orbiter, solid-rocket boosters, and external tank.
Space System:	A system of equipment consisting of launch vehicle(s), spacecraft, ground support equipment, and test hardware, used in ground testing, launching, operating, and maintaining space vehicles or spacecraft.
Space Transportation System:	An integrated system consisting of the Space Shuttle (Orbiter, External Tank, Solid Rocket Booster, and Flight Kits), Upper Stages, Spacelab, and any associated flight/ground hardware and software.
Spacecraft:	Systems, manned or unmanned, that are designed to be placed into a orbital trajectory, orbit about the Earth, or a trajectory to another celestial body.

SP&R:	Safety Policy and Requirements
SR&QA:	Safety, Reliability and Quality Assurance
SRB:	Solid Rocket Booster
SSME:	Space Shuttle Main Engines
STS:	Space Transportation System
STS Operator:	The NASA Headquarters/STS Operations Directorate is the STSoperator. NASA/JSC is the STS flight operator and is responsible for the safety of payload flight systems and flight operations.
System:	One of the principal functioning entities comprising the project hardware and related operational services within a project or flight mission. Ordinarily, a system is the first major subdivision of project work. Similarly, a subsystem is a major functioning entity within a system. (A system may also be an organized and disciplined approach to accomplish a task; e.g., a failure-reporting system.)
TRR:	Test Readiness Review
TSPD:	Technology & Space Program Development
UA:	Unexplained Anomoly
Validation:	The inspection and tests necessary to establish confidence for a system added or to restore confidence in a system invalidated by the installation of a modification into a Contract End Item.
VCR:	Vehicle Configuration Review
Verification:	Determination by analysis, inspection, test or a combination of the three that a product can function as intended in a particular mission; this includes assurance that the product design has been qualified and that each product item has met acceptance criteria.

Verification Procedure:	A document that implements one or more specific activities required by the verification plan. The verification procedure describes details of each activity such as instrumentation, data collection, and reporting. It includes provisions for safety and contamination control that are associated with the test being conducted.
Waiver:	A written authorization accepting a departure, after occurrence, from a baseline requirement, normally limited to a single application of GEI.
WBS:	Work Breakdown Structure

APPENDIX B

NASA DOCUMENTS REVIEWED

This appendix contains a list of the supplied NASA documents reviewed in this study. It also contains a list of the FAA and DoD documents reviewed.

AMES RESEARCH CENTER
DOCUMENTS

NUMBER	TITLE AND DATE
AHB 1700-1	AMES Health & Safety Manual Chapter 5: Facility Operational Safety Chapter 9: Aviation Safety Chapter 10: Pressure System Safety No Date
AHB 1710-3	Certification and Recertification of Ground Based Pressure Vessels and Pressurized Systems - June 1981
AHB 1740-2	Outline for Airworthiness and Flight Safety Reviews - January 1975
AMM 1740-1	Management Manual Airworthiness and Flight Safety Reviews February 18, 1975
AMM 1760-1	Management Manual Man-Rating of Simulators September 19, 1980
AMM 1770-1	Management Manual Project Safety Reviews of Major (Discrete) Construction of Facility Modification September 19, 1980

GODDARD SPACE FLIGHT CENTER
DOCUMENTS

NUMBER	TITLE AND DATE
GMI 1700.3	Management Instruction System Safety for Flight Projects September 8, 1981
GMI 5330.7	Management Instruction Development and Implementation of Environmental Verification Requirements for Space Flight Hardware December 9, 1979
GMI 8010.1B	Management Instruction Spacecraft Design Review Program March 22, 197

JET PROPULSION LABORATORY
DOCUMENTS

NUMBER	TITLE AND DATE
JPL D-363 OER 82-4	Guidelines for Planning and Conduct of Formal and Informal Reviews February 7, 1983
1-28	Policy Work Output and Proposal Review Policy August 28, 1978
MJS77-RLH-76-09	Hardware Reviews - April 19, 1976
PD618-210	Project Document Mariner Jupiter/Saturn 1977 Spacecraft Procurement Instructions January 10, 1974
PD618-223	Project Document Mariner Jupiter/Saturn 1977 Spacecraft System Review Program April 15, 1975
JPL-750-150	Flight Experiment Requirements and Guidelines July 1981

JOHNSON SPACE CENTER
DOCUMENTS

NUMBER	TITLE AND DATE
LA2	Space Shuttle Program System Integration Flight Readiness Review Planning October 8, 1980
LA3-82-059	Flight Readiness Review (FRR) and L-2 Day Review September 23, 1982
LC-82-224	Flight Readiness Review (FRR) and L-2 Day Review Revised September 23, 1982
JSC07700	Configuration Verification, Volume IV No Date
None	Space Shuttle Program Orbital Flight Test Design Certification Review Plan December 21, 1978
None	Space Shuttle Flight Readiness Review Plan February 26, 1982
None	Space Shuttle Vehicle Configuration Review (VCR) Plan March 15, 1982
JSC-16898	Space Shuttle Orbiter Flight Readiness Review Plan, Orbital Flight Test Plan Revision A June 1981
JSC-17453	Space Shuttle Orbiter Configuration Verification Review Plan, Operational Orbiter Vehicles September 1981
JSC-14046	Payload Verification Requirements March 1982
None	Space Shuttle Orbiter Review Plan Preliminary Design Review Critical Design Review January 11, 1974

NUMBER	TITLE AND DATE
JSC 16898	Space Shuttle Orbiter Flight Readiness Review Plan, Orbital Flight Test STS-1 September 1980
JSC 08117 Rev. B	Space Shuttle Program Procedure for Certification of Flight Readiness May 17, 1978
None	Space Shuttle Program System Integration, Flight Readiness Review Planning October 8, 1980
JSC 11758	Orbiter Flight Readiness Review Plan for Approach and Landing Test November 1976
JSC 13830	Implementation Procedure for STS Payloads, System Safety Requirements May 1979

KENNEDY SPACE CENTER
DOCUMENTS

NUMBER	TITLE AND DATE
DE-ID8020.1A	Implementing Directive Design Engineering Shuttle Transportation System Readiness Review Cycle September 15, 1981
K-SM-04.8.3	STS-3 and Subs Readiness Review Management Plan March 1982
KPD 8620.5	Program Directive Space Transportation System Flight Readiness Reviews August 7, 1979

LANGLEY RESEARCH CENTER
DOCUMENTS

NUMBER	TITLE AND DATE
1710.1	Management Manual Human Factors Research Man-Rating Requirement,and Committee Review Procedures June 22, 1977
LHB 7121.1	Announcement Langley Proposals for New Starts May 9, 1977
LHB 7121	Project Management, Handbook December 1975
LMI 7000.2	Management Manual Review Program for Major Construction, Rehabilitation, and Modification Projects of Research Facilities March 26, 1981
LMI 7120.1	Management Manual Aeronautic and Space Flight Projects and Experiments Review Program October 21, 1980

LEWIS RESEARCH CENTER
DOCUMENTS

NUMBER	TITLE AND DATE
01-14 Rev. 4	Operating Instruction ATLAS/CENTAUR Launch Vehicle Hardware and Software Review Milestones July 1, 1980
01-19 Rev. 2	Operating Instruction - 19 LVD Procedure for Review and Disposition of Launch Vehicle System Quality Problems July 1, 1980
01-20 Rev. 2	Operating Instruction - 20 Launch Vehicle Division Critical Problem List July 1, 1980
01-22 Rev. 2	Operating Instruction - 22 System Engineer's Duties and Responsibilities July 1, 1980
01-23 Rev. 3	Operating Instruction - 23 Launch Vehicles Division Engineering Review Board (ERB) July 1, 1980
01-24 Rev. 3	Operating Instruction - 24 Processing of Changes to the Centaur Unified Test Plan (UTP) July 1980
01-28 Rev. 1	Operating Instruction - 28 Processing of Software Change Sheets July 1, 1980
01-30 Rev. 1	Operating Instruction - 30 Unscheduled Removal of Atlas/Centaur Flight Hardware after Vehicle Erection
None	Aircraft Operations Manual Appendix B, Aircraft Operations Safety Assurance Plan - No Date Appendix C, Flight Workorder Control System - No Date

MARSHALL SPACE FLIGHT CENTER
DOCUMENTS

NUMBER	TITLE AND DATE
MM 2314.2	Data Management Manual MSFC Data Management Operating Procedures March 15, 1972
MMI 8010.5	Management Instruction MSFC Baseline Design Review July 7, 1980
MMI 8030.2A	Management Instruction Policy on MSFC Payloads March 4, 1980
MM 8040.12A	Standard Contractor Configuration Management Requirements MSFC Programs March 3, 1981
MMI 8040.15B	Management Instruction Configuration Management May 12, 1976

NASA HEADQUARTERS
DOCUMENTS

NUMBER	TITLE AND DATE
E-885-83-01	Prelaunch, Mission Operation Report Infrared Astronomical Satellite (IRAS) Launch - January 3, 1983
SP-6502	Elements of Design Review for Space Systems
ESA Contract N^{O} 4846/81/NL/PP(SC)	A Comprehensive Study on Project Review Techniques Final Report - December 31, 1982
NMI7121.1C	Management Instruction - Planning and Approval of Major Research and Development Projects - March 24, 1977
None	ST-S-5 EMU Interim Report to the Independent Anomaly Review Team - December 17, 1982
None	Certification Process: Lithium Batteries December 17, 1982
1700.7A	Safety Policy and Requirements for Payloads Using the Space Transportation System (STS) - December 9, 1980
403-174-001	Safety Reviews - No Date
None	Certification Review Process January 3, 1983
None	Design Certification Review of New Designs for STS-5 and STS-6 - December 22, 1982
None	Outline - STS Payload Project Review Guidelines - June 10, 1979
None	An Independent Review of the Flight Certification Program - No Date
None	Space Transportation Systems (STS) Certification Review - November 13, 1979
None	Charter - Special Staff to the Chief Engineer - No Date

NUMBER	TITLE AND DATE
NMI 8010.1	Classification of NASA Space Transportation System (STS) Payloads - September 26, 1979
NHB5300.4(1B)	Reliability and Quality Assurance Publication Quality Program Provisions for Aeronautical and Space System Contractors - April 1969
NHB5300.4(1A)	Reliability and Quality Assurance Publication Reliability Program Provisions for Aeronautical and Space System Contractors - April 1970

DoD DOCUMENTS REVIEWED

NUMBER	TITLE AND DATE
AR70-37 NAVMAT INST 4130.1A MCO 4130.1A AFR 65-3 DSAR 8250.4 NAS/CSS 80-14 DNA INST 5010.18	Configuration Management July 1, 1974
AFR 800-2	Acquisition Program Management August 13, 1982
AFR 57-1	Statement of Operational Need (SON) June 12, 1979
MIL-STD-480A	Configuration Control-Engineering Changes Deviations and Waivers December 29, 1978
MIL-STD-481A	Configuration Control-Engineering Changes Deviations and Waivers (Short Form) October 18, 1972

FAA DOCUMENTS

NUMBER	TITLE AND DATE
8110.4	Type Certification December 27, 1967 Reprint October 1978 Includes Changes 1 through 22
	FAA Aviation Regulations, Change 3, Part 25 - Airworthiness Standards: Transport Category Airplanes February 10, 1977
	Southern Region FAA Flight Standards Division Application Guide for Obtaining Supplemental Type Certificate March 5, 1965
8110.21	Supplemental (Type) Certificate (STC) Approvals, "One Aircraft Only" September 22, 1976
8110.10C	FAA Approvals of Major Modifications/ Alterations January 30, 1978

APPENDIX C

NASA DOCUMENTS REFERENCED

This appendix contains a list of the NASA documents referenced in one or more of the documents supplied for review.

NASA DOCUMENTS REFERENCED

- NMI 7121.1, "Planning and Approval of Major Research and Development Projects"
- NHB 7121.4, "Guidelines for Project Planning"
- LMI 1710.1, "Human Factors Research, Man-Rating Requirements, and Committee Review Procedures"
- LHB 7121.1, "Project Management"
- MM 8040.12 "Standard Contractor Configuration Management Requirements"
- MMI 8030.2 "Policy on MSFC Payloads"
- MMI 8040.15 "Configuration Mangement"
- MM 2314.2 "MSFC Data Management Operation Procedures"
- KMI 2530.4, "Transcription, Monitoring, Interception, or Recording or Telephone or other Conversations, or the Proceedings of Meetings"
- KMI 5310.9B, "Safety Hazard and Reliability Analyses of Ground Support Equipment and Facilities, and Launch Operations Operational and Integrated Hazards Analyses"
- OSTS "Space Shuttle Flight Test Operations Directive," Revision C, dated January 1979
- KPD 8010.2A, "Certificate of Flight Readiness Sign-off for KSC"
- KSC KPD 8620.5, STS Flight Readiness Reviews
- K-SM-04.8.2, STS-2 Readiness Review Management Plan
- K-SM-04.8.1, STS-1 Readiness Review Management Plan
- GMI 8010.1B Design Review Program, March 22, 1973
- NHB 5300.4(3A) Requirements for Soldered Electrical Connections
- NHB 5300.4(1B) Quality Program Provisions for Aeronautical and Space System Contractors

- NHB 5300.4(1A); April 1970 — Reliability Program Provisions for Aeronautical and Space Systems Contractors (Applies only as defined in 612-16)

- NHB 5300.4(1C) Inspection System Provisions for Suppliers of Space Materials, Parts, Components and Service

- JSC-14046 "Payload Verification Requirements" March 1982

- NHB 1700.7A "Safety Policy and Requirements - For Payloads Using the STS" December 9, 1980

- JSC-07700, "Configuration Management Requirements" Jan. 31, 1981 Vol. IV

- "Space Shuttle Program Orbital Flight Test Design Certification Review Plan" December 21, 1978

- "Space Shuttle Flight Readiness Review Plan" February 15, 1980

- WC2/80-308 Letter — "JSC Document No. 16898, Space Shuttle Flight Readiness Review Plan for Orbital Flight Test, STS-1" September 29, 1980

- JSC-16898 "Space Shuttle Orbiter Flight Readiness Review Plan" September 1980

"Space Shuttle Program System Integration Flight Readiness Review Planning" October 8, 1980

"Space Shuttle Flight Readiness Review Plan" February 26, 1982

"Space Shuttle Vehicle Configuration Review (VCR) Plan March 15, 1982

- LC-82-224 Letter — "Flight Readiness Review (FRR) and L-2 Day Review" September 23, 1982

"Space Shuttle Flight Readiness Review Plan" September 1, 1982

- LA3-82-059 "Flight Readiness Review (FRR) and L-2" September 23, 1982

- NMI 1052.12A, "NASA-DOD Agreement for Performance of Contract Administration and Contract Audit Services in Support of NASA Contracts"
- NHB 1200.1, "Basic Management Processes"
- NHB 1700.1(vi), "Basic Safety Requirements"
- NPD 2220.3, "Relationship Between Scientific Investigations Under Contract to NASA and NASA Contract Monitors"
- NHB 2410.1A, Management Procedures for ADP Equipment"
- 2570.3, "Radio Frequency Management Manual"
- 5100.2, "NASA Procurement Regulations"
- 5101.1A, "Requirements for Legal Review of Procurement Matters"
- 5101.19, "Avoiding Conflict-of-Interest Situations in Placing of NASA Contracts"
- NMI 5103.4B, "Source Selections by the Administrator in Competitive Procurements"
- NMI 5104.1, "NASA Policy and Procedures for Use of Contracts for Nonpersonal Services"
- NHB 5104.3A, "DOD and NASA Incentive Contracting Guide"
- 5104.4, "Cost Plus Award Fee Contracting Guide"
- NPD 5300.7A, "Basic Policy on Safety and Reliability and Quality Assurance"
- NHB 5300.4(1A), "Reliability Program Provisions for Aeronautical and Space System Contractors
- NHB 5600.2, "Statements of Work Handbook"
- NHB 5610.1, "Handbook for Preparation of Work Breakdown Structures"
- NPD 7000.1A, "Authorization and Control of Agency Programs and Allocation of Resources"
- NHB 7100.5B, "Launch Vehicle Estimating Factors for Advance Mission Planning"

- NMI 7100.11, "Announcement of Opportunity Process - Acquisition and Administration of Space Science Investigations"
- NMD/A 7110.1A, "To Approve Advanced Studies of Possible Aeronautical and Space Missions"
- NMI 7121.1B, "Planning and Approval of Major Research and Development Projects"
- NHB 7121.2, "Phased Project Planning Guidelines"
- NHB 8030.4G, "Space Flight Payload Capability"
- NMI 8030.5, "Submission and Selection of Advanced Research and Technology Space Flight Experiments"
- NHB 8030.6, "Guidelines for Acquisition of Investigations"
- NPD 8621.1A, Investigation of Accidents and Mission Failures"
- NHB 9090.6, "Guidelines for Evaluation of Contractor Accounting Systems"
- 9501.2A, "Procedures for Contractor Reporting of Correlated Cost and Performance Data"
- LHB 1700.1, "Safety Program"
- LHB 1700.6, "Control of Hazardous Materials"
- LHB 2310.1, "Resource Management System"
- LMI 5000.2, "Procurements"
- LHB 5000.2, "Basic procurement Guide"
- LMI 5300.1, "LRC Reliability and Quality Assurance Management"
- LMI 700.2, "Reviews of Major Construction or Facility Modification Projects"
- LHB 7100.1, "Research and Development Program Management Procedures"
- LMI 7100.3, "Procedures for the Use of Purchase Requests in Research and Development Procurements"
- .MI 7120.1, "Review of Small Flight Projects and Experiments"

- LMI 7120.2, "Authority and Respnsibilities of Managers of Small Space Flight Projects"
- LMI 9100.1, "Job Orders"
- LMI 9500.1, "Contractor Financial Management Reporting"
- SP-6501, "An Introduction to the Evaluatio of Reliability Program"
- SP-6502, "Elements of Design Review for Space Systems"
- SP-6505, "Parts and Materials Application Review for Space Systems"

APPENDIX D

REVIEW DESCRIPTIONS

This appendix contains a description of different reviews shown in selected documents supplied for the seven (7) centers. The centers are not called out by name since it was not the purpose of this review to audit the current documentation of individual centers. The method of presentation varies since the information shown is extracted directly from the documents supplied. The general format of the review descriptions follows:

- Procedures: procedures followed in organizing and conducting reviews.
- Personnel: personnel making up the Review Board.
- Responsibilities: responsibilities of the Review Board personnel.
- Review Items/Data: items and data to be reviewed by the review board for the specific review as called for in the review agenda.
- Feedback: description of the method for informing the review board of actions taken on all action items.
- Closeout: description of the method described for closing-out actions items.

CENTER NO. 1

REVIEWS

DOCUMENT NO. 1-1

CENTER NO. 1

DOCUMENT NO. 1-1

PROCEDURES

Formal Reviews are conducted when the work or proposal exhibits one or more of the following characteristics:

- The activity represents a large dollar volume in a given fiscal year or in total
- The products are highly visible deliverables
- Success or failure to produce will impact important future assignments
- The conduct of the activity involves matters of substantial institutional concern
- The activity reports directly to an Assistant Laboratory Director
- The activity is one for which an Assistant Laboratory Director or Deputy Laboratory Director is the convening authority

Criteria for the large dollar volume are arbitrarily recommended as being expenditures in excess of $1,000,000 in a given fiscal year or $3,000,000 in total resources for all fiscal years. The judgment as to whether or not tasks require formal reviews is left to the responsible organization.

Standing Review Boards are selected for projects or tasks which have a high level of activity and resource requirements. Selection of board members by the convening authority is generally made from senior JPL technical and management staff. Supplemental technical or management supporting members or advisors may be added to the board as required by circumstances. If the review board is to function over the lifetime of a project it is advisable to select extra board members and rotate to cover needs.

Review Plans. Early in the life of a project or task, or as soon as a proposal is initiated, a Review Plan should be prepared which identifies all reviews, their schedules, and the make-up of the review boards. The Plan should also indicate for each specified review the purpose, the convening authority, and the methodology. For tasks which will conduct informal reviews, the Proposal Phase Checklist is recommended.

CENTER NO. 1

DOCUMENT NO. 1-1

PROCEDURES (cont'd)

Convening Authority. For major flight projects such as Voyager and Galileo, the reviews are classified according to level of importance (see PD 625-7). The convening authority is normally the Program Manager or the Assistant Laboratory Director of the cognizant Program Office for level 1 reviews; the Project Manager for level 2, and the cognizant System Manager for level 3 reviews. For all other reviews the convening authority is the official next in line above the manager of the activity being reviewed. The responsibilities and functions of the convening authority are given in Section 4.1.

Formal Reviews. A written charter is issued by the convening authority to identify the scope and objective of the review. This charter includes board members, review agenda, location, and a timetable for review activities. The charter also includes the specific functions the board is to address.

Formal Reviews. The convening authority names the board chairman and, assisted by the board chairman and Project, System, or Task Manager, names the review board members. The board must include a majority number of individuals not performing or managing the work being reviewed. The chairman appoints the board secretary.

Formal Reviews. Background information and review presentation material of use to the board members should be distributed to the review board members early enough to enable them to examine it prior to the meeting.

Informal Reviews are conducted according to the needs of the project or task and they are based on the decision of the convening authority. Informal reviews should include the following minimum characteristics:

- An assigned chairman
- A review board which includes at least one individual who is not managing or performing the work being reviewed
- A presentation of the material being reviewed
- Assigning, tracking, and closing action items

By this definition meetings related to technical discussions and decisions, periodic resource expenditure and project or task status, and progress monitoring are not necessarily reviews.

the convening authority is the official next in line above the manager of the activity being reviewed.

PROCEDURES (cont'd)

Informal Review Minimum Level. A board chairman and a review board including at least one individual not managing or performing the work being reviewed is named by the convening authority.

Preparation. When technical issues are to be included it is sometimes advisable to prereview with technical specialists and make results available to the review board.

Informal Review. Presentations using existing documentation such as drawings and reports may be adequate. Prepared material such as viewgraphs should be provided to the review board and meeting attendees if used.

Informal Review. Background information and review presentation material of use to the board members should be distributed to the review board members early enough to enable them to examine it prior to the meeting.

CENTER NO. 1

DOCUMENT NO. 1-1

PERSONNEL AND RESPONSIBILITIES

Convening Authority. The responsibilities of the convening authority are to:

- Determine whether a review will be formal or informal
- Appoint the review board chairman and review board members
- Issue the charter describing the scope, authority, and purpose of the review
- Review and accept or reject the review board findings and recommendations
- Report board findings to Deputy Director if appropriate
- Approve the cognizant manager's response to the review board report
- Approve closure of action items, including responsibility for transmital to board secretary

Cognizant Manager. The responsibilities of the cognizant manager (Project, System, or Task) are to:

- Recommend board chairman and review board candidates to the convening authority
- Contribute to the generation of the review charter
- Ensure that the review data package is adequate and is distributed on schedule
- Support the review board chairman in developing the review agenda
- Recommend to the convening authority disposition of the findings and recommendations of the board
- Approve and impose the action items that are generated
- Prepare for the convening authority's approval the written response to the board's report, including how action items will be handled
- Monitor the action item status and report close out of action items to convening authority

PERSONNEL AND RESPONSIBILITIES (cont'd)

Board Chairman. The responsibilities of the board chairman are to:

- Establish an agenda, assisted by the cognizant manager, to include all information relevant to the purpose of the review
- Specify the date and location of review meetings
- Identify any unique or specific objectives, constraints, or goals of review meetings
- Appoint a secretary
- Chair the review and keep it on subject and on schedule
- Convene the review board as required to deliberate, and arrive at findings and recommendations
- Develop, where necessary, a consensus of findings of the board, including an assessment of the risk associated with problem areas; develop recommendations for action
- Ensure that a written report of findings, including recommendations for actions, is submitted on a timely basis to the convening authority with a copy to the cognizant manager and the Office of Engineering and Review
- Approve action item closure prior to distribution to board members

Board Secretary. The responsibilities of the secretary are to:

- Record comments of the board members
- Assist the chairman in preparing the board report
- Maintain a file of all board actions, including closure memoranda
- Maintain a list of action item closures and due dates for outstanding actions items

Board Members. The responsibilities of the review board members are to:

- Become familiar with the documentation and presentation material and with the objectives and criteria for assessment and evaluation prior to the review
- Participate in all scheduled meetings and contribute to the fulfillment of the objectives of the review board
- Assist in developing a disposition for the material reviewed, make recommendations for action, and contribute to the review board report

PERSONNEL AND RESPONSIBILITIES (cont'd)

- Provide signature approval of the board report or prepare a minority report

Review Presenters. The responsibilities of persons assigned to make presentations at each review are to:

- Assemble the data package for the review, including appropriate documents, and provide handouts of the oral presentation material and supplementary data as required
- Make the oral presentation and respond to questions
- Assist the cognizant manager in defining action items
- Follow up and respond in writing on action items assigned

Project Requirements Review. As is the case with other level 2 project reviews, the Requirements Review is formal and normally conducted by the standing Project Review Board.

Purpose. To assure that the project objectives (particularly the science objectives for a flight project) have been properly translated into definite and unambiguous statements of requirements; and to assure that the impact of these requirements on the design of the major project elements and systems is sufficiently well understood that trade-offs between requirements and constraints can be properly made.

REVIEW ITEMS

- Mission objectives
- Science objectives
- Mission design criteria
- Project policy and requirements
- Management structure
- Constraints
- Risk assessment

Preliminary Mission and Systems Review.

Purpose. To assure that an adequate beginning has been made in designing the project systems to meet mission and science objectives.

REVIEW ITEMS

- Final draft of the Project Requirements document
- Preliminary design documentation of the leading project system and conceptual designs of the other systems
- Design approach
- System interfaces and constraints
- Developments required
- Project/systems block diagrams
- Satisfaction of mission and science objectives
- Problems and areas of concern

REVIEW AND REVIEW ITEMS/DATA (cont'd)

Definition Plan Review

Purpose. To ensure that the scope, resources, and schedule for the effort are compatible, that the technical direction and management structure are clearly understood and viable, and that any unusual circumstances or problems are identified.

REVIEW ITEMS

- Scope of effort
- Schedule of definition phase activities with all critical milestones
- Cost plan, by month
- Workforce loading plan, by month
- Procurements (studies, consultants)
- Management structure
- Identification of key personnel
- Memoranda of Understanding with supporting Divisions
- Proposed costing methods to be used in developing that portion of the Task Implementation Plan
- Breadboard plans (if any)
- Plans for tracking resource expenditure and technical activities during definition phase
- Risk assessment

Definition Results Review.

Purpose. To evaluate the adequacy of the draft plans, assess the state of readiness to proceed into the implementation phase, examine the validity of the costs presented, and recommend any changes to the plans prior to their release.

REVIEW ITEMS

- The results of studies carried out during the definition phase
- The results of trade-offs carried out during the definition phase
- The results of at least two different costing methods (detailed, analogy, model, or contractor quotations)
- The reconciliation of the differences between the results obtained from the costing methods
- Any changes to the proposal risk assessment memorandum (flight experiments)
- Any changes to the proposal exceptions memorandum (flight experiments)
- The functional requirements document draft
- The task implementation plan draft
- Risk assessment

Implementation Plan Review.

Purpose. To assess all aspects of the Implementation Plan and to recommend remedial action, if necessary prior to its approval and implementation.

REVIEW ITEMS

- Final draft of the Implementation Plan
- Any changes in cost plans imposed by the actual funding provided by the sponsor at the initiation of the implementation phase
- Any changes in the scope imposed by the sponsor from the proposal or definition phase
- Any changes in the schedule imposed by the sponsor
- Any changes to the proposal risk assessment memorandum (flight experiments)
- Listing of exceptions to requirements of JPL Document 750-150 (flight experiments)
- Implementation organization and staffing
- Schedule and resource plans including reserves and contingency plans
- Test and training plans, criteria, deliverables, and methods
- Compliance with or waiver from all standards
- Risk assessment
- Plans for reserve utilization

If no Definition Results Review has been conducted, the following additional items are presented:

- The results of any studies carried out after the submission of the proposal or definition phase results
- The results of any trade-offs carried out after the submission of the proposal or definition phase results
- The results of at least two different costing methods (detailed, analogy, model, or contractor quotations)
- The reconciliation of the differences between the results obtained from the costing methods

User Requirements Review. This review is analogous with the project Requirements Review, and may also be conducted during the definition phase.

Purpose. To demonstrate that the Task organization has attained an understanding of the requirements that the task is to fulfill.

REVIEW ITEMS

- Review of the user needs statement
- The results of "get smart" studies
- Verification of the desired capabilities through a solicitation of inputs from future users
- The results of any trade-offs carried out as a result of new inputs
- The reconciliation of differences between the Task plans and the user needs
- Any changes in the technology mix or workforce
- Any changes to the proposal risk assessment, costs, or schedule

Functional Design Review.

Purpose. To ensure that the proposed technical direction of the task plan is conceptually viable and that any developments required for successful completion of the task are identified.

REVIEW ITEMS

- Configuration and definition of hardware and software elements
- Design approach
- Trade-offs for important design parameters
- Satisfaction of subsystem requirements by the design
- Areas of concern and problems
- Interfaces with other subsystems (hardware and software) and cables
- Man-machine interfaces and operations
- Final draft of the Functional Requirements
- Detailed end-to-end system block diagram
- Rationale for system technical approach
- Subsystem budget apportionments (error, weight, power, reliability, etc.)
- System interfaces and constraints
- Areas of technical uncertainty
- Developments required
- Identification of any differences from proposal baseline
- Design traceability

Preliminary Design Review. A large number of Preliminary Design Reviews are conducted during the life of a project or task at various levels of complexity and formality. The previously discussed Functional Design Review and Preliminary Mission and Systems Review are specific examples of top level preliminary reviews which may be required.

Purpose. The Preliminary Design Review is a review at the system, subsystem, or assembly level and is intended to assure that the proposed implementation solutions satisfy the needs and requirements within existing technologies. This review may assess the timely availability of technically qualified personnel and proper facilities.

REVIEW ITEMS

- Final functional requirements
- Compliance with functional requirements/specifications
- Suitability of inherited designs and hardware
- Environmental design requirements
- Interface design requirements
- Design parameters, restraints, and constraints
- Discussion of block diagrams
- Discussion of single-point failures (flight hardware)
- Preliminary parts, materials, and processes list
- Hardware and software development plan and schedule (including verification tests on analyses to be performed)
- Software standards to be applied
- Experiment performance analysis, including an analysis of the instrument-system accuracy requirements (flight experiments)
- Preliminary data management flow and reduction plans
- Safety, reliability, and QA compliance plans
- Plans for spares provisioning
- Support equipment requirements and plans
- Preliminary operations planning
- Schedules and status of the task including cost as well as technical developments
- Presentation of design optimization
- Documentation plans and controls
- Design traceability

REVIEW AND REVIEW ITEMS/DATA (cont'd)

Final Mission and Systems Design Review. This review is the top level Critical Design Review for a major project. See also Section 5.3.6.

Purpose. To assure that all of the final systems designs are compatible with the project objectives and mission and science requirements. It also reviews the overall macrostructure for Project systems integration and test.

REVIEW ITEMS

- Inheritance assessment
- Specifications (test and performance)
- Prototype test results
- Design mechanization and analysis
- Design trade-offs and alternatives considered
- Detailed interfaces and cable configurations
- Detailed analysis of failures
- Safety analyses and human factors
- Maintainability, repairability, operability, and reliability
- Schedule and resource plans
- Man-machine interfaces
- Training plans
- Conformance of the design to the functional requirements
- Differences between the system and subsystem performances relative to the performances estimated at the preliminary design review
- Status of preliminary design review action items
- Detailed design parameters, restraints, and constraints
- Interface details/agreements
- Weight and power
- Detail circuit drawings
- Electronic parts classification
- Screening specifictions
- Nonelectronic parts, materials, and processing list
- Purchased devices list
- Materials and processing specifications
- Identification and traceability
- Electronic and mechanical parts stress analysis results
- Worst-case analysis
- Conformance to environmental design requirements
- Details of design, construction, and electronics packaging
- QA plans and procedures
- Manufacturing plans
- Configuration control plans (hardware and software)
- Documentation status
- Flow plan and schedule status (hardware and software)
- Problem/failure reporting system
- Failure mode, effects, and analysis
- Preliminary test plans
- Developmental and detailed test results
- Qualification and acceptance test plans
- Calibration plan
- Data management plan
- Formal and informal report plans
- Final design verifications plans

REVIEW ITEMS

- Initial customer handling or operating constraints and precautions
- Spares provisioning
- Support equipment requirements
- Flight operations approach
- Schedule and cost status
- Risk assessment

Detailed (Critical) Design Review. A Detailed Design Review is conducted to match each Project or Task Preliminary Design Review. Due to high technology content or detailed technology, major projects often utilize pre-critical design reviews by individuals or teams. The results of these detailed studies are presented as a part of the Detailed (Critical) Design Review materials.

Purpose. To assure that the detailed design meets the requirements, that an adequate qualification program exists, and that detailed interfaces are compatible. This review also determines to what degree the design and reliability meet the provisions of the system design characteristics, constraints, and other controlling requirements.

REVIEW ITEMS

- Inheritance assessment
- Specifications (test and performance)
- Prototype test results
- Design mechanization and analysis
- Design trade-offs and alternatives considered
- Detailed interfaces and cable configurations
- Detailed analysis of failures
- Safety analyses and human factors
- Maintainability, repairability, operability, and reliability
- Schedule and resource plans
- Man-machine interfaces
- Training plans
- Conformance of the design to the functional requirements
- Differences between the system and subsystem performances relative to the performances estimated at the preliminary design review
- Status of preliminary design review action items
- Detailed design parameters, restraints, and constraints
- Interface details/agreements
- Weight and power
- Detail circuit drawings
- Electronic parts classification
- Screening specifictions

REVIEW AND REVIEW ITEMS/DATA (cont'd)

REVIEW ITEMS

- Nonelectronic parts, materials, and processing list
- Purchased devices list
- Materials and processing specifications
- Identification and traceability
- Electronic and mechanical parts stress analysis results
- Worst-case analysis
- Conformance to environmental design requirements
- Details of design, construction, and electronics packaging
- QA plans and procedures
- Manufacturing plans
- Configuration control plans (hardware and software)
- Documentation status
- Flow plan and schedule status (hardware and software)
- Problem/failure reporting system
- Failure mode, effects, and analysis
- Preliminary test plans
- Developmental and detailed test results
- Qualification and acceptance test plans
- Calibration plan
- Data management plan
- Formal and informal report plans
- Final design verifications plans
- Initial customer handling or operating constraints and precautions
- Spares provisioning
- Support equipment requirements
- Flight operations approach
- Schedule and cost status
- Risk assessment

Manufacturing Review. A detailed review of the procedures and facilities which will be used in the fabrication of flight hardware.

Purpose. To assure that the facilities and procedures used in the fabrication of flight hardware are adequate. Items of specific importance are the manufacturing orders and configuration control methods to be used.

REVIEW ITEMS

- Manufacturing orders
- Configuration control plans
- Manufacturing process
- Personnel certification
- Mandatory inspection points
- Rework procedures
- Review of manufacturing facilities
- Hardware protection procedures
- Production control plans

REVIEW AND REVIEW ITEMS/DATA (cont'd)

80% Complete/90-Day Review.

Purpose. To assure that the task commitments will be met and to present the plans for meeting those commitments within the time and resources remaining.

REVIEW ITEMS

- Status of effort remaining
- Final report status and outline
- Schedule of remaining activities
- Workforce and resource plan for remaining effort
- Reconciliation of remaining effort with remaining resources
- Risk assessment
- Plan for follow-on work

Subsystem Transfer Review.

Purpose. To assure that the subsystem implementation has been completed, requirements have been met, required testing has been performed and passed, required documentation and spares are delivered, training support has been provided, and any discrepancies have been resolved.

REVIEW ITEMS

- Report on acceptance test performance
- Spares status
- Documentation status
- Anomalies and liens
- Training status
- Software status

System Test Plan Review

Purpose. To assess adequacy of planning for system level test and integration, and compatibility with project level design verification.

REVIEW ITEMS

- Verification of all functional requirements
- Environmental requirements
- Draft test plans
- Test equipment design
- Test complex block diagrams
- Test layout and circuitry
- Test objectives
- Open action items requiring test to close

System Test Review

Purpose. To review results from each system level test and to assure that any open action items relative to functional or environmental qualification are resolved.

The review concentrates upon complete system test results records. It is also appropriate to review open action items and prior problem/failure history against test results. All functional requirements must be verified.

Project Capabilities Review

Purpose. To evaluate final prelaunch mission design and mission capabilities against Project requirements; to compare "as-built" capabilities of all systems with established requirements; to prepare for intersystem testing; and to close out all open action items.

REVIEW ITEMS

- All System Test Review results
- Mission design verification test plans
- Intersystem testing plans
- Problem/failure report history
- Status of all currently approved drawing and specifications, including specification changes and waivers
- Hardware status and documentation, including configuration management records

Preshipment Review

Purpose. To verify that testing is complete with no unresolved problems, and to evaluate readiness of the hardware for delivery. For a flight project, to verify the readiness of ground-based facilities at the launch site and of the integrated flight team training.

REVIEW ITEMS

- Verification of availability of current approved drawings and specifications, and of adequate definition of the item, including approved specification changes and waivers
- Review of hardware status and documentation, including all interface documentation, to assure that the latest changes have been incorporated in affected hardware, as reflected in a summary of the Engineering Change Requests
- Review of test documentation status and determination (by review of the test results) of the adequate and proper testing of hardware
- Status of prior formal review action item closures
- Review of the Problem/Failure Report documentation to determine its status and evaluate its total impact, particularly with respect to risk for the experiment
- Review of the quality history to ensure that necessary inspections have been performed and all discrepancies have been properly disposed of, including Material Review Board actions
- Review of the results of each instrument calibration report to ensure compliance with the Functional Requirements and the calibration plan, including measured instrument weight and power
- Shipping and handling requirements and plans
- Safety compliance verification
- Status and acceptability of the deliverable end item data package
- Risk assessment

Project Readiness Review. This review is required only for flight projects, and is normally chaired by the Project Manager.

Purpose. To assess results of the ground data test program; verify that the flight crew is trained and that ground system deficiencies that might affect launch and encounter have been corrected; assure that operational procedures have been verified; and assess readiness of the flight systems after integration with the injection vehicle.

This review examines any problems encountered after the flight systems have been delivered to the launch site, and assures that all integration and final testing have been satisfactorily completed.

Launch Readiness Review. Like the Project Readiness Review, this review is unique to flight projects. It is normally chaired by the Assistant Laboratory Director for Flight Projects.

Purpose. To verify that no unresolved problems exist with the flight systems, launch vehicle, launch complex, and operational configuration for launch; and to commit to launch.

REVIEW ITEMS

Same as for the Project Readiness Review, including the findings of that review.

Postlaunch Software Requirements Review

Purpose. To review adequacy of software requirements and planning for encounter operations.

REVIEW ITEMS

- All software documentation
- Current operational experiences
- Planned encounter scenarios

Orbit Operations Readiness Review. This review is required only for a flight project which involves operations in orbit about a body in space. A similar review would be required for a flight project which involved landed operations.

Purpose. To verify operational readiness for encounter.

REVIEW ITEMS

Includes as a minimum all plans for orbit insertion and science sequences in the vicinity of the objective.

Encounter Capabilities Review. This review is required only for a flight project when final refinement of operational planning requires information only available after the space systems are in orbit, e.g., precise determination of trajectories for planetary satellite encounters or orbits.

Purpose. To review any changes in mission operations planning to assure that the mission as implemented will meet project requirements; to assess the status of any capabilities being added.

REVIEW ITEMS

All operational planning and science sequence changes.

Final Report Review. This discussion addresses primarily the review of a task rather than a project.

Purpose. To review the results of the project or task, in particular the final reports, to ascertain that the report is credible and of a sufficient quality to satisfactorily represent JPL/Caltech.

REVIEW ITEMS

- Comments on the final report draft
- Customer viewpoint on task
- Potential for follow-on work
- Schedules and resources for remaining effort

CENTER NO. 1

DOCUMENT NO. 1-1

FEEDBACK

Formal Reviews. During the review, requests for action are submitted by review board members and attendees if invited to participate on forms that are provided by the secretary. Following the review these are screened by the review board to consolidate them and to ensure that the chairman and cognizant manager understand the intent of the requests. The requests for action support the findings of the board and are normally included as an attachment to the board report.

Informal Review Minimum Level. An attendee may be designated to compile the requests, which may be provided either verbally or in writing.

CLOSEOUT

Formal Reviews. The responsibility for accepting, rejecting, or acting in part on the board's recommendations rests with the cognizant manager. A written response to the board provides documentation of the disposition of the recommendations and provides assurance that the board's recommendations are properly interpreted and considered. The cognizant manager reviews proposed action items with those to whom the action is assigned. They should establish an action plan (i.e., how the action item will be resolved, by whom, when). The cognizant manager should report on the status of the action items to the convening authority, with copies to the board secretary and the Office of Engineering and Review.

Formal Reviews. Action items are closed by memorandum, and copies are sent to the chairman for approval and distribution. The memoranda are to include the supporting information for the recommended closure action. The secretary of the board maintains a file of all board actions, including closure memoranda, as a central point for all board members.

Formal Reviews. Following appropriate board deliberation and consensus where possible, the findings of the board and any recommendations are prepared by the secretary, approved by the board, and sent to the convening authority and the cognizant manager for their study and disposition. Dissenting opinions may also be attached. The cognizant manager determines disposition of the findings and recommendations; eg., identifies action items, formulates an ad hoc study team, makes policy decisions, or takes whatever action he believes is appropriate for each specific finding, concern, or recommendation.

Informal Review Minimum Level. The cognizant manager advises the convening authority by issuing a list of action items, action item assignees, and due dates.

Informal Review Minimum Level. At preestablished intervals the cognizant manager should update the listing of action item closures and obtain new closure dates on past-due items. This information is distributed periodically until all action items are closed.

Informal Review Minimum Level. A brief memo documenting findings is desirable.

CENTER NO.2

DOCUMENT NO. 2-1

CENTER NO.2

DOCUMENT NO. 2-1

LAUNCH VEHICLE COMPONENT AND SYSTEM DESIGN REVIEW

Purpose

This section establishes general guidelines and requirements for conducting launch vehicle component and system design reviews which are under the purview of NASAcenteras applicable to the Atlas/Centaur launch vehicle and its related ground support equipment. It is not intended that these reviews be held for every vehicle, but rather for new systems designs, first of a kind components and/or changes in design philosophy.

Scope

The scope of the design reviews may range from piece parts, subassemblies, unit level, systems or combined systems, on vehicle airborne or ground support hardware, and be mechanical or electrical in nature or combinations of both. Since the scope is wide, a list of common guidelines is indicated for design reviews in general. A second list indicates those criteria which may apply to a particular hardware design and should be referred to as a checklist for possible areas to be covered.

PROCEDURES

Procedures are not described in this document.

CENTER NO. 2

DOCUMENT NO. 2-1

PERSONNEL

NASA/ center Chairman
- LV Division Chief - Optional
- LVD Branch Chief/Section Head as appropriate - Optional
- Responsible System Engineer
- System Engineering Staff Engineer
- Mission Project Engineer - Optional
- Reliability and Quality Assurance Engineers - Optional

Contractors/Vendors

KSC/EV - Optional

Spacecraft Agency - Optional

RESPONSIBILITIES

The responsibilities of review board personnel are not described in this document.

CENTER NO.2

DOCUMENT NO. 2-1

REVIEW ITEMS/DATA

1. Special environmental criteria; e.g., temperature, thermal cycling, humidity, radiation, pressure, acoustic, shock or steady state loads, EMI, acceleration.

2. Size/weight considerations.

3. Mounting requirements.

4. Power, grounding or shielding requirements, connector locations, PIN assignment, etc.

5. Items for special consideration or program control; e.g., contamination, age/cycle/use limits, warning/caution marking, radiation, vibration limits, vibration effects and electrical and mechanical isolation.

6. Packaging requirements.

7. Hardware maintainability; ease of cleaning, adjusting and replacement.

8. Human engineering aspects.

9. Special tools, test equipment and facilities required for fabrication, test or operations.

10. New processes, materials or techniques required.

11. Part and material selection of vendor items to optimize reliability, standardization, availability, inspection, test, handling, preservation and application.

12. Testing at piece part, subassembly, unit and system levels.

13. Special analysis required; e.g., circuits, thermal, stress, electrical stress/derating, clearance, worst case, tolerance, test logic, error, single point failure, hazard, etc.

14. Effect on other systems or interfaces.

15. Effect on software.

16. Identification methods.

CENTER NO.2

DOCUMENT NO. 2-1

REVIEW OF REVIEW ITEMS/DATA

1. Review and approve the design requirements and criteria specified for the hardware under review.

2. Review and approve primary conceptual design and alternate designs considered.

3. Review and approve general layout or block diagram level description of primary design.

4. Review detail drawings/schematics where appropriate to explain design features.

5. Review expected performance parameters, if appropriate.

6. Review the design for failure modes and their effects on reliability, inspection, test and operation. The techniques of Failure Modes and Effects Analysis (FMEA) are used iteratively during design and development.

7. Review design checklist to assure that all aspects of design have been covered as applicable.

8. Review the design for its effects on personnel and launch vehicle safety.

9. Review and approve the test program outlined for carrying the design through development, qualification and finally hardware acceptance testing.

10. Review the design to see that it permits and facilitates producibility, repeatability and inspectability and that related quality considerations are obtained.

11. Review the schedule for design release through hardware availability.

12. Review cost, contractual status and/or vendor selection.

CENTER NO. 2

DOCUMENT NO. 2-1

FEEDBACK

No feedback process is described in this document.

CLOSEOUT

The contractor provides the necessary materials to present the design including drawings, schematics, photographs, Vu-graphs/slides and data. The contractor will also prepare the minutes and publish any action items resulting from the review with signature concurrence on the action items.

Due dates for satisfying the action items shall be established and closed as soon as possible. The status and completion of action items will be monitored by the responsible system engineer.

CENTER NO.3

DOCUMENT NO. 3-1

CENTER NO.3

DOCUMENT NO. 3-1

CONCEPTUAL DESIGN REVIEW (CODR)

PRELIMINARY DESIGN REVIEW (PDR)

CRITICAL DESIGN REVIEW (CDR)

PREFLIGHT REVIEW PRESHIPMENT READINESS REVIEW

POST FLIGHT REVIEW
PROCEDURES

This instruction sets forth the criteria, policy, and procedures for review of aeronautic and space flight projects and experiments under the management of this Center and flight experiments included as a part of a mission managed external to this Center.

The criteria stated herein are minimum requirements that will permit total visibility by a third-party review committee of the technical and management aspects of flight projects and experiments. The requirements of this instruction do not supersede other reviews imposed by NASA Headquarters, other Centers, or other reviews.

This Center will conduct the following sequential set of reviews for flight projects and experiments:

- Design Reviews
  - Conceptual Design Review (CoDR)
  - Preliminary Design Review (PDR)
  - Critical Design Review (CDR)
- Preshipment Readiness Review
- Preflight Review
- Postflight Review

This policy may be altered by the cognizant Program Director to meet unique requirements.

The above reviews are advisory in nature and do not relieve personnel of the responsibility for the success of the project or mission.

The Chairperson of each review, or the cognizant Program Director, may also establish other special reviews to supplement the above reviews.

All Program Directors are to support the above reviews. They are to furnish senior personnel, experienced in the required technical disciplines, as requested.

The Chairperson of each review shall organize the Committee and draw support from other Centers or Federal Agencies as required.

Deviations from the review policies established in this instruction may be made only with the approval of the cognizant Program Director.

The primary objective of the above reviews is to enhance the probability of success of flight missions. This will be achieved by utilizing the cumulative knowledge and skills of the team of engineers and scientists who have been selected for their experience with particular systems and functions.

The reviews will be technically oriented, however, proper consideration is to be given to operating constraints — particularly those involving primary mission objectives and program costs and schedules.

The Project Manager, or equivalent, is to insure that personnel from the appropriate NASA Headquarters Program Office are informed of review date and, to the extent practicable, arrange for reviews to be scheduled to allow NASA Headquarters' participation.

There are three levels of design reviews which are to be phased into the project/mission schedule at appropriate times. New designs are to include all three reviews; namely:

- Conceptual Design Review (CoDR) — In some cases this review may be eliminated if the concept has been demonstrated and only minor changes are necessary.
- Preliminary Design Review (PDR)
- Critical Design Review (CDR)

The CoDR will normally be scheduled at a time which will permit assessment as noted above and prior to the start of development testing.

CENTER NO.3

DOCUMENT NO. 3-1

CDR, PDR, CODR, POST FLIGHT REVIEW

PERSONNEL AND RESPONSIBILITIES

Chairperson:	Assistant Director for Systems Engineering and Operations or designated representative
Secretary:	Appointed by the Chairperson
Members:	Representative, Systems Safety, Quality and Reliability Office
	At least five representatives from supporting line organizations as deemed appropriate by the Chairperson.

The Project Manager, or equivalent, is responsible for notifying the Chairperson of a review within sufficient time so as to permit an orderly preparation of the review.

PRESHIPMENT READINESS REVIEW

Chairperson:	Chairperson, CDR Committee
Secretary:	Appointed by the Chairperson
Members:	Head, Systems Safety, Quality and Reliability Office
	At least five representatives from supporting line organizations as deemed appropriate by the Chairperson

PREFLIGHT REVIEW

Chairperson:	Cognizant Program Director
Secretary:	Appointed by the Chairperson
Members:	Chairperson, Preshipment Readiness Review
	Chief, Flight Electronics Division
	Chief, Systems Engineering Division
	Public Affairs Officer
	Head, Systems Safety, Quality and Reliability Office
	Representatives from other organizations as deemed appropriate by the Chairperson.

PERSONNEL AND RESPONSIBILITIES (Contd.)

PREFLIGHT REVIEW (Contd.)

The Chairperson is responsible for documenting the major findings of the Preflight Review resolution of all open items, and reporting flight readiness of the project/mission to the Director center.

POST FLIGHT REVIEW

The Project Manager, or equivalent, is to arrange for such a review through the cognizant Program Director.

CENTER NO. 3

DOCUMENT NO. 3-1

REVIEW ITEMS/DATA

CONCEPTUAL DESIGN REVIEW

The objective of the CoDR is to present the scientific requirements and examine the proposed design approach to accomplish these requirements by examining, completing, and presenting the:

- initial design
- trade-off studies
- alternate configurations
- selection of critical parts
- preliminary analyses
- definition of environments
- interface requirements
- Government Supplied Equipment (GSE)
- project planning
- software approach, etc.

so that the design can be examined at the conceptual level with confidence.

PRELIMINARY DESIGN REVIEW

The objective of the PDR is to examine in detail the baseline project/mission design being planned for manufacture and qualifications, validate the design approaches as related to project/mission requirements, and cover such items as:

- mechanical design layouts
- circuit designs
- design analyses
- performance analyses
- results of development testing
- GSE requirements
- manufacturing and qualification test planning
- status of reliability, quality assurance, and systems safety programs
- status of planning for data retrieval, analysis, and publication

The PDR will normally be scheduled at the completion of the preliminary design and prior to the fabrication of qualification hardware.

REVIEW ITEMS/DATA (contd.)

CRITICAL DESIGN REVIEW

The objective of the CDR is to examine details of the final design and mission, verify the final plans, design, fabrication plans, and flight acceptance test planning as related to project/mission requirements, and cover such items as:

- updated final design and analyses
- qualification test and calibration test results
- functional and performance test results
- reliability, quality assurance, and safety programs
- a review of the plans for data retrieval, analysis, and publication

The CDR will normally be scheduled at the completion of the qualification test program.

PRESHIPMENT READINESS REVIEW

The objective of the Preshipment Readiness Review is to inspect flight hardware, make final review of project/mission plans, concentrate on results of acceptance testing, and cover such items as:

- validating the quality of the hardware
- confirming that the hardware is flightworthy and will perform properly under the simulated flight environment
- assessing that the mission objectives will be met
- compliance with mission requirements and specifications
- refurbishment and recalibration plans (when required)
- shipping and storage plans
- confirmation of compatibility with all interface, weather protection, and contamination control plans
- all failures or anomalies during test
- status of safety and reliability analyses and verification of compliance with documentation requirements

The Preshipment Readiness Review will normally be held after the completion of major acceptance testing and prior to shipment of flight hardware.

PREFLIGHT REVIEW

The objective of the Preflight Review is to assess the overall readiness of the project to perform its project/mission and is to cover such items as:

- flight readiness of all hardware, software, and operational elements
- completed ground support operations
- interfaces with other flight equipment
- ground based mission support requirements
- flight operations plans
- data retrieval and processing, including ground network compatibility tests
- public information plans

The Preflight Review will normally be held as near as practicable to the flight date.

POST FLIGHT REVIEW

A Postflight Review for Center Management is to be held as soon as a general assessment of the project/mission can be made.

CENTER NO. 3

DOCUMENT NO. 3-1

FEEDBACK

Minutes

Minutes of each review are to be distributed to committee members and appropriate Division Chiefs and Program Directors.

Minutes are to be made a part of project/mission files.

CENTER NO. 3

DOCUMENT NO. 3-1

CLOSEOUT

The Project Manager, or equivalent, is responsible for insuring that appropriate action items, comments, and recommendations resulting from a review, also any open action items, are appropriately discussed at the next review.

At the conclusion of the CDR, the review committee should have confidence that they have reviewed the final design and planning, that sufficient data has been presented to demonstrate the design is compatible with the total flight system, and the project/mission will be accomplished within cost and schedule constraints.

CENTER NO.4

DOCUMENT NO. 4-1

CENTER NO.4

DOCUMENT NO. 4-1

BASELINE DESIGN REVIEW

PURPOSE

To provide policy, guidelines, and responsibilities for a consistent approach to the conduct of baseline design reviews research and development hardware and software.

SCOPE

This Instruction is applicable to all involved in the planning, research, design, development, testing, and management of space hardware and software, subject to the limitations as noted in the Instruction.

PROCEDURES

It is the policy that a consistent approach be used in the preparation and conduct of baseline design reviews for all programs, projects, payloads, and experiments managed by the Center. In consonance with this policy, it is recognized that the diversified programs and projects assigned require considerable variation in the management and operational modes used by the program/project managers. Therefore, although a consistent approach to baseline design review is essential, the scope of the individual reviews may vary. For example, in the development of experiments, a limited scope of review may be proposed and conducted, subject to agreement and concurrence of the program/project manager and the Director, Science and Engineering. For full scale reviews the complete Board Structure and documentation as specified by this Instruction will be required, consistent with the scope of the review, and subject to the agreement and concurrence of the program/project manager and the Director, Science and Engineering.

CENTER NO. 4

DOCUMENT NO. 4-1

BASELINE DESIGN REVIEW

PERSONNEL

BOARD

- PROGRAM/PROJECT MANAGER
- PROGRAM/PROJECT OFFICES LEVEL
- OFFICE OF DIRECTOR LEVEL
- CHIEF ENGINEER
- LAB DIRECTORS LEVEL
- SAFETY OFFICE AND OTHERS AS APPLICABLE
- OTHER NASA
- OTHER GOVERNMENT
- CONTRACTOR (NON-VOTING)

PREBOARD

- PROGRAM/PROJECT OFFICES LEVEL
- CHIEF ENGINEER
- LAB DIRECTORS LEVEL
- OTHER LAB PERSONNEL
- SAFETY OFFICE AND OTHERS AS APPLICABLE
- OTHER NASA
- OTHER GOVERNMENT
- CONTRACTOR (NON-VOTING)

TEAM

- PROGRAM/PROJECT OFFICES LEVEL
- CHIEF ENGINEER
- OTHER LAB PERSONNEL
- SAFETY OFFICE AND OTHERS AS APPLICABLE
- OTHER NASA
- OTHER GOVERNMENT
- CONTRACTOR (NON-VOTING)

CENTER NO.4

DOCUMENT NO. 4-1

BASELINE DESIGN REVIEW

PERSONNEL (cont'd)

SUB-TEAM

- PROGRAM/PROJECT OFFICES LEVEL
- OTHER LAB PERSONNEL
- SAFETY OFFICE AND OTHERS AS APPLICABLE
- OTHER NASA
- OTHER GOVERNMENT
- CONTRACTOR (NON-VOTING)

CENTER NO.4

DOCUMENT NO. 4-1

RESPONSIBILITIES

- Program/Project Offices are responsible for the initiation and overall conduct of design reviews and for providing a summary of each review and the results to management. This responsibility includes preparation of a Configuration Management Plan for each discrete program/project. The Configuration Management Plan will establish minimum requirements for each review. The required data and the completion percentages of the data will be included in the Configuration Management Plan following approval. Program/project managers will obtain the required concurrence from the Associate Director for Engineering, S&E. Resolution of any nonconcurrence will involve joint review and agreement by senior S&E and Program Office management.

- Science and Engineering is responsible for the technical aspects of design reviews, for providing technical support and expertise at all levels of the review, and for presenting assessments to the Program/Project Offices.

- Review Boards will review previous actions by teams and Preboards and rule on (approve/disapprove) RID action recommendations submitted by the Preboard, assuring that the design requirements levied on the program/project are met and verified, and recommend approval of the baseline documents.

- Preboards will review previous actions by teams; evaluate RID's from various technical teams; integrate or consolidate similar RID's; recommend acceptance of RID's as written or modified; recommend RID's for study; recommend RID's to the Board for resolution; and provide a summary of actions to the Board.

- Teams will evaluate RID's; integrate similar RID's from subteams; generate RID's; recommend disposition of RID's to Preboard; and provide a summary of actions to the Preboard.

- Subteams will review and evaluate data made available for review; and generate RID's. In cases where subteams are not required, these responsibilities will be carried out at the team level.

CENTER NO.4

DOCUMENT NO. 4-1

REVIEW ITEMS/DATA

- SCIENCE REQUIREMENTS LISTING
- DRAWINGS, SKETCHES AND SCHEMATICS
- ANALYSES
- STUDY REPORTS
- DESIGN CONCEPT DOCUMENTS
- PRELIMINARY INTERFACE REQUIREMENTS
- REQUIREMENTS SPECIFICATIONS
- PRELIMINARY WBS
- GENERAL TEST PLANS
- PRELIMINARY R&QA PLANS
- PHASE B STUDY RESULTS
- DEVELOPMENT PLANS
- FLOW DIAGRAMS
- SAFETY ANALYSIS
- SAFETY ANALYSIS
- FMEA AND CRITICAL ITEM LIST
- TEST VERIFICATION/VALIDATION PLANS
- INTERFACE REQUIREMENTS
- PART 1 CEI SPECIFICATION (DRAFT)
- SYSTEM DESCRIPTION DOCUMENT
- WBS
- SOFTWARE PROGRAM DESIGN DOCUMENT
- SPARES PHILOSOPHY
- ICOs
- TEST RESULTS (PRELIMINARY)
- CODE TO DESIGN SPECIFICATIONS
- USERS MANUALS
- ACCEPTANCE TEST
- SPARES LIST
- INTEGRATION PLANS
- SUBSYSTEMS DESCRIPTION DOCUMENT
- ALL TECHNICAL DATA, DRAWINGS, AND SPECIFICATIONS
- DELIVERABLE DATA PER CONTRACT
- DATA AS DEFINED IN PACKAGE OF DES REVIEW ANNOUNCEMENT

CENTER NO.4

DOCUMENT NO. 4-1

REVIEW ITEMS/DATA (cont'd)

- VERIFY CONFIGURATION CONCEPTS AND REQUIREMENTS
- VERIFY MISSION OBJECTIVES
- QUALIFY APPROACH
- ESTABLISH AND APPROVE PROGRAM/PROJECT REQUIREMENTS BASELINE
- BASIC DESIGN APPROACH
- COMPATIBLE DESIGN/REQUIREMENTS
- TEST PLANNING
- SAFETY ASSESSMENT
- ESTABLISH AND APPROVE DESIGN REQUIREMENTS BASELINE
- CONFIGURATION DESIGN
- SYSTEMS COMPATIBILITY
- DESIGN INTEGRITY
- RELIABILITY ASSESSMENT
- ESTABLISH SCHEDULE
- ESTABLISH AND APPROVE "DRAWING BASELINE"
- CONFIGURATION WAIVERS AND DEVIATIONS
- VALIDATE QUALIFICATION TESTS
- ASSESS SYSTEM TESTS
- ACCEPT GSE CONFIGURATION
- ESTABLISH AND APPROVE PRODUCT CONFIGURATION BASELINE
- REVIEW CRITICAL HARDWARE
- REVIEW PARTICAL
- ASSESS DEFICIENCIES
- CERTIFY DESIGN
- CERTIFY READINESS

CENTER NO. 4

DOCUMENT NO. 4-1

FEEDBACK AND CLOSEOUT

- Review Boards will review previous actions by teams and Preboards and rule on (approve/disapprove) RID action recommendations submitted by the Preboard, assuring that the design requirements levied on the program/project are met and verified, and recommend approval of the baseline documents.

- Preboards will review previous actions by teams; evaluate RID's from various technical teams; integrate or consolidate similar RID's; recommend acceptance of RID's as written or modified; recommend RID's for study; recommend RID's to the Board for resolution; and provide a summary of actions to the Board.

- Teams will evaluate RID's; integrate similar RID's from subteams; generate RID's; recommend disposition of RID's to Preboard; and provide a summary of actions to the Preboard.

- Subteams will review and evaluate data made available for review; and generate RID's. In cases where subteams are not required, these responsibilities will be carried out at the team level.

CENTER NO.5

DOCUMENT NOS. 5-1 & 5-2

CENTER NO.5

DOCUMENT NO. 5-1

DESIGN ENGINEERING SHUTTLE TRANSPORTATION

SYSTEM READINESS REVIEW CYCLE

PURPOSE

This directive establishes requirements, organizational responsibilities and procedures to be used within DE for the preparation of the Launch Readiness Review cycle presentations.

Readiness Reviews (LRR)

The following reviews are required:

(a) ET/SRB Mate Review

(b) Pre-Stack Review

(c) VAB Rollout Review

(d) Launch Readiness Review

CENTER NO.5

DOCUMENT NO. 5-1

PERSONNEL AND RESPONSIBILITIES

- Project Management Directorate, DF
  (1) Prepares LRR/Pre-LRR presentations.
  (2) Disseminates schedules and program requirements within DE for Readiness Reviews.
  (3) Provides representations at all Readiness Reviews.
  (4) Establishment of badging requirements and distribution.
- Mechanical and Facilities Engineering Directorate (DD) and the Electronic Directorate (DL). Provides design support to DF as required in the development of Readiness Reviews.
- Management Operations Office, DE-MOO
  (1) Develop policy for Readiness Reviews.
  (2) Coordinate with other elements to ensure that DE policies and procedures are compatible with policy.

CENTER NO.5

DOCUMENT NO. 5-1

REVIEW ITEMS/DATA

The Readiness Review Cycle typical coverage will include:

- major configuration changes subsequent to previous launch.
- previous anomalies, damage or problems as related to the activity under review.

Present the status of priority spare parts.

- the Systems Assurance Analyses (SAA's). List the numbers of category 1, 1S and 2 single failure points (SFP's) and residual hazards and discuss those for which the risks have not been accepted.
- a status of the Operation and maintenance Requirements and Specifications Documentation (OMRSD) and acceptance of waivers received from O&M.
- a summary assessment of the readiness of the design of the hardware and software to support achievement of the objectives of the milestone event.
- a listing of all approved changes not yet installed, that are required to support the milestone event.

CENTER NO.5

DOCUMENT NO. 5-1

FEEDBACK

- Review major configuration changes subsequent to previous launch.
- Review previous anomalies, damage or problems as related to the activity under review.
- Present the status of priority spare parts.
- Review the Systems Assurance Analyses (SAA's). List the numbers of category 1, 1S and 2 single failure points (SFP's) and residual hazards and discuss those for which the risks have not been accepted.
- Present a status of the Operation and maintenance Requirements and Specifications Documentation (OMRSD) and acceptance of waivers received from O&M.
- Present a summary assessment of the readiness of the design of the hardware and software to support achievement of the objectives of the milestone event.
- Provide a listing of all approved changes not yet installed, that are required to support the milestone event.

CENTER NO. 5

DOCUMENT NO. 5-2

SPACE TRANSPORTATION SYSTEM
FLIGHT READINESS REVIEW

PURPOSE

This Directive establishes the role of the Center in support of the Orbital Flight Test (OFT) Program flight readiness review (FRR) cycle.

APPLICABILITY AND SCOPE

This Directive applies to all organizational elements and serves as the authority document for preparation and conduct of the Flight Readiness Review (FRR). It also defines the Center's responsibilities in support of the National Aeronautics and Space Administration (NASA) Office of Space Transportation Systems (OSTS) OFT FRR. However, this Directive recognizes that the Payload Mission Managers are responsible for the individual mission payloads and they will execute "Certification of Flight Readiness" documents and FRR functions which are outside the scope of this Directive.

CENTER NO.5

DOCUMENT NO. 5-2

PROCEDURES

The FRR cycle provides a means of assessing the readiness of flight hardware and supporting (hardware/software) systems to successfully accomplish assigned functions during launch, flight, and landing operations of the space vehicle, cargo, and flight crews for each Orbital Flight Test (OFT) flight.

An FRR will be scheduled approximately two weeks prior to each OFT flight. All activities/elements necessary for safe and successful conduct of the forthcoming flight will be reviewed at each FRR as follows:

- Pre-FRR Level II Reviews. Prior to each FRR, appropriate Level II reviews covering all elements associated with the upcoming flight will be scheduled and conducted at locations designated by Level II. Results of the Level II reviews will be documented and provided to the FRR board members no later than one day prior to the FRR. This documentation should include minutes of the proceedings, review item dispositions (RIDs), and signed statements of flight readiness for applicable categories.

- FRR Conduct. FRRs will be chaired by the Associate Administrator/Space Transportation System (AA/STS), and board members will be designated by him. Routine status, background and/or subsystems descriptions will be limited to those necessary for adequate coverage of the issues on the agenda. The agenda will be developed by Level II, in coordination with the Program Director, to emphasize significant issues and open items identified at or subsequent to Level II reviews.

- Post-FRR. All action items and open work identified at the FRR must be formally closed prior to flight with the signature of the Program Manager and Program Director or their designated representatives. The closeout documentation is to include a brief summary narrative description of the actions taken on each FRR action item and the documentation necessary to support the summary narrative (e.g., vugraph material). In addition, open items that arise subsequent to the FRR that could delay the flight, change test vehicle configuration, or cause basic changes to the operations planning are to be reported to the Program Director.

Prior to each launch, the Level II Program Manager will review and present closeout rationale for all open items at an L-2 day meeting with the Program Director and the AA/STS.

CENTER NO. 5

DOCUMENT NO. 5-2

PROCEDURES (cont'd)

The normal preparation [illegible] in support of a FRR shall begin by a flight readiness review (FRR) which will be scheduled 5 days prior to, and in preparation for, the Pre-FRR. The [illegible] FRR shall be chaired by the Manager, Shuttle Projects Office and presented to the Center director. The review will describe and document the readiness state of the vehicle, GSE, vehicle cargo, supporting systems and facilities, and launch, landing, and recovery teams to successfully accomplish launch of the STS vehicle in support of OFTs.

A Special FRR for STS-0 will be required due to the uniqueness of the FRF as part of the CDDT for FMOF and shall be conducted by the Manager, Shuttle Projects Office. This review will describe and document the state of STS-0 readiness for successfully accomplishing the CDDT/FRF. A subsequent Delta FRR will be accomplished for STS-1, and it will be controlled within the management structure

CENTER NO.5

DOCUMENT NO. 5-2

PERSONNEL AND RESPONSIBILITIES

The Manager, Shuttle Projects Office is responsible for:

- Serving as the intercenter interface with NASA Headquarters and other centers for support of the FRR.

- Receiving, interpreting, and disseminating FRR requirements, guidelines, agenda, and schedule.

- Providing a representative to serve as a member of the FRR Secretariat to arrange for:

  - Meeting facilities.

  - Access controls.

  FRR Secretariat support, to include office space, furniture, supplies, clerical assistance, reproduction facilities, and telephones.

Reporting to Level I & II with the assistance of the Directors of Shuttle Operations, Design Engineering, Technical Support, Cargo Operations, Administration and Management Operations, Safety, R&QA and Protective Services, the Manager, Cargo Projects Office, and the Biomedical Office on the readiness of the space vehicle, GSE, Shuttle to Cargo Integration, launch and landing facilities, support services, and ETR support services as follows:

- -Presenting data on:

  - Open work.

  - Significant issues.

  - Status of vehicle and launch support facilities, systems, equipment, range support, launch commit criteria, and other routine operational support (e.g., personnel training, documentation, etc.).

  - Category 1, 1S, and 2 SFPs residual hazards and problem reports.

  - Deviation/Waivers.

  - Operation and Maintenance Instructions (OMIs) status.

  - Other data deemed pertinent to, or requested by, OSTS to be presented to Levels I and II.

PERSONNEL AND RESPONSIBILITIES (cont'd)

- Certifying the readiness of the space vehicle, facilities, systems, equipment, support, launch and landing support, and team services to support launch and landing for each flight

Chairing the FRR.

- Developing guidelines and coordinating requirements with the Directors of participating primary organizations.
- Identifying items which require resolution prior to launch, and assigning these items to the cognizant Director.
- Providing the following facilities, arrangements, or services:
  - Date of the FRR and agenda.
  - Meeting facilities, including audio-visual equipment.
  - Access control and seat allocations.
  - Secretariat to record FRR action items.

The Director of Design Engineering is responsible for:

- Presenting an assessment of 1, 1R, 1S & 2 criticality categories as defined by the Facilities, Systems and Equipment Organizational Level OMD Baseline and essential to the support of launch and landing operations.
- Presenting, in summary format, a listing of all Category 1, 1R, 1S, and 2 single failure points (SFPs) and residual design hazards (RDHS) that have been identified. The list should indicate those items for which the Center Director has accepted risks and dates of acceptances. (This includes system, line replaceable units (LRUs), and components.)
- Discussing the status of software under his cognizance and associated residual hazards.
- Summarizing significant changes in configuration of launch support facilities and systems baseline.
- Discussing open mandatory modifications, identifying those for which modification packages are to be released, and providing impact of modifications upon the launch operations vehicle and systems.
- Identifying and discussing any significant problems which could impact the launch schedule.

PERSONNEL AND RESPONSIBILITIES (cont'd)

The Directors of Shuttle Operations and Technical Support are responsible for presenting their respective assessments of facilities, systems, and equipment including associated hardware (within their O&M responsibility) as defined by the Facilities, Systems and Equipment Organizational Level OMD Baseline and essential to launch and landing operations. The Director of Shuttle Operations is also responsible for presenting an assessment of the flight hardware/software relative to the launch and landing operations function. The presentations shall include:

- Open work and special tests to be completed (e.g.,OMIs, Category II paper, Operations & Maintenance Requirements/Specifications (OMRS) not met, Engineering Support Requests (ESRs), and concerns related to their successful completion).

- Open or potential problems documented by problem report(s), deviation/waiver(s) or equivalent report(s). The discussion should identify operational concern, corrective action in work or planned, and impact on the launch schedule.

- Status of the launch commit criteria and a discussion of any changes (deltas) to the previous mission baseline.

- Identification and status of any essential facility, system, or equipment not operational due to shortage of spare parts, including discussion of any work-arounds.

- A discussion of significant changes in the CDDT and launch countdown OMIs.

- Status of other operations and support functions, to include, but not be limited to, the following:

  - Range support.

  - Personnel training.

  - Replacement of limited life components.

  - Material shortages.

  - Documentation.

- Status of operational software.

- A summary of all residual operational hazards including those associated with the operational software.

The Director of Shuttle Operations will sign the Certification of Flight Readiness, Endorsement #2.

The Director of Administration and Management Operations is responsible for presenting an assessment of the availability of spare parts for support of essential facilities, systems, and equipment reported nonoperational.

PERSONNEL AND RESPONSIBILITIES (cont'd)

The Director, Safety, R&QA, and Protective Services is responsible for:

- Reporting on the status of security, fire and rescue plans, training, equipment, and personnel.

- Summarizing the design and operational hazardous situations and providing the status of open hazards in the Integrated Hazard Analysis.

The Director, Biomedical Office is responsible for presenting an assessment of medical equipment, facilities, and personnel within the Biomedical Office's area of responsibility.

The Manager, Cargo Projects Office and the Director of Cargo Operations are responsible for presenting their respective assessments of facilities, systems, and equipment including associated hardware (within their O&M responsibility) as defined by the Facilities, Systems, and Equipment Organizational Level OMD Baseline and essential to the cargo processing facility, GSE, and software. The Manager, Cargo Projects Office, and the Director of Cargo Operations are also responsible for presenting an assessment of responsibilities. The presentations shall include:

- Open work and special tests to be completed (e.g., OMIs, Category II paper, Operations & Maintenance Requirements/Specifications (OMRS) not met, Engineering Support Requests (ESRs), and concerns related to their successful completion).

- Open or potential problems documented by problem report(s), deviation/waiver(s) or equivalent report(s). The discussion should identify operational concern, corrective action in work or planned, and impact on the launch schedule.

- Status of the launch commit criteria and a discussion of any changes (deltas) to the previous mission baseline.

- Identification and status of any essential facility, system, or equipment not operational due to shortage of spare parts, including discussion of any work-arounds.

- A discussion of significant changes in the CDDF and launch countdown OMIs.

PERSONNEL AND RESPONSIBILITIES (cont'd)

- Status of other operations and support functions, to include, but not be limited to the following:
  - Range support.
  - Personnel training.
  - Replacement of limited life components.
  - Material shortages.
  - Documentation.
- Status of operational software.
- A summary of all residual operational hazards.

The Manager, Cargo Projects Office and the Director of Cargo Operations are responsible for implementing the necessary reviews, certifications and assessments related to the OFT cargo and elements thereof in preparation for the STS FRR.

CENTER NO.6

DOCUMENT NO. 6-1

CENTER NO. 6

DOCUMENT NO. 6-1

DESIGN CERTIFICATION REVIEW

PURPOSE

The purpose of this plan is to define the activities for accomplishing the Space Shuttle Program Orbital Flight Test (OFT) Design Certification Review (DCR).

SCOPE

This plan establishes schedules, responsibilities, and procedures for the organization and presentation of briefings and supporting data required for the OFT Design Certification Review.

APPLICABILITY

This plan is applicable to all NASA organizations and their contractors who have responsibility for the design and development of Space Shuttle System flight and ground hardware and software.

CENTER NO. 6

DOCUMENT NO. 6-1

PROCEDURES

The Design Certification Review is a formal, comprehensive review of all hardware and software elements of the Space Shuttle System. The primary review will be conducted at the project level with summary briefings and certifications presented to program management and will culminate in final presentations to the DCR Board chaired by the Associate Administrator for Space Transportation Systems.

The presentations must show:

- Design requirements and end item specifications are consistent.
- Design requirements have been met and confirmed by test results and/or analyses.
- Appropriate remedial actions have been taken to resolve any significant problems that have arisen.
- Open items and issues that must be resolved before flight?

The oral briefings to the DCR Board will be supplemented by written statements by cognizant managers certifying that hardware and/or software elements for which they are responsible meet all of the requirements set forth in applicable specifications (or that approved waivers have been obtained) and are capable of supporting the Space Shuttle Orbital Flight Test Program.

PROCEDURES (cont'd)

DCR CYCLE - The DCR will be divided into three phases:

- o Phase I - Individual review of data and preparation of briefings by respective project managers
- o Phase II - Program Manager's review and critique of the summary briefings and supporting data
- o Phase III - Summary briefings with written supporting data to the DCR Board

Phase I - Phase I will consist of reviews by individual project managers covering the respective program elements for which they have responsibility. Design assessment briefings will be prepared by the appropriate NASA/contractor organizations and presented to the respective project managers for review. Corrective actions and revisions resulting from these reviews will be incorporated into the briefings prior to the Phase II review.

Phase II - Phase II will consist of a preboard review of the presentations and supporting data on all program elements by the Program Manager.

The purpose of the Phase II review is to:

- o Assure adequate depth, accuracy and consistency of coverage for each element of the Space Shuttle System .
- o Technically critique the data to be submitted, and the proposed presentations.
- o Assure that presentations and supporting data are properly integrated for submittal to the DCR Board.

The presentations and supporting data for Phase II should approach the content of the briefings and data to be submitted during Phase III. Material added to, or revised in, the briefings on supporting data subsequent to the Phase II review should be

coordinated with the Program Manager prior to Phase III of the DCR. Changes and revisions should be made only as the result of:

- o Additional test results, solutions to problems, and reliability/verification data.
- o Response to action items.
- o Open item closures.
- o Actions assigned by the Program Manager.
- o New problems and proposed corrective actions.

Phase III - Phase III of the DCR will consist of the oral briefings and supporting data to the DCR Board established and chaired by the Associate Administrator for Space Transportation Systems.

Post-Phase III - Subsequent to the Phase III review, actions assigned by the DCR Board must be completed by the responsible program elements. Recommended action closures will be submitted through the Program Manager and the Program Director to the Associate Administrator for recommended closure. All assigned actions must be closed prior to the Flight Readiness Review (FRR) for the applicable orbital flight.

CENTER NO. 6

DOCUMENT NO. 6-1

PERSONNEL AND RESPONSIBILITIES

Space Shuttle Program Director - is responsible for:

- o Organizing, scheduling and conducting Phase III of the DCR.
- o Reviewing proposed closeout of action items assigned during Phase III.
- o Preparing and executing a Space Shuttle Program Design Certification Document identifying any actions upon which certification of the Space Shuttle System is contingent.

Manager, Space Shuttle Program - is responsible for:

- o Planning for the OFT DCR.
- o Organizing, scheduling and conducting Phase II of the DCR.
- o Establishing and chairing a Phase II DCR Pre-Board.
- o Reviewing and approving closeout of actions resulting from the Phase II review.
- o Reviewing and approving additions or revisions to the Phase II presentations and supporting data.
- o Reviewing proposed closeout of actions resulting from the Phase III review and submitting recommended closeouts to the Program Director and the Associate Administrator for Space Transportation Systems.

PERSONNEL AND RESPONSIBILITIES (cont'd)

Manager for Management Integration - is responsible for:

- o Detailed planning for the OFT DCR.
- o Reviewing formats and element plans for the DCR briefings and supporting data.
- o Providing the status of DCR implementation progress to the Program Manager.

Manager for Systems Integration - is responsible for:

- o Implementing the requirements of the OFT DCR Plan relative to Space Shuttle System Integration tasks.
- o Reviewing and critiquing the DCR Phase I Space Shuttle System Integration Plan.
- o Assuring the preparation and updating of the Space Shuttle System Integration briefing and supporting data.
- o Presenting the Space Shuttle System Integration assessment and certification at the Phase II and Phase III DCR Reviews.

Project Managers - The project managers for the Orbiter, the Space Shuttle Main Engine, the External Tank, the Solid Rocket Booster, Crew Related Government-Furnished Equipment, Launch and Landing, and Integrated Communications and Data Systems are responsible for:

- o Implementing the requirements of the OFT DCR Plan within their respective projects.
- o Reviewing and critiquing the DCR Phase I Space Shuttle reports for their project elements.
- o Assuring the preparation and updating of the briefings and supporting data for the Phase II and Phase III DCR Reviews.

PERSONNEL AND RESPONSIBILITIES (cont'd)

- Presenting the assessment and certification for their project elements at the Phase II and Phase III DCR Reviews.

Director, Safety, Reliability and Quality Assurance (SR&QA) - The Director, SR&QA, is responsible for:

- Presenting a summary of hardware/software Level II accepted risks; projects will present Level III accepted risks.
- Reviewing and critiquing the DCR data presented at the Phase II and Phase III reviews.

PHASE I REVIEW

ORGANIZATION	SYSTEM/ELEMENT	APPROVAL RESPONSIBILITIES
JSC	Sys. Int.	Mgr. Sys. Int.
	Integr. Comm. & Data Sys.	Mgr. Integr. Comm. & Data Sys.
	GFE	Mgr. GFE Proj.
	Orbiter	Mgr. Orb. Proj.
	Safety	Director - SR&QA
MSFC	ET	Mgr. ET
	SSME	Mgr. ET
	SRB	Mgr. SRB
KSC	Launch & Landing	Mgr. Launch & Landing Proj.

PERSONNEL AND RESPONSIBILITIES (cont'd)

PHASE II REVIEW

Approval Responsibility - DCR Preboard

Preboard membership is as follows:

Chairman: JSC SS Program Mgr.

Members: MSFC Shuttle Proj. Mgr.

KSC Shuttle Proj. Mgr.

JSC Dir. of Engineering and Development

JSC Shuttle Payload Integration and Development Prog. Mgr.

JSC Director of Flight Operations

JSC Manager for OFT

JSC Dir. of Data Systems and Analysis

JSC Dir. of Safety, Reliability & Quality Assur.

JSC Manager Program Operations

JSC Dir. of Space and Life Sciences

SAMSO-Deputy for Space Launch Systems

NASA Hqs. Director, Space Shuttle Program (ex officio)

JSC Director (ex officio)

JSC Deputy Director (ex officio)

PHASE III REVIEW

Approval Responsibility - DCR Board

Chaired by the Assoc. Admin. for Space Transportation Systems, membership will be established at a later date.

CENTER NO.7

DOCUMENT NO. 7-1

CENTER NO.7

DOCUMENT NO. 7-1

PERSONNEL AND RESPONSIBILITIES

The Director of Office of Flight Assurance has overall responsibility for the Spacecraft Design Review Program (SDRP), and will appoint the members and Chairman of each Design Review Team (DRT) by memorandum.

The Chief, Systems Review Office is responsible for implementing and executing design reviews and generating design review plans and procedures.

FEEDBACK AND CLOSEOUT

At the completion of each review a formal report to the Director, will be prepared by the DRT. Minimum requirements of the report are:

(a) a summary statement of the DRT findings;

(b) recommendations made by the DRT to the project; and

(c) comments or responses of the project to the findings and recommendations of the DRT.

The completed design review report will contain the results of each review conducted for the project together with a mission launch readiness statement issued by the Chairman of the DRT.

The design review report will be issued and formally accepted by the Director prior to the launch operation.

CENTER NO. 7

DOCUMENT NO. 7-1

SPACECRAFT DESIGN REVIEW PROGRAM

PURPOSE

This instruction defines the policy and general procedures for the design review of projects.

APPLICABILITY

The provisions of this instruction are applicable to all spacecraft projects, including experiments and unique support equipment.

DEFINITION

Design Review is a systematic, technically oriented, and documented evaluation of spacecraft and associated equipment by a team of specialists.

CENTER NO. 7

DOCUMENT NO. 7-1

PROCEDURES

All spacecraft and major flight experiments shall be subject to the SDRP.

The SDRP shall be supported by all Directorates who will furnish the DRT with senior personnel experienced in the required technical disciplines.

DESIGN REVIEW OBJECTIVES

The primary objectives of the SDRP is to enhance the probability of success of spacecraft missions. This objective will be achieved by bringing **to bear on each project the cumulative knowledge of a team of engineers and scientists who have had extensive prior experience with the particular types of systems and functions involved. While the design review is technically oriented, proper consideration will be given to constraints operating on the projects; particularly those involving primary mission objectives and program costs and schedules. These reviews shall assure that each project has the benefit of Centerwide experience gained on other projects. They shall also provide the Center's review of the projects' Systems Safety Program.**

The Design Review Team

The DRT will include personnel experienced in design, systems engineering and integration, reliability, quality assurance, testing, materials, and other applicable disciplines. The personnel will be selected from throughout the Center with the approval of the appropriate Directors.

Number of Reviews

(1) The Chief, Systems Review Office, Office of Flight Assurance, in conjunction with the individual Project Manager will develop a total design review plan. Except in cases of repeat missions, the following reviews will normally be held:

(a) Design Reviews - these reviews occur during the design phase and prior to the start of assembly. They will emphasize implementations of design approaches resulting from the study phase as well as test plans for the prototype and flight systems. For new systems generally two design reviews will be conducted.

(b) Environmental Review - this review occurs after prototype qualification testing, or prior to acceptance testing if no prototype is used. The primary purpose of this review is to determine the qualification status of the hardware and to evaluate flight acceptance test plans.

(c) Flight Readiness Review - this review will usually take place prior to shipment of the flight spacecraft to the launch range, and will concentrate on spacecraft performance during acceptance testing.

(d) Flight Operational Readiness Review - this review will be conducted when a flight operations plan is available. While all of the previous reviews involve operations, this review will emphasize the final orbital operations plans, as well as the compatibility of the spacecraft with ground support equipment and ground network, including summary results of the network compatibility tests.

(2) All flight experiments which are required for mission success are subject to this review program. One or two Experiment design reviews, depending on need, shall be held prior to integration.

Design Review Schedule

The several reviews will be conducted on a schedule determined by the Chief, Systems Review Office after consultation with the individual Project Manager. The major reviews shall be depicted in the Monthly Status Review.

APPENDIX E

APPLICATION OF MINIMUM STANDARD REVIEWS TO PAYLOAD CLASSIFICATIONS

The issue of the applicability of the six identified minimum standard reviews to the payload classifications defined in NMI 8010.1 was addressed based on the data available. Only one of the documents reviewed addressed the identification of the nature of the reviews or the requirements for data evaluation as a function of payload classification. Therefore, the guidelines contained in this appendix are the result of limited input from NASA documents combined with interpretation and judgement by ARINC Research based on the definitions of the payload classifications. Consequently, these review requirements should be reviewed with the individual centers to obtain more NASA input.

Due to the nature of Class D payloads, where formal design verification requirements are limited to safety and STS-compatibility verification, no attempt was made to evaluate the applicability of different reviews or data items. In practice, most of these payloads will be provided to NASA by private companies or universities (such as Getaway Special canisters), who will perform the majority of the reviews internally. Reviews by NASA will be limited to safety and interface analyses, with limited formal evaluation by NASA of their performance characteristics. In general, the requirements for the evaluation of Class C payloads could be followed for a Class D payload where applicable and cost-effective.

The classification of the six minimum reviews as a function of payload classifications A, B and C is shown in Table E-1.

Most of the reviews are formal reviews, which have the following characteristics:

- The convening authority issues a written charter for the review which identifies the scope and objective of the review. The charter delineates the Board members, review agenda, location, timetable for the review activities, and specific areas the board will address.

- The review board consists of the board chairman, board secretary and an appropriate number of personnel with the proper qualifications to address the issues before the Board.

Table E-1. CLASSIFICATION OF REVIEWS			
Review	Class A	Class B	Class C
Preliminary Requirements Review	Formal	Formal	Informal
Preliminary Design Review	Formal	Formal	Informal
Critical Design Review	Formal	Formal	Informal
Preshipment Review	Formal	Formal	Informal
Design Certification	Formal	Formal	Formal
Flight Readiness Review	Formal	Formal	Formal

- Review presentation is generally in the form of viewgraphs, with copies provided to Review Board members and other attendees.

- Requests for action are submitted by Review Board members (and other attendees if invited to participate) on forms provided by the Board secretary. Following the review, the review board reviews the actions items, consolidates them and ensures that the chairman and cognizant manager understand the intent of the requests. These requests for action are normally included as an attachment to the board report.

- Following appropriate Board deliberation and consensus where possible, the findings of the Board and any recommendations are prepared by the secretary, approved by the Board, and sent to the convening authority and the cognizant manager for their study and disposition. Dissenting opinions may also be attached. The cognizant manager determines disposition of the findings and recommendations; e.g., identifies action items, formulates an ad hoc study team, makes policy decisions, or takes whatever action he believes is appropriate for each specific finding, concern, or recommendation.

- The responsibility for accepting, rejecting, or acting in part on the Board's recommendations rests with the cognizant manager. A written response to the board provides documentation of the disposition of the recommendations and provides assurance that the Board's recommendations are properly interpreted and considered. The cognizant manager reviews proposed action items with those to whom the action is assigned. They should establish an action plan (i.e., how the action item will be resolved, by whom, when). The cognizant manager should report on the status of the action items to the convening authority, with copies to the Board secretary and the Office of Engineering and Review.

- Action items are closed by memorandum, and copies are sent to the chairman for approval and distribution. The memoranda are to include the supporting information for the recommended closure action. The secretary of the Board maintains a file of all Board actions, including closure memoranda, as a central point for all Board members.

A number of the reviews for Class C payloads may be informal in nature. An informal review is distinguished from a formal review in that:

- A memorandum identifying the review subject, chairman, independent reviewer(s), review time and location replaces a formal written charter for the review.

- The Review Board may consist of a Board chairman and a minimum number of individuals, consistent with the size of the program, not associated with the program or project under review.

- Review presentation material may be limited to existing documentation, rather than more formal viewgraphs or other specially-prepared material.

- Requests for action during the review may be oral or written but special forms are not required.

- A brief memo may be used to document the review findings rather than a formal report.

- Levying the closure of action items may be accomplished by the cognizant manager rather than through formal memoranda to the Review Board.

- At preestablished intervals the cognizant manager should update the listing of action item closures and obtain new closure dates on past-due items. This information is distributed periodically until all action items are closed.

Other aspects of an informal review are similar to a formal review.

The last reviews for a Class C payload, the DCR and the FRR, should be formal reviews to provide the opportunity for more formal review and documentation of the project or program prior to flight commitment. It was felt that informal reviews were not appropriate in the final stages of the system development.

The applicability of the evaluation of specific data items as a function of payload classification during the six reviews is shown in Tables E-2 through E-7. No distinction could be made between A and B payloads for these minimum review items. The evaluation of certain data items are either not required for Class C payloads, limited to top-level analysis, or limited to safety and STS interface requirements only.

Table E-2. PRELIMINARY REQUIREMENTS REVIEW DATA EVALUATION APPLICABILITY

Review Item/Data	Class A	Class B	Class C
- Statement of mission objectives	X	X	X
- Mission requirements analyses	X	X	X
- Preliminary preferred requirements	X	X	X
- Functional analyses	X	X	X
- Preliminary interface requirements	X	X	X
- Support agreements	X	X	X
- Preliminary reliability and quality assurance requirements	X	X	X
- Scientific requirements	X	X	X
- Concept drawings and sketches	X	X	X
- Block and logic diagrams	X	X	Top-Level only
- Costs and schedules	X	X	X
- Design concept documentation	X	X	X
- General test requirements	X	X	X
- Preliminary study reports	X	X	X
- Heritage analyses	X	X	

Table E-3. PRELIMINARY DESIGN REVIEW DATA EVALUATION APPLICABILITY

Review Item/Data	Class A	Class B	Class C
- Status of PRR action items	X	X	X
- Final functional requirements	X	X	X
- Functional requirements/-specifications compliance analyses	X	X	X
- Inherited designs and hardware suitability analyses	X	X	
- Environmental design requirements	X	X	X
- Interface design requirements	X	X	X
- Design parameters, restraints, and constraints	X	X	
- Block diagrams	X	X	
- Single-point failure analyses	X	X	
- Preliminary parts, materials, and processes list	X	X	X
- Hardware and software development and schedule (including verification tests on analyses to be performed)	X	X	X
- Software standards to be applied	X	X	X
- Experiment performance analysis	X	X	Safety and STS interface items only

Table E-3. PRELIMINARY DESIGN REVIEW DATA EVALUATION APPLICABILITY (continued)

Review Item/Data	Class A	Class B	Class C
- Preliminary data management flow and reduction plans	X	X	X
- Safety, reliability, and quality assurance compliance plans	X	X	X
- Spares provisioning plans	X	X	X
- Support equipment requirements and plans	X	X	X
- Preliminary operations planning	X	X	X
- Schedules and status of the project including cost as well as technical developments	X	X	X
- Design optimization analyses	X	X	X
- Plans and controls documentation	X	X	X
- Design traceability	X	X	

Table E-4. CRITICAL DESIGN REVIEW DATA EVALUATION APPLICABILITY			
Review Item/Data	Class A	Class B	Class C
- Status of PDR action items	X	X	X
- Hardware and software inheritance	X	X	
- Specifications (test and performance)	X	X	X
- Prototype test results	X	X	X
- Design mechanization and analysis	X	X	
- Design trade-offs and alternatives considered	X	X	X
- Detailed interfaces and cable configurations	X	X	STS interfaces only
- Detailed analysis of failure modes	X	X	
- Safety analyses and human factors	X	X	X
- Maintainability, repairability, operability, and reliability	X	X	
- Schedule and resource plans	X	X	X
- Man-machine interfaces	X	X	STS interfaces only
- Training plans	X	X	X
- Conformance of the design to the functional requirements	X	X	X
- Differences between the system and subsystem performances relative to the performances estimated at the preliminary design review	X	X	X
- Detailed design parameters, restraints, and constraints	X	X	X

Table E-4. CRITICAL DESIGN REVIEW DATA EVALUATION APPLICABILITY (continued)

Review Item/Data	Class A	Class B	Class C
- Interface details/agreements	X	X	X
- Weight and power	X	X	X
- Detail circuit drawings	X	X	
- Electronic parts classification	X	X	
- Screening specifications	X	X	
- Nonelectronic parts, materials, and processing list	X	X	
- Purchased devices lists	X	X	
- Materials and processing specifications	X	X	
- Identification and traceability of materials and specifications	X	X	Lot traceability
- Electronic and mechanical parts stress analysis results	X	X	
- Worst-case analysis of end-item failure	X	X	
- Conformance to environmental design requirements	X	X	X
- Details of design, construction, and electronics packaging	X	X	X
- Quality assurance plans and procedures	X	X	X
- Manufacturing plans	X	X	
- Configuration control plans (hardware and software)	X	X	X

Table E-4. CRITICAL DESIGN REVIEW DATA EVALUATION APPLICABILITY (continued)

Review Item/Data	Class A	Class B	Class C
- Documentation status	X	X	X
- Flow plan and schedule status (hardware and software)	X	X	X
- Problem/failure reporting system	X	X	X
- Failure modes and effects analysis	X	X	
- Preliminary test plans	X	X	X
- Developmental and detailed test results	X	X	X
- Qualification and acceptance test plans	X	X	X
- Calibration plan	X	X	X
- Data management plan	X	X	X
- Formal and informal report plans	X	X	
- Final design verifications plans	X	X	X
- Initial user handling or operating constraints and precautions	X	X	X
- Spares provisioning	X	X	X
- Support equipment requirements	X	X	X
- Flight operations approach	X	X	X
- Schedule and cost status	X	X	X
- Risk assessment	X	X	X

Table E-5. PRESHIPMENT REVIEW DATA EVALUATION APPLICABILITY

Review Item/Data	Class A	Class B	Class C
- Status of prior action item closeouts	X	X	X
- Current approved drawings and specifications, and adequate definition of the end-item, including approved specification changes and waivers	X	X	Top assembly drawings and definition of end-item
- End-item status and documentation, including all interface documentation, to assure that the latest changes have been incorporated in affected hardware	X	X	X
- Test documentation status and determination (by review of the test results) of the adequate and proper testing of end-items	X	X	X
- Problem/Failure Report documentation to determine its status and evaluate its total impact, particularly with respect to risk for the mission	X	X	Safety and STS interface items only
- Quality assurance history documentation to ensure that necessary inspections have been performed and all discrepancies have been properly closed out	X	X	X
- Shipping and handling requirements and plans	X	X	X
- Safety compliance verification	X	X	X
- Status and acceptability of the deliverable end-item data package	X	X	X
- Risk assessment	X	X	X

Table E-6. DESIGN CERTIFICATION REVIEW DATA EVALUATION APPLICABILITY

Review Item/Data	Class A	Class B	Class C
- Status of previous action items	X	X	X
- Item change data	X	X	X
- Analysis and test documentation	X	X	
- Reliability documentation	X	X	X
- Safety analyses and human factors	X	X	X
- Specified requirements derived from mission objectives	X	X	X
- Previous failures/incidents analysis	X	X	X
- Physical and functional configuration verification	X	X	Safety and STS interface items only
- Validation of analytical models of equipment and system	X	X	
- Validation of thermal control design approach	X	X	
- Hazards control review	X	X	X
- Safety system and subsystem checklist	X	X	X
- Training of ground flight personnel	X	X	X
- Operational plans and status	X	X	X
- Mission rules	X	X	X

Table E-6. DESIGN CERTIFICATION REVIEW DATA EVALUATION APPLICABILITY (continued)

Review Item/Data	Class A	Class B	Class C
- Results and status of verification planning, testing and analysis for the total system and associated ground support systems	X	X	X
- Deviations from baseline configuration	X	X	X
- Configuration inspection documentation	X	X	X

Table E-7. FLIGHT READINESS REVIEW DATA EVALUATION APPLICABILITY

Review Item/Data	Class A	Class B	Class C
- Status of prior action item closeouts	X	X	X
- Status of vehicle and launch support facilities, systems, equipment, range support, launch commit criteria and personnel training	X	X	X
- Residual hazards and problem reports	X	X	X
- Status of operation/maintenance instructions	X	X	X
- Configuration changes since prior review	X	X	X
- Hardware and software anomalies	X	X	X
- Status of development and qualification testing	X	X	X
- Limited life components, life remaining, and age life/time cycle	X	X	
- Status of logistics readiness (spares support)	X	X	
- Verification of documentation completion	X	X	X
- Identification of actual hardware shortages and open work items	X	X	X
- Safety, reliability, and quality assurance assessment	X	X	X
- Identification of problems that may constrain the flight	X	X	X
- Failures/incidents and accidents reports	X	X	X