NASA Procedural Requirements

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COMPLIANCE IS MANDATORY

NASA Research and Technology Program and Project Management Requirements (w/change 1 dated 11/24/10)

Responsible Office: Office of the Chief Engineer

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Change History

NPR 7120.8 NASA Research and Technology Program and Project Management Requirements

Chg #	Date	Description/Comments
1	10/26/10	Change url in 2.2.1.1b from https://polaris.nasa.gov to https://nen.nasa.gov/web/pm to migrate program & project information

Preface

P.1 Purpose

a. This document establishes the program and project management requirements by which NASA will formulate and execute research and technology (R&T), consistent with the governance model contained in NASA Policy Directive (NPD) 1000.0, NASA Strategic Management and Governance Handbook.

P.2 Applicability

a. This NASA Procedural Requirements (NPR) applies to NASA Headquarters and NASA Field Centers, including Component Facilities and the Jet Propulsion Laboratory, and contractors/service providers to the extent specified in their contracts with NASA.

b. This NPR applies to all current and future R&T managed or funded by NASA (excluding all NASA funded programs, projects, and activities managed under NPR 7120.5, NASA Space Flight Program and Project Management Requirements, NPR 7120.7, Institutional Infrastructure and Information Technology Program and Project Management Requirements, and investments funded with Center discretionary funds within Center General and Administrative (G&A)). R&T programs and projects shall be managed using NPR 7120.5 in lieu of this NPR when: 1) the R&T is directly funded by a space flight program/project; and 2) the space flight mission's success and schedule are directly tied to the success of the R&T. For existing R&T programs and projects, the requirements of this document are applicable to the program/project's extant phase as of the effective date of this NPR and to phases yet to be initiated.

c. In cases of any conflict between NPR 7120.5 and this NPR, NPR 7120.5 shall take precedence. The NASA Associate Administrator (AA), Mission Directorate Associate Administrator (MDAA) or the Mission Support Office Director (MSOD) may direct the use of NPR 7120.5 in lieu of this NPR for any R&T investment.

P.3 Authority

a. 42 U.S.C. 2473(c)(1), Section 203(c) (1) of the National Aeronautics and Space Act of 1958, as amended.

b. NPD 7120.4, Program/Project Management.

P.4 Applicable Documents

a. NPD 1000.0, Strategic Management and Governance Handbook.

b. NPD 1000.3, The NASA Organization.

c. NPD 7120.4, Program/Project Management.

P.5 Measurement/Verification

a. Compliance with this document is verified through oversight by the governing Program Management Council (PMC) and NASA internal controls described in NPD 1200.1, NASA Internal Control and Accountability. Special audits are performed per NPD 1000.0, Strategic Management and Governance Handbook.

P.6 Cancellation

a. NPR 7120.5C, NASA Program and Project Management Processes and Requirements, dated March 2005, is cancelled for Basic and Applied Research (BAR) and Advanced Technology Development (ATD).

/s/
Michael Ryschkewitsch
NASA Chief Engineer

Chapter 1. Introduction

1.1 Background

1.1.1 This document establishes the process by which NASA will formulate and implement R&T managed or funded by NASA consistent with the governance model contained in NPD 1000.0, NASA Strategic Management and Governance Handbook. NASA manages a wide variety of R&T, including but not limited to, scientific research, aeronautics research, and technology developed for space activities. Due to this wide-range of activities, this NPR does not standardize this development into a single process but unifies the overarching management requirements for R&T. This NPR then establishes the management processes and practices available for NASA R&T activities and identifies the Decision Authority (DA) responsible to select the appropriate process.

1.1.2 Central to building this cohesive management process is the introduction of NASA R&T program and project life cycles and the identification of the Key Decision Points (KDPs) within these life cycles. Along with program and project life cycles and KDPs, this document also defines the roles and responsibilities of key personnel responsible for NASA R&T program and project management.

1.1.3 This document distinguishes between programmatic requirements, on the one hand, and management process requirements, on the other. Both categories of requirements must ultimately be satisfied in program and project formulation and implementation. Programmatic requirements focus on the products to be developed and delivered and specifically relate to the goals and objectives of a particular NASA program or project.

1.1.4 Management process requirements focus on how NASA does business and are independent of any particular program or project. These requirements are issued by NASA Headquarters, including the Office of the Administrator, Mission Directorates (MDs), Mission Support Offices (MSOs), and by Center organizations. Management process requirements may respond to Federal statute, regulation, treaty, or executive order.

1.2 Overview of Management Process

1.2.1 Program and project management based on life cycles, KDPs, and evolving products during each life-cycle phase are embedded in NASA's four-part process for managing programs and projects consisting of:

a. **Formulation** - the assessment of feasibility, technology and concepts, risk assessment, team-building, development of operations concepts and acquisition strategies, establishment of high-level requirements and success criteria, the preparation of plans, budgets, and schedules essential to the success of a program or project, and the identification of how the program or project supports the Agency's strategic needs, goals, and objectives.

b. **Approval** - the ongoing effort by responsible officials above the program and project management level to review plans and performance at key decision points and authorize continuation of the effort and progression to the next phase.

c. **Implementation** - the execution of approved plans for the development and operation of

programs and projects, the establishment of control systems to ensure performance to plan, and alignment with current Agency strategies.

d. **Evaluation** - the continual, independent (i.e., outside the advocacy chain of the program/project) evaluation of the performance of a program or project, and incorporation of the evaluation findings to ensure adequacy of planning and execution according to plan.

1.2.2 Program and project management philosophy at NASA reflects NASA's core values of Safety, Teamwork, Integrity, and Mission Success. All organizational elements and employees of NASA must adhere to these core values, which are repeated here for emphasis:

a. **Safety** - NASA's constant attention to safety is the cornerstone upon which we build mission success. We are committed, individually and as a team, to protecting the safety and health of the public, our team members, and those assets that the Nation entrusts to us.

b. **Teamwork** - NASA's most powerful tool for achieving mission success is a multi-disciplinary team of competent people. The Agency will build high-performing teams that are committed to continuous learning, trust, and openness to innovation and new ideas.

c. **Integrity** - NASA is committed to an environment of trust, built upon honesty, ethical behavior, respect, and candor. Building trust through ethical conduct as individuals and as an organization is a necessary component of mission success.

d. **Mission Success** - NASA's reason for being is to conduct successful space missions on behalf of this Nation. We undertake missions to explore, discover, and learn. And we believe that mission success is the natural consequence of an uncompromising commitment to safety, teamwork, and integrity.

1.3 Document Structure

1.3.1 This document is organized as follows: Chapter 2 defines NASA life cycles for managing R&T; Chapter 3 defines the requirements for R&T programs; Chapter 4 provides Technology Development (TD) Project requirements; and Chapter 5 provides R&T Portfolio Project requirements.

1.3.2 The Appendices contain Technology Readiness Levels (TRLs), Work Breakdown Structure (WBS), References, Definition of Terms, Acronyms, and templates for key management documents.

1.3.3 In this document, a requirement is identified by "shall," a good practice by "should," permission by "may" or "can," expectation by "will," and descriptive material by "is" or "are."

Chapter 2. NASA Life Cycles for Managing Research and Technology

2.1 Programs

2.1.1 Program Definition and Life Cycle

2.1.1.1 The following definitions are used to define Programs within this NPR:

a. **Program** - a strategic investment by a Mission Directorate (MD) or Mission Support Office (MSO) that has a defined architecture and/or technical approach, requirements, funding level, and a management structure that initiates and directs one or more Agency projects. A program defines a strategic direction that the Agency has identified as critical. It should also be noted that not all programs adhere to this NPR.

b. **Agency Program** - a program confirmed to be on the current list of programs within the "Program and Project List" at https://nen.r https://nen.nasa.gov/web/pm/ and/or the Meta-Data Manager (MdM) https://nsminfo.nasa.gov/nsminfo/home/Home.aspx. Programs on these lists are particular, because they are issued four digit alpha numeric designators by the Office of the Chief Financial Officer (OCFO) for organizing funding within NASA and explaining NASA's funding to external groups. Also, Agency-level organizations such as the Office of the Administrator, Program Analysis and Evaluation (PA&E), the Office of the Chief Engineer (OCE), the OCFO, and the Office of Safety and Mission Assurance (OSMA) track, monitor, and assess the health and success of Agency programs. While most programs are Agency programs, there are special cases such as in Cross-Program Research or Center discretionary funding where the Agency or personnel within the Agency may refer to an investment as a program when it is not on these lists. An Agency program may consist of Space Flight Projects, TD Projects, R&T Portfolio Projects, and Institutional Projects. It should also be noted that not all Agency programs adhere to this NPR.

Agency programs are usually long-term commitments by the Agency with a common focus. Because of this, NASA rarely begins new programs and they may appear to have no beginning, end, or life cycle. In actuality, Agency programs do follow a specific life cycle, usually in an ongoing program implementation phase with periodic program reviews and the cyclical starts and stops of projects.

c. **R&T Program** - an Agency program that is strictly comprised of R&T projects. The R&T Program life cycle is defined in Figure 2.1.1. The life cycle includes the minimum set of reviews and gate products. The R&T Program management requirements are defined in Chapters 2 and 3 of this document.

d. **Cross-Program Research** - collective management of R&T Portfolio Projects taken from various Agency programs within the MD or MSO. Cross-Program Research is controlled by a Research Director (typically at NASA Headquarters (HQ)) rather than a Program Lead. The Cross-Program Research management requirements are defined in Chapter 3, Section 3.5.

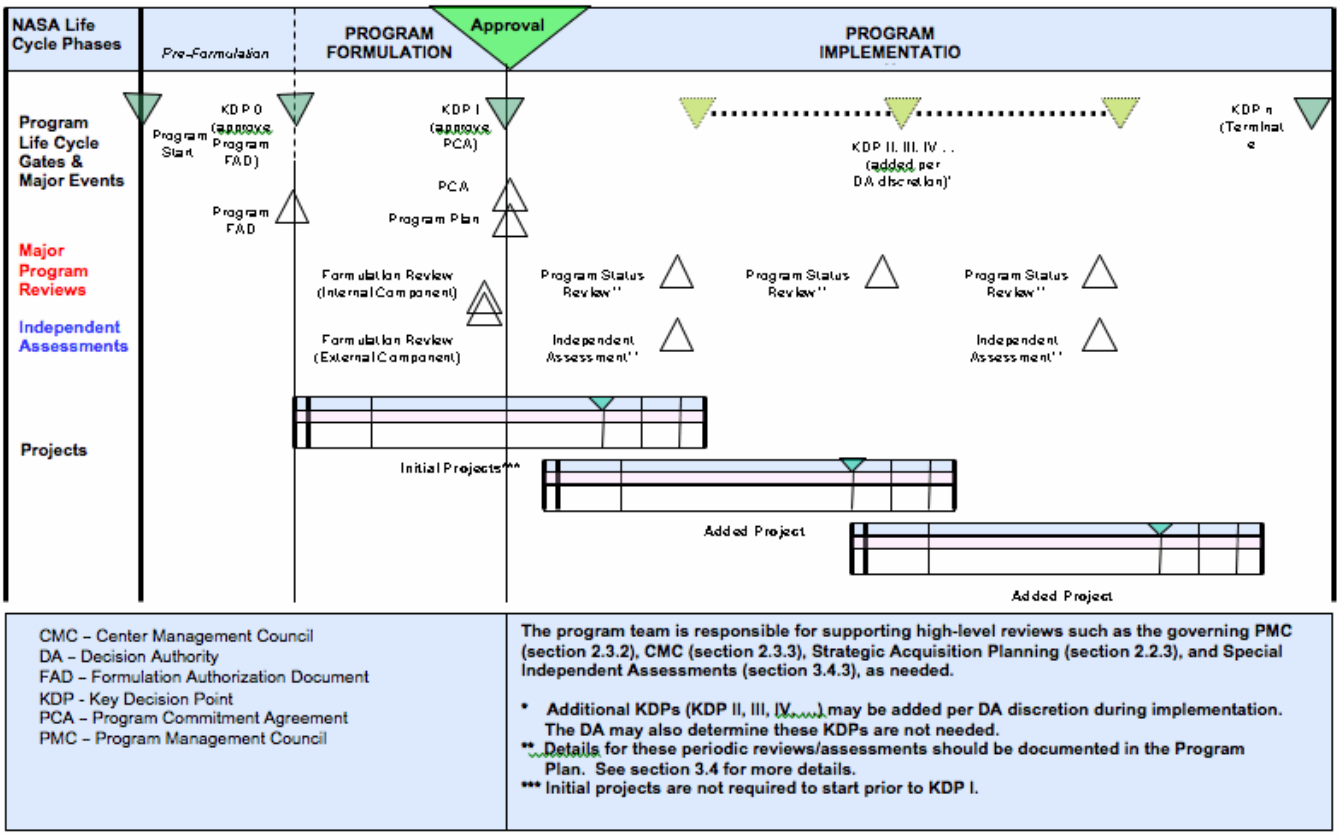


Figure 2.1.1 R&T Program Life Cycle (Chapter 3)

2.2 Research and Technology Projects

2.2.1 Project Definitions and Life Cycles

2.2.1.1 The following definitions are used to define projects within this NPR:

a. Project - specific investment identified in a Program Plan having defined requirements, a life-cycle cost, a beginning, and an end. A project yields new or revised products that directly address NASA's strategic needs. It should also be noted that not all projects adhere to this NPR.

b. Agency Project - a project confirmed to be on the current list of projects within the "Program and Project List" at https://polaris.nasa.gov/ and/or the Meta-Data Manager (MdM) https://nsminfo.nasa.gov/nsminfo/home/Home.aspx. Projects on these lists are particular, because they are issued six digit alpha numeric designators by the Office of the Chief Financial Officer (OCFO) for organizing funding within NASA and explaining NASA's funding to external groups. Also, Agency-level organizations such as the Office of the Administrator, Program Analysis and Evaluation (PA&E), the OCE, the OCFO, and the OSMA track, monitor, and assess the health and success of Agency projects. While most projects are Agency projects, there are cases where lower- level projects (e.g., project elements) are confused with Agency projects or personnel within the Agency refer to specific Center investments as projects when they are not on these lists. It should also be noted that not all Agency projects adhere to this NPR.

c. R&T Project - an Agency project that is strictly comprised of R&T investments. Compared to other projects, R&T projects tend to define a cost/schedule structure rather than a life-cycle cost (LCC) and end date. R&T projects are managed as Technology Development (TD) Projects (as defined in Chapter 4 of this NPR) or as R&T Portfolio Projects (as defined in Chapter 5 of this NPR).

d. Technology Development (TD) Project - a specific R&T project identified in an Agency Program Plan as a TD Project. The TD Project is managed by a Project Lead who reports to a Program Lead. The TD Project life cycle is defined in Figure 2.2.1. The TD Project management requirements are defined in Chapter 4 of this document. A TD Project may be referenced elsewhere in Agency documentation as Advanced Technology Development (ATD).

e. R&T Portfolio Project - a specific R&T project identified in an Agency Program Plan as an R&T Portfolio Project. An R&T Portfolio Project may be made up of one or more groups of R&T investigations that address the goals and objectives of the R&T Portfolio Project. An R&T Portfolio Project is managed by a Project Lead who reports to a Program Lead or Research Director. The R&T Portfolio Project life cycle is defined in Figure 2.2.2. The R&T Portfolio Project management requirements are defined

in Chapter 5 of this document. An R&T Portfolio Project may be referenced elsewhere in Agency documentation as Basic and Applied Research (BAR).

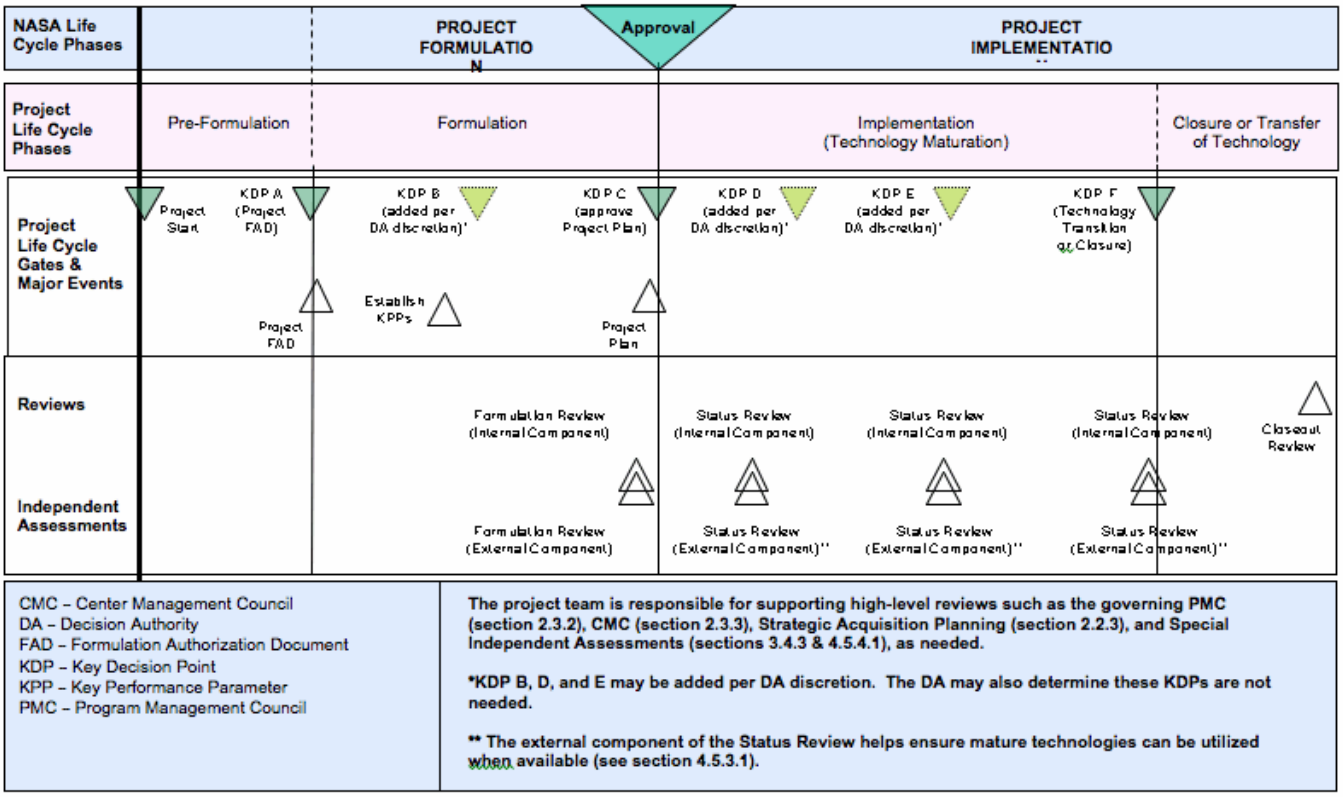


Figure 2.2.1 Technology Development Project Life Cycle (Chapter 4)

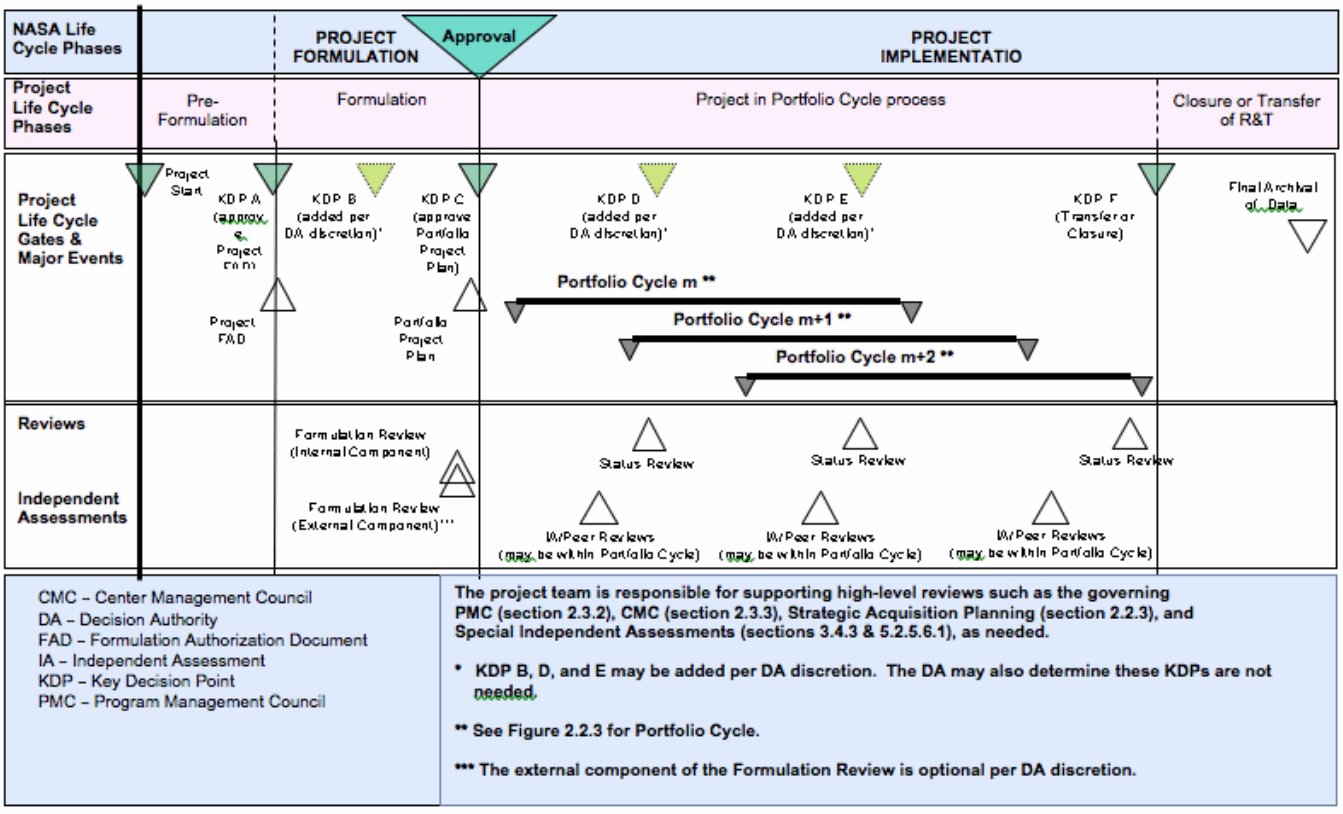


Figure 2.2.2 R&T Portfolio Project Life Cycle (Chapter 5)

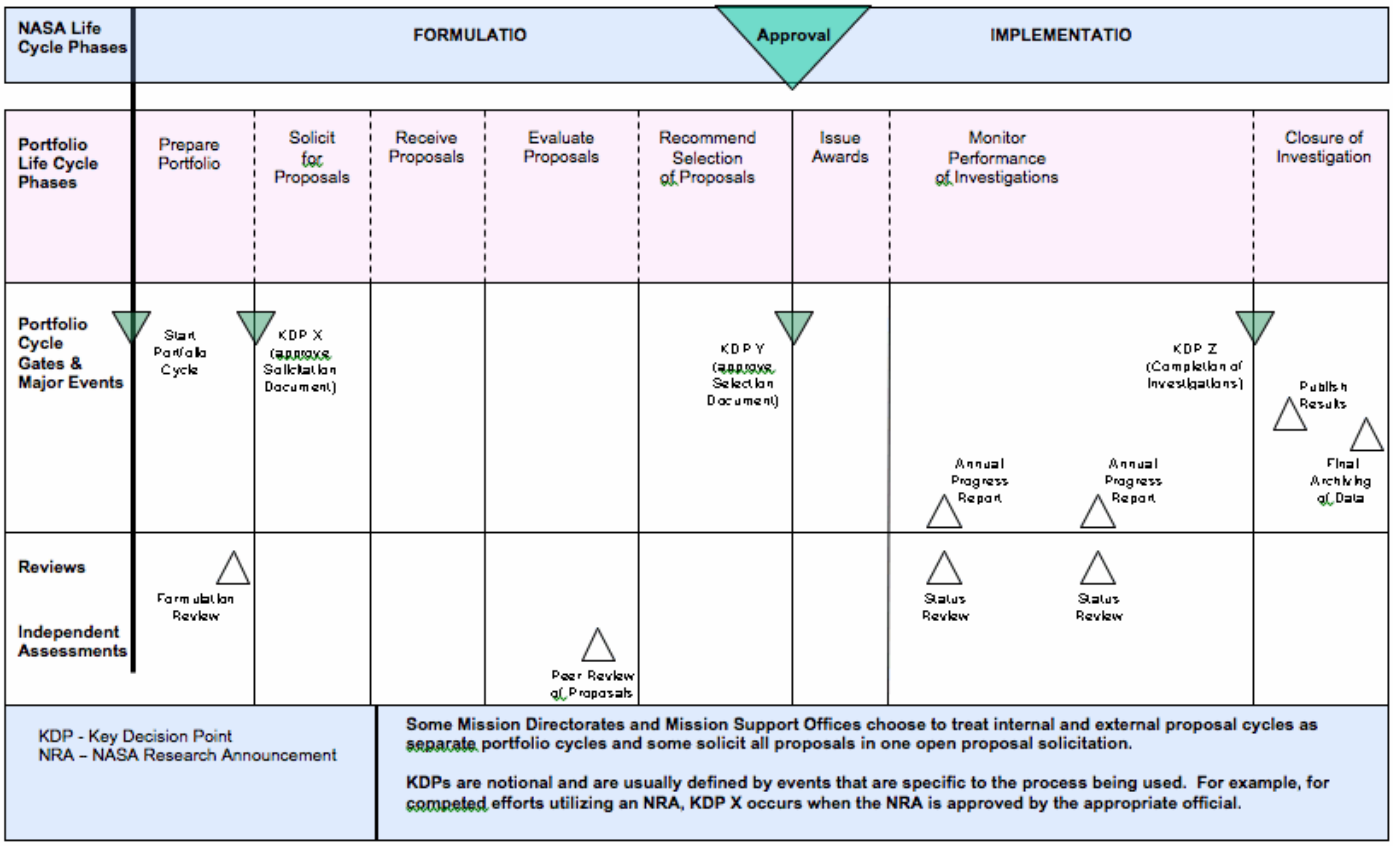


Figure 2.2.3 Portfolio Cycle (Chapter 5)

2.2.2 Meta-Data Manager (MdM)

2.2.2.1 The OCFO with assistance from the OCE maintains the official database of NASA programs and projects known as the MdM. This database is the basis for the Agency's WBS and forms the structure for program and project status reporting across all MDs and MSOs.

2.2.3 Strategic Acquisition Planning

2.2.3.1 NASA's strategic acquisition planning and authorization is a continuous process requiring the earliest possible informed decisions to ensure programs and projects have the proper budget authorization and Agency commitment.

2.2.3.2 Three discrete acquisition events facilitate this decision process: the Acquisition Strategy Planning (ASP) meeting, the Acquisition Strategy Meeting (ASM), and the Procurement Strategy Meeting (PSM).

2.2.3.2.1 The ASP provides the forum for senior Agency management to review major acquisitions before authorizing budget/expenditures. The ASP meeting is used during approval of programs and projects for formulation.

2.2.3.2.2 The ASM examines the Agency's acquisition approach (e.g., internal make-or-buy, Center assignments, etc.). The ASM is program- or project-specific and is more detailed than the ASP meeting. The ASM occurs during the program and project formulation and approval processes.

2.2.3.2.3 The PSM, formerly called the Acquisition Strategy Meeting, approves the procurement approach for each procurement. The PSM is project- or contract-specific and is developed by the Project Lead, supported by the Contracting Officer, and approved as prescribed in NPR 5100.4, Federal Acquisition Regulation Supplement (NASA/FAR Supplement) [48 CFR 1800-1899].

2.2.3.3 R&T Programs, TD Projects, and R&T Portfolio Projects are subject to each of these three strategic acquisition events.

2.2.3.3.1 Applicability of the ASP and the ASM is dependent on multiple factors, including associated resources and workforce parameters. To determine ASP and/or ASM applicability, and to obtain additional guidance regarding these meetings, the cognizant MD or MSO will consult with NASA Headquarters, Office of Program and Institutional Integration.

2.2.3.3.2 To determine PSM applicability, the cognizant MD or MSO, supported by the Project Lead and the Contracting Officer, will consult with NASA Headquarters, Office of Procurement, Program Operations Division.

2.2.3.3.3 When determined applicable, these three strategic acquisition events are part of the normal program and project formulation and implementation activities described in the following paragraphs and chapters.

2.3 R&T Program, Technology Development (TD) Project, and R&T Portfolio Project Oversight and Approval

2.3.1 This section describes NASA's oversight approach for R&T Programs, TD Projects, and R&T Portfolio Projects. This section also defines KDPs and the Decision Authority (DA) responsible for approval of each KDP.

2.3.2 To ensure the appropriate level of management oversight, NASA has established a hierarchy of Program Management Councils (PMCs)?the Agency PMC and MD PMCs (or MSO equivalent). Each council has the responsibility of periodically evaluating the cost, schedule, risk, and performance of Agency programs or Agency projects under its purview. The evaluation focuses on whether the Agency program or Agency project is meeting its commitments to the Agency and is following appropriate management processes. Each Agency program and Agency project has a governing PMC that provides management oversight. For R&T Programs, TD Projects, and R&T Portfolio Projects, the governing PMC and the DA for each KDP are defined in Table 2.3.1 and Table 2.3.2 (see Table 5.1.1 for more detail on R&T Portfolio Projects).

	R&T Program (Figure 2.1.1)	**Comments**
Approving Official for Start and KDP 0	MDAA (or MSOD)	
Program Decision Authority (DA) (KDP I, II, III, ... n)	NASA Associate Administrator (AA)	While the R&T Program KDP I is the NASA AA's signature on the R&T Program Commitment Agreement (PCA), the MDAA or MSOD concurrently signs the R&T Program Plan for an R&T Program to continue into implementation. The NASA AA can delegate responsibility to the MDAA or MSOD (see section 3.3.3.1.5). Optional KDPs (KDP II, III, IV, ...) may be added per DA discretion during implementation. The DA may also determine these optional KDPs are not needed.
Selecting Official for Formulation Review Team	NASA AA	The NASA AA can delegate responsibility to the MDAA or MSOD for selection of the Formulation Review team. This refers to the Formulation Review in section 3.3.3.3.
Selecting Official for Independent Assessment Team(s)	MDAA or MSOD	This refers to the independent assessments specific to section 3.4.1. The MDAA or MSOD can delegate responsibility for selection of independent assessment team(s). The Associate Administrator for PA&E will ensure that the team(s) and process is independent and objective. The MDAA or MSOD must obtain approval from the AA for PA&E and the Chief Engineer per section 3.4.1. Other independent assessments may occur per section 3.4.
Governing PMC	Agency PMC	The Agency PMC can delegate oversight responsibility to the MD PMC or MSO equivalent.
Governing Document	R&T Program Plan	The R&T Program Plan is approved by the MDAA or MSOD.

The R&T Program and Project Plans must reflect modifications due to the comments above and document the attendant rationale for the change.

Table 2.3.1 Summary of Authorities for R&T Programs

	Technology Development Project (Figure 2.2.1)	**R&T Portfolio Project** (Figure 2.2.2)	**Comments**
Approving Official for Start	MDAA (or MSOD)	MDAA (or MSOD)	The MDAA or MSOD can delegate responsibility to the Program Lead or Research Director.
Project Decision Authority (DA) (KDP A-F)	MDAA (or MSOD)	MDAA (or MSOD)	The MDAA or MSOD can delegate responsibility to the Program Lead or Research Director.
Selecting Official for Independent Assessment and Formulation Review Team(s)	MDAA (or MSOD)	MDAA (or MSOD)	The MDAA or MSOD can delegate responsibility to the Program Lead or Research Director. This refers to the Formulation Review in section 4.3.4.3 and 5.2.3.5. This refers to the independent assessments in section 4.5.2.4 and 5.2.5.6.1. The MDAA or MSOD must obtain approval from the Chief Engineer and the AA for PA&E per section 4.3.4.3.2 and 4.5.2.4.
Governing PMC	MD PMCor MSO equivalent	MD PMC or MSO equivalent	
Governing Document	TD Project Plan	R&T Portfolio Project Plan	The TD and R&T Portfolio Project Plans are approved by the Project DA with concurrence by the Program Lead/Research Director and applicable Center Director(s) (CD).

The R&T Program and Project Plans must reflect modifications due to the comments above and document the attendant rationale for the change.

Table 2.3.2 Summary of Authorities for R&T Projects

2.3.3 Oversight of Agency programs and Agency projects is also performed by a Center Management Council (CMC), which may evaluate all R&T work executed at that Center. The CMC evaluation is an independent assessment that focuses on whether Center engineering and management practices (e.g., resources, contracting, institutional, and technical authority) are being followed by the R&T work under review, and whether Center resources can support R&T work requirements. The evaluation should also focus on the technical authority role of the Center to ensure technical and scientific integrity of work conducted at that Center. A CMC provides its findings and recommendations to the governing PMC.

2.3.4 A KDP occurs when the DA determines the readiness of a program or project to progress to the next phase of its life cycle. As such, KDPs serve as gates through which programs and projects must pass. To support the decision process, a KDP is typically preceded by one or more reviews. KDPs enable a disciplined approach to assessing programs and projects. The potential outcomes at a KDP include:

a. Approval to enter the next phase of the life cycle.

b. Approval to enter the next phase of the life cycle, pending resolution of actions.

c. Disapproval to enter the next phase of the life cycle, with a decision to terminate.

d. Disapproval to enter the next phase of the life cycle, with follow-up actions required. In such cases, follow-up actions are documented and the KDP is redone after the follow-up actions are completed.

2.3.5 To support the decision process, the DA will designate the required supporting materials (gate products) that will be submitted in support of the KDP. These materials may include: the governing PMC review recommendation; the Independent Assessment (IA) report; the Program Lead's recommendation; the Project Lead's recommendation; Cost Estimation reports; the CMC's recommendation; relevant lessons learned; any documents requiring the DA signature (e.g., R&T Program FAD, R&T Program Plan, and R&T PCA); and any other documentation the DA deems appropriate.

2.3.6 The DA's decision is based on consideration of a number of factors, including but not limited to:

a. Continued relevance to the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan.

b. Technical quality of effort.

c. Continued cost affordability with respect to the Agency's resources.

d. Remaining risks (cost, schedule, technical, management, programmatic, safety).

e. Infrastructure resource readiness.

f. The viability and the readiness to proceed to the next phase.

2.3.7 At each KDP, the DA reviews the program or project to ensure that it is currently in line with the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan. At each KDP, the DA ensures that the criteria defined in the Preface P.2 are currently applicable to continue use of this NPR in lieu of NPR 7120.5, NASA Space Flight Program and Project Management Requirements.

2.3.8 To complete formal actions at a KDP, the DA makes and documents the decision and its basis (including materials presented, major issues, options, and open action items) and archives the documents, as appropriate. Following the decision, the DA signs the applicable documents, if no changes are required. If changes are required, the documents are revised, all parties-to signatures obtained, and resubmitted to the DA for final signature. Dissenting opinions are resolved in accordance with the process described in section 3.6.

2.4 Program and Project Reviews

2.4.1 The program and project reviews identified in the life cycles are essential elements of conducting, managing, evaluating, and approving R&T programs/projects. R&T programs and projects must conduct the appropriate independent reviews or assessments that assure the relevance, quality, and performance of the program or project per the requirements in the White House guidance: http://www.whitehouse.gov/omb/part/. See the Quality Assessment Process and Performance Measurement Metrics in NPR 1080.1, NASA Science Management for additional guidance on assessments. In preparation for these reviews, programs and projects may conduct internal reviews to establish and manage the program/project baseline. Programs and projects are required to document in their Program and Project Plans their approach to conducting both program/project independent external and internal reviews.

2.4.2 At a minimum, Independent Assessments (IA) occur during the life cycle as shown in Figure 2.1.1, 2.2.1, 2.2.2, and 2.2.3. Programs and projects are required to document in their Program and Project Plans their approach to supporting the IAs. The Terms of Reference (ToR) for each program and project IA is a document specifying the nature, scope, schedule, and ground rules for these types of independent reviews or independent assessments.

2.4.3 When practical, other Agency and Center reviews should be coordinated with planned program and project reviews.

Chapter 3. R&T Program Requirements

3.1 Overview of Roles and Responsibilities

3.1.1 The roles and responsibilities of senior management are defined in NPD 1000.0, NASA Strategic Management and Governance Handbook, and NPD 1000.3, The NASA Organization.

3.1.2 It is important for the Program Lead and Project Lead to coordinate early and throughout the program and project life cycles with mission support organizations at NASA Headquarters and the implementing Centers. These mission support organizations include legal, procurement, safety, security, finance, export control, human resources, public affairs, international affairs, property, facilities, environmental, aircraft operations, information technology (IT) security, planetary protection, and others. They provide essential expertise and assure compliance with relevant laws, treaties, Executive Orders, and regulations. Refer to Appendix L as a guide to applicable documents.

3.1.3 The Program Lead shall support reviews required by the governing PMC (section 2.3.2), CMC (section 2.3.3), Strategic Acquisition Planning (section 2.2.3), and Special Independent Assessments (sections 3.4.3, 4.5.2.1, and 5.2.5.6.2).

3.1.4 For R&T Programs, the governing PMC and the DA for each KDP shall be as defined in Table 2.3.1.

3.2 Specific Roles and Responsibilities

3.2.1 Specific R&T roles and responsibilities are summarized as follows:

a. NASA Associate Administrator (AA) -- is responsible for oversight of all Agency Programs at the Agency level, chairing the Agency PMC, serving as decision authority/selecting official as specified in Table 2.3.1, and approving the R&T PCA.

b. Mission Directorate Associate Administrator (MDAA) -- is responsible for oversight of all Agency Programs and Projects within the MD, chairing the MD PMC, serving as decision authority/selecting official as specified in Table 2.3.1 and Table 2.3.2, approving Program Plans, approving Cross-Program Research Plans, and appointing and delegating functions within the MD. The MDAA has ultimate responsibility for all budgets, schedules, program requirements, and project-level requirements within the MD.

c. Mission Support Office Director (MSOD) -- is responsible for oversight of all Agency Programs and Projects within the MSO, chairing the MSO governing board, serving as decision authority/selecting official as specified in Table 2.3.1 and Table 2.3.2, approving Program Plans, approving Cross-Program Research Plans, and appointing and delegating functions within the MSO. The MSOD has ultimate responsibility for all budgets, schedules,

program requirements, and project-level requirements within the MSO.

d. Center Director (CD) -- is responsible for establishing, developing, and maintaining the institutional capabilities (processes and procedures, human capital, facilities, aircraft, and infrastructure) required for the execution of programs and projects, including the system of checks and balances to ensure technical and scientific accuracy of the portion of the programs and projects that are conducted at the Center or specifically assigned to the Center by NASA HQ (see section 3.7 for technical authority role and section 3.8 for scientific accuracy role).

e. Chief Engineer -- is responsible for the establishment of policy, oversight, and assessment of the NASA engineering and program/project management process; implements the engineering technical authority process; serves as principal advisor to the Administrator and other senior officials on matters pertaining to the technical capability and readiness of NASA programs and projects to execute according to plans; directs the NASA Engineering and Safety Center (NESC); and directs programs/projects to respond to requests from the NESC for data and information needed to make independent technical assessments and to respond to these assessments.

f. Chief Safety and Mission Assurance Officer -- is responsible to assure the existence of robust Safety and Mission Assurance (SMA) processes and activities through the development, implementation, assessment, and functional oversight of Agency-wide safety, reliability, maintainability, and quality policies and procedures; serves as principal advisor to the Administrator and other senior officials on Agency-wide safety, reliability, maintainability, and quality assurance matters; performs independent program and project compliance verification audits; and implements the SMA technical authority process.

g. Chief Health and Medical Officer (CHMO) -- is responsible for the establishment of policy, oversight, and assessment on all health and medical matters associated with NASA missions and is responsible for implementation of medical/health technical authority process; and serves as principal advisor to the Administrator and other senior officials on health and medical issues related to the Agency workforce.

h. Program Lead -- is responsible for the formulation and implementation of the program per the governing document with the sponsoring MDAA or MSOD. A Program Lead is a generic term for the leader of a program and could be designated as a Program Manager, Program Director, or some other term.

i. Project Lead -- is responsible for the formulation and implementation of the project per the governing document with the Program Lead. A Project Lead is a generic term for the leader of a project and could be designated as a Project Manager, Project Principal Investigator, or some other term.

j. Research Director -- is responsible for the formulation and implementation of cross-program research (see section 3.5) per the governing document with the sponsoring MDAA or MSOD.

3.3 R&T Program Management Process

3.3.1 R&T Program Pre-Formulation

3.3.1.1 The MDAA or MSOD has the authority to start an R&T Program's life cycle (see Figure 2.1.1) by entering into an R&T Program's pre-formulation phase. The MDAA or MSOD is responsible for ensuring the start of new R&T Programs are in line with the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan. The R&T Program shall follow the life cycle in Figure 2.1.1, including the minimum set of reviews and gate products specified in this NPR.

3.3.1.2 The MDAA, MSOD, or their delegated representative shall assign a Program Lead for Pre-Formulation to manage the effort.

3.3.1.2.1 If the Program Lead resides at a Center, the MDAA, MSOD, or their delegated representative shall coordinate the assignment of the Program Lead with the Center Director.

3.3.1.2.2 The MDAA, MSOD, or their delegated representative shall provide, in writing, a scope of the R&T Program to the Program Lead.

3.3.1.3 The MDAA or MSOD may allocate discretionary funds or utilize funding specifically designated by the Office of the Administrator or Congressional mandate to perform pre-formulation tasks associated with a potential R&T Program. These funds may be allocated by the MD or MSO to specific Centers, managed internally, or may be used to fund external studies associated with a potential R&T Program.

3.3.1.4 The Program Lead is responsible for defining the R&T Program's scope down to at least the project level prior to completion of Pre-Formulation.

3.3.1.5 To minimize duplication of effort and to look for opportunities to augment R&T from other agencies, it is recommended that the Program Lead or designee perform a literature search of R&T prior to investment in new R&T areas (for element within a TD Project, see Gap Analysis, section 4.3.4.2).

3.3.1.6 R&T Program Formulation Authorization Document (FAD).

3.3.1.6.1 The Program Lead shall create the R&T Program FAD using the template provided in Appendix C. The R&T Program FAD is approved by the MDAA or MSOD.

3.3.1.6.2 As a minimum, an R&T Program FAD shall:

a. Contain a statement of purpose for the proposed R&T Program and define its relationship to the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan.

b. Establish the scope of work to be accomplished.

c. Provide initial constraints, including resources, schedule, and participating organizations within and external to NASA, including international partnerships.

d. Identify the Program Lead who will manage the Formulation effort.

e. Define the approach, resources, and reviews required to conduct R&T Program formulation.

3.3.2 R&T Program Key Decision Point (KDP) 0 -- Approval to Initiate R&T Program Formulation

3.3.2.1 KDP 0 occurs when the MDAA or MSOD approves the R&T Program FAD. This approval authorizes the R&T Program to move from the Pre-Formulation to the Formulation phase. The MDAA or MSOD is responsible for ensuring the R&T Program is formulated and then continues to be in line with the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan.

3.3.2.2 The OCFO issues all NASA R&T Programs four digit alpha numeric designators once they have confirmed that the R&T Program FAD has been approved by the MDAA or MSOD, and that the MD or MSO has correctly coordinated the appropriate funds for the R&T Program.

3.3.2.3 The OCFO notifies all Agency organizations of an R&T Program entering Formulation by adding a listing of the new R&T Program to the MdM database. Agency-level organizations, such as the Office of the Administrator, PA&E, OCE, OCFO, and OSMA, use the MdM as a summary of all current NASA programs and projects and their key attributes.

3.3.3 R&T Program Formulation

3.3.3.1 R&T Program Commitment Agreement (PCA)

3.3.3.1.1 The R&T PCA is the agreement between the MDAA and the Program DA that authorizes transition from Formulation to Implementation (KDP I). A PCA can be considered an executive summary of the R&T Program Plan. The content of the initial PCA baselined at KDP I reflects the maturity of the R&T Program at that point in the R&T Program's life cycle. Prior to approval of the PCA, the MDAA and the Program DA shall coordinate with any Center Directors contributing to the R&T Program (not including competitively selected activities) to ensure their commitment to support the R&T Program in terms of resources needed by the R&T Program.

3.3.3.1.2 The Program Lead shall create the R&T PCA, using the template provided in Appendix D. The R&T PCA is signed by the MDAA or MSOD and approved by the Program DA.

3.3.3.1.3 As a minimum, an R&T PCA shall:

a. Define the broad R&T Program objectives and its relationship to the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan.

b. Summarize the technical performance metrics with goals and minimum thresholds needed to achieve the R&T Program objectives.

c. Identify the Program Lead who will manage the implementation effort.

d. Identify schedule, cost, safety, and risk factors.

e. Explain the involvement of R&T Program participants within and external to NASA,

including international partnerships and a listing of the specific agreements to be concluded.

f. Specify the independent reviews that will be performed during the life cycle of the R&T Program.

g. Define any optional KDPs (KDP II, III, IV, etc.) required by the Program DA during Implementation (the Program DA may determine that optional KDPs are not needed).

3.3.3.1.4 The Program Lead shall update the R&T PCA every two years. Updates may occur more frequently if there have been significant R&T Program changes as determined by the R&T Program Lead, MDAA, or MSOD so that it remains consistent with NPD 1001.0, NASA Strategic Plan, higher level architectures, and budget authority. Each revised R&T PCA is reviewed and approved using the same process as the original.

3.3.3.1.5 The R&T PCA may be used to document delegation of authority, as specified in Table 2.3.1.

3.3.3.2 R&T Program Plan.

3.3.3.2.1 The R&T Program Plan is an agreement between the MDAA or MSOD (who has approval authority for the plan) and the Program Lead that details how the R&T Program will be managed and contains the list of specific R&T projects (updated as needed) that are official R&T Program elements. The R&T Program Plan is signed concurrent with KDP I. The content of the initial R&T Program Plan baselined at KDP I reflects the maturity of the R&T Program at that point in the R&T Program's life cycle. Note that it is not uncommon to re-baseline R&T Programs due to the uncertain nature of research and technology. It is possible that this may occur as a result of periodic assessments. The R&T Program Plan is used by the governing PMC in the review process to determine if the R&T Program is fulfilling its agreement.

3.3.3.2.2 The Program Lead shall create the R&T Program Plan, using the template provided in Appendix E. The R&T Program Plan is signed by the Program Lead and approved by the MDAA or MSOD.

3.3.3.2.3 As a minimum, an R&T Program Plan shall:

a. Define the R&T Program goals and specific objectives with clear traceability to the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan.

b. Identify the main customers/beneficiaries and stakeholders of the R&T Program.

c. Identify the projects under the R&T Program and identify whether they will be managed as Technology Development Projects or R&T Portfolio Projects.

d. Briefly describe the architecture of the R&T Program and its major components.

e. Identify the Program Lead who will manage the implementation effort.

f. Document the R&T Program requirements/objectives, including performance requirements/objectives, and technical success criteria.

g. Provide a schedule of R&T Program activities and events covering the life of the R&T Program.

h. Describe the process by which the R&T Program assures compliance with NASA policies and directives, as well as other applicable requirements.

i. Briefly describe the budget and acquisition approach to be applied at the R&T Program level toward each project.

j. Summarize the risk management approach to be used for the R&T Program.

k. Identify the reviews that the R&T Program will conduct and the approach for the related projects, including Independent Assessments, R&T Program status reviews, and others in response to MDAA, MSOD, or governing PMC requirements.

l. Identify any optional KDPs (KDP II, III, IV, etc.) required by the Program DA during Implementation (the Program DA may determine that optional KDPs are not needed).

3.3.3.2.4 The MDAA or MSOD shall determine whether projects within the R&T Program will be managed as Technology Development Projects or R&T Portfolio Projects. This determination is identified in the R&T Program Plan.

3.3.3.2.5 The R&T Program Plan shall identify those R&T Projects that have been designated as part of a Cross-Program Research (see section 3.5).

3.3.3.2.6 The R&T Program Plan shall document that management responsibility and decision authority for those R&T projects have been assigned to the Cross-Program Research. Further description of those R&T projects is documented in the Cross-Program Research Plan, not the R&T Program Plan.

3.3.3.2.7 The R&T Program Plan shall be updated every two years, but updates may occur more frequently if there have been significant R&T Program changes, as determined by the Program Lead, MDAA, or MSOD. Each revised R&T Program Plan is reviewed and approved using the same process as the original.

3.3.3.2.8 The Program Lead shall ensure the R&T Program Plan and R&T PCA are consistent. If changes are required, the approval process for the applicable document(s) will be followed.

3.3.3.3 Prior to KDP I, a Formulation Review shall be conducted. The Formulation Review has both an internal and external component. The internal component is an R&T Program review to ensure the R&T Program is ready to proceed to KDP I. The external component is an independent assessment and is performed by PA&E under the direction of the selecting official identified in Table 2.3.1, or the selecting official may assign the IA to a separate organization. The selecting official for the Formulation Review team (see Table 2.3.1) is responsible for the development and approval of the Terms of Reference (ToR) for the Formulation Review. Conflicts during ToR development should be resolved in accordance with section 3.6.

3.3.3.4 The Program Lead shall ensure the R&T Program meets environmental requirements in accordance with NPR 8580.1, Implementing the National Environmental Policy Act and Executive Order 12114.

3.3.3.5 The Program Lead shall consult with the NASA Headquarters National

Environmental Policy Act (NEPA) Coordinator during R&T Program formulation to evaluate potential for program cost and schedule savings associated with NEPA strategies.

3.3.3.6 Preference to use Systeme Internationale (SI) Units is desirable. Per NPR 8010.2, Use of the SI (Metric) System of Measurement in NASA Programs, document where and how the SI system is to be used.

3.3.3.7 If an R&T Program contains elements that include hardware used for flight (piloted or unpiloted), flight control software, wind tunnel testing, or systems that could result in potential harm to personnel or property, the Program Lead shall ensure a Safety and Mission Assurance (SMA) plan is developed. The plan identifies and documents program element-specific SMA roles, responsibilities, and relationships with appropriate Headquarters and/or Center- SMA organizations. The plan should reflect the SMA role in areas such as: procurement, management, design and engineering, design verification and test, software design, software verification and test, manufacturing, manufacturing verification and test, operations, and pre-flight verification and test. In many cases, these plans are already established by Center and/or facility procedures for operations such as wind tunnel tests and flight testing and do not need to be developed by the R&T Program. The R&T Program Plan should be used to document when program elements or other entities will need to develop unique SMA plans. However, these plans should still be stand-alone documents.

3.3.3.8 If an R&T Program contains elements that include hardware used for flight (piloted or unpiloted), flight control software, wind tunnel testing, or systems that could result in potential harm to personnel or property, the Program Lead shall ensure a risk management plan is developed. In many cases these plans are already established by Center and/or facility procedures for operations such as wind tunnel tests and flight testing and do not need to be developed by the R&T Program.

3.3.3.9 If a risk management plan does not already exist for a program element containing hardware used for flight (piloted or unpiloted), flight control software, wind tunnel testing, or systems that could result in potential harm to personnel or property, the Program Lead shall ensure a stand-alone risk management plan is developed that includes the content shown in NPR 8000.4, Risk Management Procedural Requirements. The R&T Program Plan should be used to document when unique risk plans need to be developed for program elements because existing plans are not sufficient or when no plan exists. However, these plans should still be stand-alone documents.

3.3.4 R&T Program KDP I -- Approval to Initiate R&T Program Implementation

3.3.4.1 KDP I occurs when the Program DA approves the R&T PCA. This approval authorizes the R&T Program to move from Formulation to the Implementation phase. The Program DA is responsible for ensuring the R&T Program is in line with the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan.

3.3.5 R&T Program Implementation

3.3.5.1 During R&T Program implementation, the MDAA or MSOD shall:

a. Chair the MD PMC or MSO governing board.

b. Update the R&T PCA, as appropriate.

c. Call periodic R&T Program status reviews, independent assessments, and MD PMC or MSO reviews, as appropriate. It is recommended that these reviews be performed at least annually.

d. Provide oversight of the R&T Program and report the status periodically to Agency-level management, as appropriate.

e. Approve R&T Project FADs and Technology Development/R&T Portfolio Project Plans.

f. Support any reviews, KDPs, or IAs required by this NPR.

g. Perform or delegate any DA functions as required by this NPR.

h. Determine the need to modify or end the R&T Program and make recommendation for termination to the NASA AA.

i. Support Agency PMC activities.

j. Conduct R&T Program completion activities at the end of an R&T Program (see section 3.3.6.1).

3.3.5.2 During R&T Program Implementation, the Program Lead shall:

a. Update the R&T Program Plan, as appropriate.

b. Execute the R&T Program Plan.

c. Update all required interagency and international agreements, as appropriate.

d. Conduct planning, program-level systems engineering, and integration, as appropriate, to support the MD in initiating the project selection process.

e. Support the MDAA in the selection of projects, either assigned or through a competitive process.

f. Approve R&T Project FADs and Technology Development/R&T Portfolio Project Plans.

g. Plan, prepare for, and support R&T Program status reviews, independent assessments, and governing PMC reviews, as appropriate.

h. Provide oversight of the projects within the R&T Program and report their status periodically.

i. Review and approve annual project budget submission inputs and prepare annual R&T Program budget submissions.

j. Conduct R&T Program completion activities for each project in accordance with the project life cycle (see sections 4.6 and 5.2.6).

k. Support any reviews, KDPs, or IAs required by this NPR.

l. Perform any DA functions, as required by this NPR or delegated by the DA.

3.3.5.3 Optional KDPs (KDP II, III, IV, etc.) may be added per Program DA discretion during Implementation. The Program Lead shall document any optional KDPs in the R&T PCA and R&T Program Plan. This should include determination of gate products required prior to the optional KDPs. The Program DA may determine that optional KDPs are not needed.

3.3.5.4 Results of NASA Scientific and Technical Information (STI) are published in the NASA STI Report series, whenever possible. NASA policy and requirements for STI are described in the NPD 2200.1, Management of NASA Scientific and Technical Information and NPR 2200.2, Requirements for Documentation, Approval, and Dissemination of NASA Scientific and Technical Information.

3.3.6 R&T Program KDP n -- Approval to Discontinue R&T Program

3.3.6.1 KDP n occurs when the Program DA authorizes an R&T Program to end. The Program DA should coordinate any recommendations of the MDAA or MSOD and the Program Lead. The decision of the Program DA to discontinue an R&T Program is documented in written form, including any recommendations relevant to existing contractual relationships, disposal of assets, manpower support, and timeframe of closure process.

3.4 R&T Program Status Reviews and Independent Assessments (IA)

3.4.1 Independent Assessments (IAs) occur as part of the R&T Program life cycle and will be reported to the Agency PMC at least biennially. The individual specified in Table 2.3.1 is responsible for developing the Terms of Reference (ToR) for the IA, which will include a description of the IA process and IA team membership. Members of the IA team will be selected in one of two ways: (1) by the individual specified in Table 2.3.1, or (2) by an external IA organization such as the National Research Council. In either case, the Associate Administrator for PA&E will ensure that both the IA process and IA team membership are independent and objective, and will be a co-signatory on the ToR. Furthermore, for those R&T Programs that include a large-scale (>$250M) fully integrated Technology Development system (e.g., X-33), the Chief Engineer will also be a co-signatory of the ToR. See the Quality Assessment Process and Performance Measurement Metrics in NPR 1080.1, NASA Science Management for additional guidance on assessments.

3.4.2 The ToR should be provided to the Program Lead prior to conducting the IA. Conflicts during ToR development should be resolved in accordance with section 3.6.

3.4.3 The NASA AA, MDAA, or MSOD may also authorize special independent assessments at any time in an R&T Program's life cycle. A ToR should be developed for each special independent assessment. The ToR should be developed by the individual(s) who authorize the special independent assessment in coordination with the MDAA or MSOD (or designee).

3.4.4 R&T Program status reviews are conducted periodically, as documented in the R&T Program Plan. These reviews can also be called by the NASA AA, MDAA, or MSOD at any time to determine the need to modify or end the R&T Program.

3.5 Cross-Program Research Management

3.5.1 The MDAA or MSOD may decide to collectively manage R&T Portfolio Projects taken from various Agency programs within the MD or MSO. This choice may be made when research is more efficiently solicited across program lines or a DA is needed who is independent from the Agency program. An independent DA may be needed to prevent the appearance of bias when a Center is competing for research activities that are under the purview of a Program Lead from that particular Center. Cross-Program Research is managed by a Research Director (typically at NASA HQ) and may be referenced elsewhere in Agency documentation as a "Research Program."

3.5.2 The Research Director shall create a Cross-Program Research Plan that encompasses all the R&T Portfolio Projects within his/her purview, using the template provided in Appendix F. The Cross-Program Research Plan is signed by the Research Director and approved by the MDAA or MSOD.

3.5.3 As a minimum, a Cross-Program Research Plan shall:

a. Define the Cross-Program Research goals and specific objectives with clear traceability to the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan.

b. Identify the main customers/beneficiaries and stakeholders of the Cross-Program research.

c. Briefly describe the management structure of the Cross-Program Research and associated Portfolio Projects.

d. Identify the Research Director who manages the Cross-Program Research.

e. Define the selection process for awarding R&T, including the Selection Official.

f. Document the Cross-Program Research requirements/objectives, including performance requirements/objectives, technical success criteria, and KPPs.

g. Provide a schedule of Cross-Program Research activities and events.

h. Describe the process by which the Cross-Program Research ensures compliance with NASA policies and directives, as well as other applicable requirements.

i. Briefly describe the budget and acquisition approach to be applied to the Cross-Program Research.

j. Define a process for determining openly competed, internally competed, and directed investments.

k. Summarize the risk management approach to be used for the Cross-Program Research.

l. Include information on the specific programs that are transferring R&T Portfolio Project

management to the Research Director.

m. Describe the reviews that the Cross-Program Research will conduct, including Formulation Reviews, peer reviews, and other independent assessments, in response to MDAA, MSOD, or governing PMC requirements.

n. Define any optional KDPs (KDP II, III, IV, etc.) required by the DA during Implementation or determine that these optional KDPs are not needed.

3.5.4 The Program Lead, Research Director, and MDAA or MSOD each have specific responsibilities when a Cross-Program Research Delegation occurs.

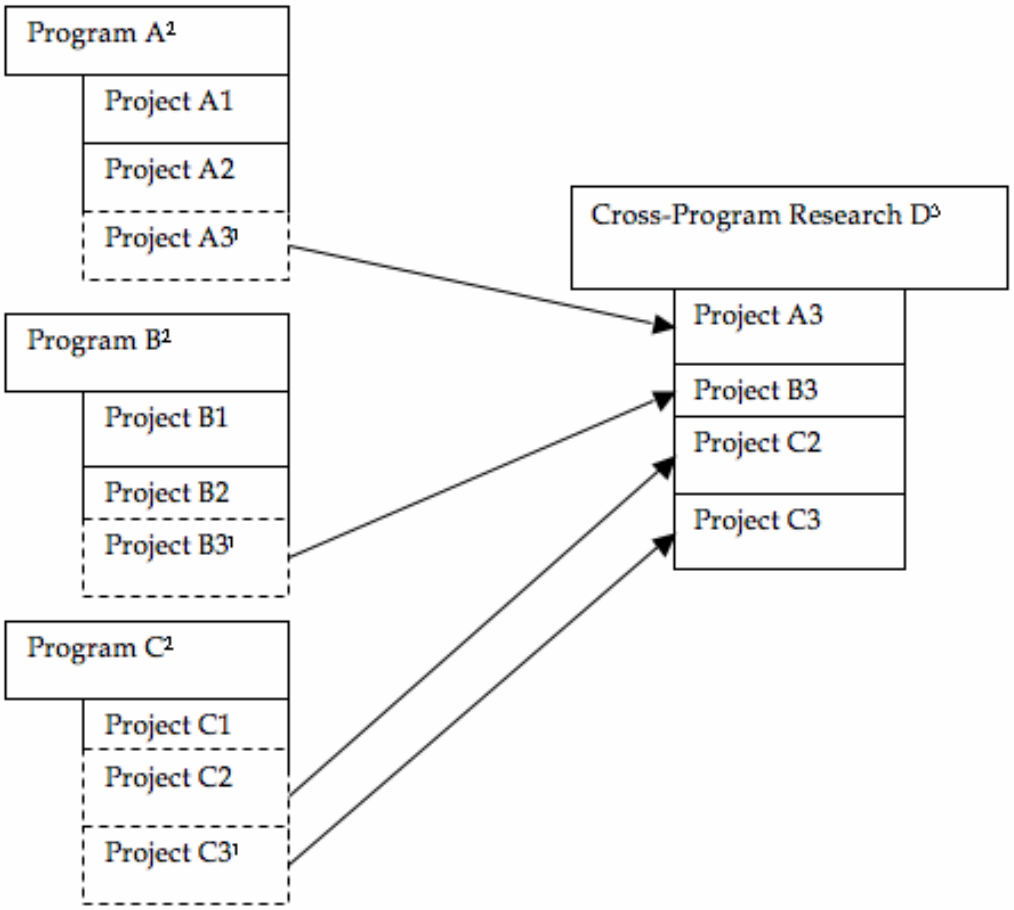
3.5.4.1 The Program Lead shall ensure the Program Plan reflects the delegation of R&T Portfolio Project management authority to the Research Director.

3.5.4.2 The Research Director shall ensure the Cross-Program Research Plan reflects the delegation of R&T Portfolio Project management authority from the Program Lead.

3.5.4.3 The MDAA or MSOD is responsible to the Program's DA and Agency PMC for the entire Program regardless of any Cross-Program Research agreement. The Program Lead, and the Research Director if there is a Cross-Program Research agreement, are responsible to the MDAA or MSOD. The Research Director shall support the MDAA or MSOD with any necessary reviews or requirements placed upon the program by the Program DA and Agency PMC.

3.5.5 The Research Director oversees the R&T Portfolio Projects within his/her purview as a Program-like Lead, may act as the MDAA or MSOD delegated DA for the R&T Portfolio Projects, and assigns in coordination with the MDAA or MSOD the management of specific R&T Portfolio Projects to R&T Portfolio Project Leads. Figure 3.5.1 illustrates the relationship between Agency programs and Cross-Program Research.

3.5.6 The Research Director shall use the R&T Program Requirements (Chapter 3) and the R&T Program Life Cycle (Figure 2.1.1) with changes specified in Table 3.5.1 as a guideline for managing Cross-Program Research.



[1]Projects A3, B3, C2, and C3 are R&T Projects. The MDAA or MSOD has directed that R&T Projects A3, B3, C2, and C3 be managed as R&T Portfolio Projects under Cross-Program Research D. [2]Program Leads A, B, and C are responsible to the MDAA or MSOD. Each Program Lead is responsible for and has authority over the projects within each program that have not been assigned as Cross-Program Research D. [3]Research Director D is responsible to the MDAA or MSOD. Research Director D is responsible for and has authority over the R&T Portfolio Projects (including budgetary) within Cross-Program Research D.

Figure 3.5.1 Relationship between Agency Programs and Cross-Program Research

	R&T Program (Figure 2.1.1)	**Cross-Program Research** (Figure 2.1.1)	**Specific Exceptions for Cross-Program Research**
Approving Official for Start and KDP 0	MDAA (or MSOD)	MDAA (or MSOD)	An R&T FAD is not required. KDP 0 occurs when the assignment of the Research Director is formally made.

Program Decision Authority (DA) *(KDP I, II, III, ... n)*	NASA AA[1,2]	MDAA or MSOD[2]	An R&T PCA is not required. KDP I occurs when the MDAA or MSOD approves the Cross-Program Research Plan.
Selecting Official for Formulation Review Team	NASA AA[1]		A Formulation Review is not required.
Selecting Official for Independent Assessment Team	MDAA or MSOD	MDAA or MSOD	
Governing PMC	Agency PMC[3]	MD PMC or MSO equivalent	
Governing Document	R&T Program Plan (Appendix E)	Cross-Program Research Plan (Appendix F)	

[1]The NASA AA can delegate responsibility to the MDAA or MSOD. [2]Optional KDPs (KDP II, III, IV, etc.) may be added per DA discretion during implementation. The DA may also determine these optional KDPs are not needed. [3]The Agency PMC can delegate oversight responsibility to the MD PMC or MSO equivalent. The Program, Project, and Cross-Program Research Plans must reflect modifications due to the comments above and document the attendant rationale for the change. The MDAA or MSOD is responsible to the Program DA and Agency PMC for the entire Program regardless of any Cross-Program Research agreement. The Program Lead, and the Research Director if there is a Cross-Program Research agreement, are responsible to the MDAA or MSOD. The Research Director supports the MDAA or MSOD with any necessary reviews or requirements placed upon the program by the Program DA and Agency PMC.

Table 3.5.1 Cross-Program Management Structure

3.6 Process for Handling Dissenting Opinions

3.6.1 NASA teams must have full and open discussions with all facts made available in order to understand and assess issues. Diverse views are to be fostered and respected in an environment of integrity and trust with no suppression or retribution.

3.6.2 Unresolved issues of any nature (e.g., programmatic, safety, engineering, acquisition, and accounting) within a team should be quickly elevated to achieve resolution at the appropriate level. At the discretion of the dissenting person(s), a decision may be appealed to the next higher level of management for resolution. Dissenting opinions raised by a Technical Authority (TA) are handled by the process set forth in section 3.7

3.6.3 When appropriate, the concern is documented by including agreed-to facts, discussion of the differing positions with rationale and impacts and the parties' recommendations, approved by the representative of each view, concurred by affected parties, and provided to program/project management and the appropriate TA with notification to the second higher level of management. In cases of urgency, an oral presentation (including the information stated above) with all affected organizations in attendance and with advance notification to the second higher level of management may be utilized with documentation follow-up.

3.6.4 Management's decision/action on the memorandum (or oral presentation) is documented and provided to the dissenter and to the notified managers, and becomes part of the program/project record. If the dissenter is not satisfied with the process or outcome, the dissenter may appeal to the next higher-level of management. The dissenter has the right to take the issue upward in the organization, even to the NASA Administrator if necessary.

3.7 Technical Authority (TA)

3.7.1 NASA has adopted two basic authority processes: the programmatic authority process and the technical authority process. The programmatic authority process is largely described by the roles and responsibilities of the NASA AA, MDAAs (or MSODs), and program and project leads in this document. The technical authority process is established in NPR 7120.5, NASA Space Flight Program and Project Management Requirements. The technical authority process is another means by which NASA maintains the technical integrity of its R&T programs and projects.

3.7.2 The technical authority process provides for the selection of individuals at different levels of responsibility, who maintain independent authority to ensure that proper technical standards are utilized in the performance of any R&T Program or project tasks at the Center. In this document, the term Technical Authority (TA) is used to refer to such an individual, but is also used (without capitalization) to refer to all the elements of the technical authority process taken together. A key aspect of the technical authority process is that the TAs are funded independently of the program/project. There are three distinct types of TAs: Engineering TAs, SMA TAs, and Health and Medical TAs, each of whom is discussed in this section. A key aspect of the technical authority process is that the TAs are funded independently of the program/project.

3.7.3 The Engineering Technical Authority establishes and is responsible for the engineering design processes, specifications, rules, best practices, etc., necessary to fulfill programmatic mission performance requirements. The NASA Chief Engineer provides overall leadership of the engineering technical authority process for NASA R&T programs and projects. This includes policy direction, requirements, and verification of technical authority process implementation. The NASA Chief Engineer hears appeals of the Engineering Technical

Authority's decisions when they cannot be resolved at lower-levels.

3.7.4 The SMA Technical Authority establishes and is responsible for the SMA design processes, specifications, rules, best practices, etc., necessary to fulfill programmatic mission performance requirements. To ensure independence, SMA Technical Authority personnel are organizationally separate from the program/project. The Center SMA Director is responsible for establishing and maintaining institutional SMA policies and practices, consistent with Agency policies and standards. The Center SMA Director is also responsible for assuring that the program/project complies with both the program/project and Center SMA requirements.

3.7.5 The Health and Medical Technical Authority is the NASA Chief Health and Medical Officer (CHMO). The CHMO delegates that authority to the Center Chief Medical Officer who is responsible for assuring that the program/project complies with health and medical requirements through the process specified in the Center Health and Medical Authority (HMA) implementation plan, which is compliant with NPD 8900.5, NASA Health and Medical Policy for Human Space Flight Exploration. The CHMO hears appeals of HMA decisions when issues cannot be resolved below the Agency level.

3.7.6 Each Center Director is responsible for the technical integrity of R&T activities and investigations that are assigned or awarded to that Center. The Center Director is the Center Engineering Technical Authority responsible for Center engineering verification/validation processes, specifications, rules, practices, and other activities, necessary to ensure the technical integrity of R&T programs and projects accomplished by the Center. The Center Engineering Technical Authority approves waivers and changes in Center requirements. The Center Director may delegate Center engineering technical authority implementation responsibility to an individual in the Center's engineering leadership. Due to the nature of R&T, the technical authority requirements for R&T programs and projects are not as specific as for space flight programs and projects. The Center Director appoints personnel, as needed, to fill the TA roles at the Center. These roles are not pre-defined in this document because they may vary greatly depending on the nature and level of effort of the R&T programs and projects.

3.7.7 Depending on the scope of R&T work being performed at the particular Center, the TA may establish periodic independent reviews. However, the scope of these reviews should reflect the R&T work being accomplished at the Center. Whenever possible, the TA independent reviews should be coordinated with planned program/project reviews for efficiency. There may be cases when it is advantageous for several Centers to work together to come up with a means of maintaining technical integrity for efforts that are not center-specific. Therefore, it is possible for several Centers to work together to conduct one TA independent review of a piece of work.

3.7.8 The day-to-day involvement of the TA in program/project activities should ensure that any significant views from the TA will be available to the program/project in a timely manner and should be handled during the normal program/project processes. The ultimate responsibility for program/project success in conformance with governing requirements remains the responsibility of the Program/Project Lead.

3.7.9 Infrequent circumstances may arise when the Technical Authority or the Program/Project Lead may disagree on a proposed programmatic or technical action and

judge that the issue rises to a level of significance that the next higher level of management should be involved. In such circumstances:

a. The Program/Project Lead has the authority to make a decision while resolution is attempted at the next higher level of Programmatic and Technical Authority.

b. Resolution should occur prior to implementation, whenever possible. However, the Program/Project Lead may proceed at risk in parallel with pursuit of resolution if deemed in the best interest of the program/project. In such circumstances, the next higher level of Programmatic and Technical Authority would be informed of the decision to proceed at risk.

c. Resolution should be attempted at successively higher levels of Programmatic Authority and Technical Authority until resolved. Final appeals are made to the Office of the Administrator.

3.8 Research Practices

3.8.1 All R&T projects, activities, and investigations are conducted in accordance with established research practices and NASA's standards to ensure the quality and acceptability in the community of the research results. Such standards and related requirements regarding NASA sponsored research are provided in NPR 1080.1, NASA Science Management.

3.8.2 Each Center Director is responsible for the conduct of R&T activities and investigations that are assigned or awarded to that Center and to ensure that the Center follows appropriate practices. The Center Director is responsible for Center scientific processes, specifications, rules, practices, and other activities, necessary to ensure the quality of results from R&T programs and projects accomplished by the Center. The CD may delegate Center responsibility to an individual in the Center's leadership.

3.8.3 Infrequent circumstances may arise when the Center leadership or the Program/Project leadership may disagree relating to the conduct of R&T that the issue rises to a level of significance that the next higher level of management should be involved. In such circumstances, resolution should be attempted at successively higher levels of Programmatic Authority and Center Leadership, in accordance with section 3.6, until resolved. Final appeals are made to the Office of the Administrator.

3.9 Unsolicited Proposals

3.9.1 The Program Lead shall handle unsolicited proposals in accordance with 48 CFR, Federal Acquisition Regulation, Subpart 15.6, Unsolicited Proposals; NPR 5100.4, Federal Acquisition Regulation Supplement (NASA/FAR Supplement) [48 CFR 1800-1899], Subpart 1815.6, Unsolicited Proposals; and NPR 5800.1, Grant And Cooperative Agreement Handbook (14 CFR 1260). See NPR 1080.1, NASA Science Management for additional guidance.

3.10 R&T Misconduct

3.10.1 R&T misconduct means fabrication, falsification, or plagiarism in proposing, performing, or reviewing R&T, or in reporting R&T results. R&T misconduct does not include honest error or differences of opinion. The NASA team, including the Program and Project Leads, shall handle allegations of R&T misconduct following processes established in NPR 1080.1, NASA Science Management and 14 CFR Part 1275, Research Misconduct.

3.11 Waiver Approval Authority

3.11.1 Waivers to NPR 7120.8 requirements may be granted by the officials shown in Table 3.11.1.

Legend	R Recommends	A Approves	I Informed

	Project Lead	Program Lead	Center Director	MDAA	Chief Engineer	NASA AA	Approval Authority for Waivers with Dissent
Programs			A	A		I	NASA
Cross-Program Research				A		I	NASA
Technology Development Projects	R		A	A	A		NASA
Portfolio Projects	R		A	A		I	NASA

Table 3.11.1 Waiver Approval for R&T Programs and Projects

3.11.2 Requests for waivers to NPR 7120.8 requirements are documented and submitted for approval using the NPR 7120.8 Waiver Form shown on the next page. (The form is available electronically on the Polaris Website at https://polaris.nasa.gov).

3.11.3 Evaluation and disposition of all other requirements change requests and waivers shall comply with the following:

a. The organizations and the organizational levels that agreed to the establishment of a requirement must agree to the change or waiver of that requirement, unless this has been formally delegated elsewhere.

b. The next higher Programmatic Authority and Technical Authority are informed in a timely manner of change requests or waivers that could affect that level.

NPR 7120.8 Waiver Form

Name of Program or Project Requesting Waiver:	Date of Request:	Date Waiver is Needed:
Name and Organization of Initiator:	Requirement to be Waived:	
Specific Deliverable Affected:	Waiver To: € Policy € Procedure € Requirement € Other € Additional information is attached	
Original Requirement of Document to be Waived (list Appropriate Sections or Text):		
Waiver Requested:		
Reason/Justification (Attach additional information, if necessary):		
Risk Assessment of the Program and Project if Waiver is Approved:		

Required Signatures	Signature	Date	Approved (Yes/No)
Project Lead			
Program Lead (Research Director)			
Center Director			
Mission Directorate AA			
NASA Chief Engineer			
NASA AA (if required)			

Chapter 4. Technology Development (TD) Project Requirements

4.1 Overview

4.1.1 Technology Development Project

4.1.1.1 A TD Project matures a particular technology or set of related technologies to the point where it is ready for use by a customer/beneficiary. A customer/beneficiary is usually well-defined for a TD Project. Customers/beneficiaries are the intended user of the technology being developed and are involved throughout the development process. Typically, a customer/beneficiary is a space flight project or the aeronautics community. Customers/beneficiaries may also be other NASA-focused technology projects where further development occurs to meet a specific mission requirement or industrial partners that NASA supplies with technology to maintain a national aerospace capability.

4.1.1.2 New technologies often emerge from R&T where fundamental scientific principles are investigated and concepts for their application are formulated. The early stages of technology development are usually performed in the laboratory; later stages may involve field tests or flight demonstration experiments to validate the technology in relevant environments.

4.1.1.3 The TD Project Lead shall support reviews required by the governing PMC (section 2.3.2), CMC (section 2.3.3), Strategic Acquisition Planning (section 2.2.3), and Special Independent Assessments (sections 3.4.3 and 4.5.2.1).

4.1.1.4 General management requirements applicable to all projects within a program, such as the Dissenting Opinions process (section 3.6) and Technical Authority process (section 3.7), are found in Chapter 3.

4.1.1.5 For TD Projects, the governing PMC and the DA for each KDP shall be defined in Table 2.3.2.

4.1.2 Description of TD Project Life Cycle

4.1.2.1 NASAÕs four-part process for managing programs and projects described in section 1.2.1 consists of: Formulation, Approval, Implementation, and Evaluation. The TD Project shall follow the life cycle in Figure 2.2.1, including the minimum set of reviews and gate products specified in this NPR.

4.1.2.2 During Formulation, technology needs are derived from mission concept studies, various technical approaches for meeting the technology needs are identified, technical performance goals called Key Performance Parameters (KPPs) are established, and a TD Project Plan is developed.

4.1.2.3 Prior to Approval, a Formulation Review is conducted to ensure that the TD Project objectives are aligned with the known or potential mission needs and that the TD Project is well planned to meet the objectives.

4.1.2.4 During Implementation, the TD Project matures the technology, and progress towards the KPPs is evaluated in periodic status reviews. At these reviews, reviewers may recommend to the DA

that the TD Project be continued, revised, or discontinued.

4.1.2.5 Throughout the TD Project life cycle, an evaluation process is used to set priorities among competing alternatives and to assess progress relative to a baseline plan. Evaluation makes use of systems analysis, KPPs, TRLs, and other tools to evaluate the TD Project (see section 4.7.1).

4.2 Project Pre-Formulation

4.2.1 The Project DA is responsible for initiating a new TD Project (see figure 2.2.1) by entering into a Project's Pre-Formulation phase. The Project DA is responsible for ensuring the start of a new TD Project is in line with the AgencyÕs vision and mission, as defined by NPD 1001.0, NASA Strategic Plan. Also, the Project DA is responsible for ensuring the start of a new TD Project is aligned with critical technology needs identified by the MD or MSO.

4.2.2 The Program Lead, in coordination with the MDAA or MSOD, shall assign a TD Project Lead to manage the effort.

4.2.2.1 If a TD Project Lead resides at a Center, the Program Lead shall coordinate the assignment of the TD Project Lead with the Center Director.

4.2.2.2 The Program Lead, in coordination with the MDAA or MSOD, should provide, in writing, a scope of the project to the TD Project Lead.

4.2.3 The Program Lead shall manage any project formulation activities required while in the Program's Formulation Phase. The Program Lead, in coordination with the MDAA or MSOD, may allocate program funds to perform pre-formulation tasks associated with a potential project. These funds may be allocated by the Program Lead to specific Centers, managed internally, or may be used to fund external studies associated with a potential project.

4.2.4 The TD Project Lead shall create an R&T Project FAD, using the template provided in Appendix G. The R&T Project FAD is approved by the Project DA with concurrence by the Program Lead.

4.2.5 As a minimum, an R&T Project FAD shall:

a. Contain a statement of purpose for the proposed project and define its relationship to the ProgramÕs strategic goals and objectives.

b. Establish the scope of work to be accomplished.

c. Identify the TD Project Lead.

d. Identify the management process for the project.

e. Provide initial constraints, including resources, schedule and project participants within and external to NASA, including international partnerships.

f. Define the approach, resources, and reviews required to conduct project formulation.

g. Identify optional KDP B if required by the DA during Formulation or identify optional KDP B is not needed.

4.2.6 Approval of the R&T Project FAD by the Project DA is KDP A, which initiates the Project's movement from Pre-Formulation into the Formulation phase of the life cycle.

4.3 Project Formulation

4.3.1 Overview

4.3.1.1 The formulation of a TD Project involves defining the customers/beneficiaries, identifying technology needs, evaluating alternatives, establishing KPPs, and planning project implementation.

4.3.1.2 During Formulation, the TD Project Lead should develop a preliminary WBS, project schedule, and the allocation of resources to perform the project (see section 4.5.1.1 for later life-cycle requirements). The projectÕs preliminary WBS and associated WBS should be consistent with Appendix K. In coordination with OCFO, the TD Project Lead should identify and establish a WBS Element (level 3 or lower) specifically for capital assets, when purchase of capital assets is required. In coordination with the OCFO, the TD Project Lead shall complete the Alternative Future Use (AFU) Questionnaire (Form NF 1739) if any NASA-owned equipment purchased on the project has an acquisition value of $100,000 or greater per item, has an estimated useful life of two years or more, and has a planned use on another project.

4.3.1.3 An optional KDP (KDP B) during Formulation may be added at the discretion of the Project DA (see section 4.5.2).

4.3.2 Customer/Beneficiary Definition

4.3.2.1 The Project Lead shall identify the customers/beneficiaries who will benefit from the TD Project. The customers/beneficiaries may include space flight projects, another R&T Program, another Government agency, the aeronautics community, or the U.S. aerospace industry.

4.3.2.2 The TD Project Lead shall define specific points of contacts (e.g., working groups, advisory committees, integrated product teams, technology infusion liaisons) that are capable of representing the customer/beneficiaryÕs requirements (e.g., technology needs, technology prioritization, key performance parameters, and technology maturity) for technology development.

4.3.3 Identification of Technology Needs

4.3.3.1 The TD Project Lead shall ensure that credible technology needs are derived from sources such as the customer/beneficiaryÕs mission concept studies or design reference missions (DRMs), technology roadmaps and associated system analysis, or technology gap analysis.

4.3.3.2 The TD Project Lead shall ensure the customer/beneficiary is involved in these assessments and the results should be consistent with the customer/beneficiaryÕs technology infusion plan.

4.3.4 Systems Analysis and Technology Prioritization

4.3.4.1 The TD Project Lead shall ensure that appropriate analyses and studies are conducted to justify technology selections. Techniques such as Alignment Matrices, Return on Investment vs. Risk Matrices, or Technology S-curve Maps can be used to determine the best mix of technologies that will balance the project's risk posture. Formal systems analysis should be performed, when practical, to support the results. These analyses should include investment priorities for developing alternative technologies to maximize the probability of success and to enable rational allocation of resources in the event of budget fluctuation.

4.3.4.2 The TD Project Lead shall perform an assessment of related technology development activities (e.g., Gap Analysis, section 4.7.2.1b) in other NASA programs, other Government

agencies, and the commercial sector to eliminate unnecessary duplication of effort.

4.3.4.3 Formulation Review

4.3.4.3.1 Prior to KDP C, a Formulation Review shall be conducted. The Formulation Review has both an internal and external component. The internal component is a project review to ensure the project is ready to proceed to KDP C. The external component is an independent assessment that includes the customer/beneficiary and may involve external advisory groups such as the National Research Council (NRC). The Formulation Review will assess the projectÕs alignment with the customer/beneficiaryÕs needs and the adequacy of the TD Project Plan to meet the specified objectives. The selecting official identified in Table 2.3.2 assigns the IA to be performed by one or more organizations. The selecting official for the Formulation Review team (see Table 2.3.2) is responsible for the development and approval of the Terms of Reference (ToR) for the Formulation Review. Conflicts during ToR development should be resolved in accordance with section 3.6. The TD Project Lead will revise the TD Project Plan to properly disposition any recommendations resulting from the Formulation Review.

4.3.4.3.2 For TD Projects that are or are a part of a large scale (>$250M) fully integrated Technology Development system (i.e., X-33), the selecting official for the independent assessment team will obtain approval for the Formulation Review team selection (external component) and ToR development from the Chief Engineer and the Associate Administrator for PA&E. The Associate Administrator for PA&E will ensure that the IA team membership and process are independent and objective. The Chief Engineer will ensure that the IA team membership is adequate to assess the project technically and that the IA membership and process is consistent with the Technical Authority process and the governance model.

4.3.4.4 At the Formulation Review, an assessment of related technology development activities (e.g., Gap Analysis) is reviewed. This assessment should be documented in the Project Plan.

4.3.5 Key Performance Parameters (KPPs)

4.3.5.1 To increase the likelihood of successful technology infusion, the TD Project Lead shall define and document KPPs that are important to the customers/beneficiaries. KPPs consist of measurable engineering parameters that would be readily understood and used by engineers concerned with the ultimate application of the technology. For each KPP, both a goal and a threshold will be specified. The goal is a performance level that the project team is striving for, and the threshold is the minimum performance level that users agree is acceptable for the end item deliverable. Typically, the threshold KPP values are set beyond the current state-of-the art to warrant investment in the project. KPPs include information that enables an assessment of the advancement of the maturity of the technology throughout the development process. The definition of a KPP includes defining the appropriate environment and the component, subsystem, or system within which the KPP measurements are to be made.

4.3.5.2 When the TD Project contains multiple tasks and deliverables, the TD Project Lead shall identify KPPs for each task or deliverable.

4.3.5.3 The TD Project Lead shall ensure KPPs are reviewed annually by the customer/beneficiary to verify that they are still aligned with mission requirements.

4.3.5.4 The Project DA is the DA for KPPs, formally approving them by approving the TD Project Plan (Appendix H). Modification of KPPs should be through updates to the TD Project Plan.

4.3.6 TD Project Plan

4.3.6.1 During Pre-Formulation or Formulation, the Project DA may request a preliminary TD Project Plan from the TD Project Lead to document an agreement between project and program regarding the objectives and approach prior to full-project approval.

4.3.6.2 The TD Project Plan is an agreement between the Project DA, the Program Lead, and the TD Project Lead that details how the project will be managed. The TD Project Lead shall create a TD Project Plan, using the template provided in Appendix H. The TD Project Plan is signed by the TD Project Lead and approved by the Project DA with concurrence by the Program Lead. The TD Project Plan is used by the governing PMC in the review process to determine if the project is fulfilling its agreement.

4.3.6.3 As a minimum, a TD Project Plan shall:

a. State the specific project objectives, performance goals, and their relationship to the program objectives and goals.

b. Present a technical description of the project.

c. Document the project requirements/objectives, including Key Performance Parameters (KPPs).

d. Document an assessment (Gap Analysis) of related technology development activities in other NASA programs, other Government agencies, and the commercial sector to eliminate unnecessary duplication of effort.

e. Identify the TD Project Lead.

f. Define the projectÕs management approach, resource requirements (including NASA personnel, facilities, and aircraft uses), schedule and work breakdown structure.

g. Describe the projectÕs strategy for technology transition.

h. Summarize the risk management approach to be used for the project.

i. Define the specific reviews that will be conducted during the performance of the project.

j. Document the project's approach to implementing IT security requirements in accordance with NPR 2810.1, Security of Information Technology.

k. Identify any optional KDPs (KDP B, D, and E) required by the DA.

4.3.6.4 If warranted by changes in the stated commitments or requirements, the TD Project Lead shall update the TD Project Plan. Each revised TD Project Plan is reviewed and approved using the same process as the original.

4.3.6.5 The TD Project Lead shall ensure the TD Project Plan and R&T Program Plan are consistent. If changes are required, the approval process for the applicable document(s) will be followed.

4.3.6.6 If the TD Project resides at a Center, the TD Project Lead shall add the Center Director (or designee) responsible for committing workforce and facilities as a concurrence signature to the TD Project Plan. Other concurrence signatures such as the customer(s)/beneficiary(ies) may be added, if applicable.

4.3.6.7 For TD Projects proposing the construction of new or modification to existing NASA owned facilities within normal Construction of Facilities (CoF) funding limits (see NPD 7330.1, Approval Authorities for Facility Projects (Revalidated 10/19/04)), the TD Project Lead shall complete a preliminary business case analysis in accordance with NPD 8820.2, Design and Construction of Facilities and NPR 8820.2, Facility Project Implementation Guide. A business case guide can be

located at http://www.hq.nasa.gov/office/codej/codejx/codejx.html.

4.3.6.8 For TD Projects proposing the acquisition of new aircraft, the TD Project Lead shall plan and perform these acquisitions in accordance with NPR 7900.3, NASA Aircraft Operations Management. The term "aircraft" includes both piloted and unmanned aerial vehicles.

4.3.6.9 The TD Project Lead shall ensure that proposals and plans for subordinate activities/tasks include documentation of (a) environmental compliance and permit considerations and (b) NEPA evaluation.

4.3.6.10 If a TD Project contains elements that include hardware used for flight (piloted or unpiloted), flight control software, wind tunnel testing, or systems that could result in potential harm to personnel or property, the TD Project Lead shall ensure a Safety and Mission Assurance (SMA) plan is developed. The plan identifies and documents project element-specific SMA roles, responsibilities, and relationships with appropriate Headquarters and/or Center- SMA organizations. The plan should reflect the SMA role in areas such as: procurement, management, design and engineering, design verification and test, software design, software verification and test, manufacturing, manufacturing verification and test, operations, and pre-flight verification and test. In many cases, these plans are already established by Center and/or facility procedures for operations such as wind tunnel tests and flight testing and do not need to be developed by the project. The TD Project Plan should be used to document when project elements or other entities will need to develop unique SMA plans. However, this plan should still be a stand-alone document.

4.3.6.11 If a TD Project contains elements that include hardware used for flight (piloted or unpiloted), flight control software, wind tunnel testing, or systems that could result in potential harm to personnel or property, the TD Project Lead shall ensure a risk management plan is developed. In many cases, these plans are already established by Center and/or facility procedures for operations such as wind tunnel tests and flight testing and do not need to be developed by the project.

4.3.6.12 If a risk management plan does not already exist for a project element containing hardware used for flight (piloted or unpiloted), flight control software, wind tunnel testing, or systems that could result in potential harm to personnel or property, the TD Project Lead shall ensure a stand-alone risk management plan is developed that includes the content shown in NPR 8000.4, Risk Management Procedural Requirements. The TD Project Plan should be used to document when unique risk plans need to be developed for project elements because existing plans are not sufficient or when no plan exists. However, these plans should still be stand-alone documents.

4.4 Project Approval

4.4.1 The Project DA has the authority (see Table 2.3.2) to move a TD Project from the Formulation phase to the Implementation phase (KDP C). This decision is in writing in the form of the Project DA approval of the TD Project Plan (see Appendix H). The Project DA is responsible for ensuring the TD Project is in line with the AgencyÕs vision and mission, as defined by NPD 1001.0, NASA Strategic Plan.

4.4.2 KDP C occurs when the Project DA approves the revised Project Plan, and authorizes NASA Headquarters to allocate the funding required for project execution to the NASA Centers.

4.5 Project Implementation

4.5.1 Project Management Principles

4.5.1.1 Use of accepted project management principles will increase the likelihood that the TD Project will be successful in achieving its technical objectives within cost and schedule constraints. At a minimum, the TD Project Lead shall establish a WBS, in accordance with Appendix K, a project schedule with milestones for each element in the WBS, and an allocation of the projectÕs available resources necessary to achieve each milestone (see section 4.3.1.2 for preliminary requirements). The milestones should be chosen at intervals sufficient to demonstrate steady progress towards achieving the overall KPPs for the project.

4.5.1.2 MD or MSO policy may require the use of more rigorous project management principles such as Earned Value Management (EVM).

4.5.1.3 A TD Project Lead shall track progress against a baseline plan. The WBS, the project schedule, and the allocation of resources to milestones constitute the baseline plan for assessing technical, schedule, and cost performance.

4.5.1.4 For all development projects or single contracts exceeding $250M life-cycle cost, the TD Project Lead shall provide immediate written notice and a recovery plan to the Program Lead and MDAA or MSOD, if the implementation costs of the project are estimated to exceed the baseline cost by 15 percent or more or if a schedule milestone is estimated to be delayed six months or more.

4.5.2 Independent Assessments and Optional KDPs

4.5.2.1 The NASA AA, MDAA, MSOD, AA for PA&E, or Program Lead may authorize special independent assessments at any time in a TD ProjectÕs life cycle. A ToR should be developed for each special independent assessment. The ToR should be developed by the individual(s) who authorize the special independent assessment in coordination with the MDAA or MSOD (or designee).

4.5.2.2 The Project DA shall determine if the optional KDP (KDP B) is required during Formulation or if the optional KDP (KDP B) is not needed (see section 4.3.1.3). This optional KDP is added at the Project DA's discretion and identified in the Project FAD. If the KDP B is required, the Project DA should determine the gate products required prior to this optional KDP.

4.5.2.3 The Project DA shall determine if optional KDPs (KDP D and E) are required during Implementation or if the optional KDPs (KDP D and E) are not needed. These optional KDPs are added at the Project DA's discretion and identified in the Project FAD. If these optional KDPs are required, the Project DA should determine the gate products required prior to these optional KDPs.

4.5.2.4 Independent Assessments (IAs) occur as part of the TD Project life cycle. IAs during Implementation are performed periodically and should be documented in the Project Plan. The selecting official for the independent assessment team (see Table 2.3.2) is responsible for the development and approval of the Terms of Reference (ToR) for the IA. For TD Projects that are or are a part of a large scale (>$250M) Technology Development system (i.e., X-33), the selecting official for the independent assessment team will obtain approval for the IA team selection and ToR development from the Chief Engineer and the Associate Administrator for PA&E. The Associate Administrator for PA&E will ensure that the IA team membership and process are independent and objective. The Chief Engineer will ensure that the IA team membership is adequate to assess the project technically and that the IA membership and process is consistent with the Technical Authority process and the governance model.

4.5.3 Status Reviews

4.5.3.1 The TD Project Lead shall conduct TD Project status reviews annually to assess both progress towards the KPPs and the maturity of the technology. In addition, status reviews may be called by the MDAA, MSOD, or Program Lead at any time to determine the need to modify or end the project. The status reviews are utilized by the Program Lead to recommend whether the TD Project should be continued for another year, re-directed, modified, or discontinued. Status reviews require customer/beneficiary involvement (e.g. status review's external component) and can help ensure mature technologies are utilized when available. IA per section 4.5.2.4 may also be conducted in parallel to status reviews and act as the status review's external component. Status reviews may also include members from the Formulation Review panel. The Program Lead, in consultation with the customer/beneficiary or his/her representative(s), makes a recommendation on TD Project continuation to the MDAA or MSOD. KDP F occurs when the Project DA decides to close a TD Project or transition the technology to a different project.

4.6 Project Transition/Closure

4.6.1 Technology Transition/Closure

4.6.1.1 In the Transition/Closure phase, technologies that are successful in achieving the required level of maturity are transitioned to a customer/beneficiary for further development, are used in system designs, or are thoroughly documented for resumption of development at a later date. Transition occurs when the customer/beneficiary assumes management and financial responsibility for technology development. The transition is not tied to a specific TRL or level of maturity. If the transition customer/beneficiary is a Space Flight Systems project, further technology development or space flight integration is governed by NPR 7120.5, NASA Space Flight Program and Project Management Requirements. In this phase, the investigations may also be discontinued and a method for documenting and archiving data is implemented.

4.6.2 Closeout Review

4.6.2.1 At the conclusion of each TD Project, a closeout review of the projectÕs accomplishments, including an independent assessment of the final TRL and other maturity measures is performed. A final report is required for the Closeout Review. The TD Project Lead shall document lessons learned, in accordance with NPR 7120.6, Lessons Learned Process.

4.6.3 Data Archiving and Publication

4.6.3.1 At the conclusion of the TD Project, the TD Project Lead shall ensure that sufficient data is archived so that future users can assess the technology maturity (e.g., TRL) and incorporate the technology into system designs. These data include the final report from the Closeout Review, engineering drawings, specifications, test reports, and any other documentation of project activities and results necessary for future researchers to understand the work performed and the results that were achieved.

4.6.3.2 All documentary information, regardless of format, made or received in the course of conducting NASA R&T Projects are Federal records and shall be maintained, safeguarded, and dispositioned, in accordance with the guidelines of NPR 1441.1, NASA Records Retention Schedules.

4.6.3.2 Except when the information is classified or subject to ITAR restrictions, the TD Project Lead should ensure publication of at least one peer-reviewed technical paper or the posting of a final

report external to NASA to ensure wide dissemination of technology information.

4.7 Evaluation

4.7.1 Technology Maturity Assessment

4.7.1.1 Accurate assessment of technology maturity is critical to technology advancement and its subsequent incorporation into operational products.

4.7.1.2 The TD Project Lead shall ensure Technology Readiness Levels (TRLs) and/or other measures of technology maturity that are important to the customer/beneficiary are used in conjunction with KPPs to assess maturity throughout the project life cycle. When a TD Project uses a measure of maturity other than TRLs, the measurement system should map back to TRLs. TRLs are defined in Appendix J.

4.7.1.3 An independent group should validate the current state of maturity. The maturity assessment should involve or be reviewed by the customer(s)/beneficiary(ies) or his/her representatives. The initial maturity assessment is done in the Formulation phase and updated at the project status reviews. At the conclusion of the TD Project, an independent assessment of the final TRL is performed. The Program Lead shall assign the independent group responsible for the Technology Maturity Assessment.

4.7.1.4 TRLs establish the baseline maturity of a technology at a given point-in-time. Moving to a higher-level of maturity (higher TRL) requires the assessment of an entire range of capabilities for design, analysis, manufacture, and test. These additional assessments may be embodied in other measures of technology maturity such as a Technology Maturity Index (TMI) or an Advancement Degree of Difficulty (AD2), which are described in the NASA Systems Engineering Handbook (SEHB).

4.7.2 Assessment Process

4.7.2.1 The following steps outline the process for assessing technology maturity and identify activities that should be accomplished on the part of the project.

a. Clearly define all terminology used in the TRL descriptions to be used throughout the life of the project.

b. Provide a formal Gap Analysis (see section 4.3.4.2) of technology needs supporting project contents, and identify the process for periodic project assessment, including the termination or transition of technologies out of the project and introduction of new technologies into the project.

c. Provide a formal assessment of the TRL for each new technology incorporated into the TD Project, and annually assess progress toward defined TRL goals. The assessment should occur at the system, subsystem, and component levels, as described by the TD ProjectÕs WBS.

d. The Òweakest linkÓ concept will be used in determining overall technology maturity wherein the TRL of the system is determined by the subsystem having the lowest TRL in the system, which in turn is determined by the component having the lowest TRL in the subsystem.

e. The depth of this assessment varies greatly according to the state of the project, e.g., at the concept level, only the basic building blocks are known and the major challenges identifiable. However, as the technology matures, the WBS becomes more defined and the assessment is required to go into

greater detail.

f. On the basis of the assessment, prepare a list of Critical Technology Elements, which are absolutely essential in meeting overall technology requirements and that have substantial risk, cost, and/or schedule associated with their development.

g. The assessment of heritage elements should consider the intended application and operational environment compared to how they were previously used.

h. Following the maturity assessment and the identification of critical technology elements, perform an Advancement Degree of Difficulty assessment of what is required to advance the technology to the desired TRL. This is done in conjunction with the WBS and is used as the basis for the technology roadmap and cost.

i. Prepare a roadmap for each TD Project that addresses the cost, schedule, and risk associated with advancing each element to the point necessary to meet requirements in a timely manner. Identify alternate paths, decision gates, off-ramps, fallback positions, and quantifiable milestones with appropriate schedules. The roadmap outlines the overall strategy for progressing towards the KPPs, and shows how interim performance milestones will be verified through test.

j. The TD Project will be assessed on an annual basis through the aggregate assessment of the individual technologies and their progress toward the stated TRL goal.

4.8 Requirements Flow Down for Project Elements

4.8.1 Portions or elements of TD Projects may be accomplished at different Centers. The TD Project Lead shall flow down requirements for this work sufficiently to ensure requirements are met at the TD Project level.

Chapter 5. R&T Portfolio Project Requirements

5.1 Overview

5.1.1 R&T Portfolio Projects

5.1.1.1 This chapter describes the management of R&T Portfolio Projects, including both basic and applied research. The MDAA or MSOD may also decide to use this chapter to manage technology development in lieu of Chapter 4. It is expected that any large-scale development projects with a life-cycle cost exceeding $250M will be managed under Chapter 4 or NPR 7120.5, NASA Space Flight Program and Project Management Requirements. This chapter defines how NASA manages its R&T Portfolio Projects, not how it carries out the actual development of research or technology. Basic research addresses the need for knowledge, while applied research directs this new knowledge toward a practical application. Basic and applied research is directly tied to the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan. The results of this research may expand the knowledge base, provide scientific and technological breakthroughs that are immediately applicable, or evolve into more advanced technology development. Research investigations are characterized by unpredictability of outcome, high risk, and funding usually at a fixed level on a yearly basis. The progress and relative value of such investigations are continually assessed, and the R&T is adjusted accordingly.

5.1.1.2 This chapter provides requirements for R&T Portfolio Projects and the portfolio cycle used within these projects. It is possible that the management structure used to manage R&T Portfolio Projects may have several variations, but the basic management organization and principles are the same. R&T Portfolio Projects may be managed under either programs or as Cross-Program Research (see section 3.5). For simplicity, this chapter uses the term Program Lead to refer to the responsible official of either the Program or the Cross-Program Research. When the MDAA or MSOD elects to collectively manage R&T Portfolio Projects as Cross-Program Research, the Research Director represents the "Program Lead," as specified in this chapter. Table 5.1.1 shows the mapping between the two terminologies.

5.1.1.3 The R&T Portfolio Project Lead shall support reviews required by the governing PMC (section 2.3.2), CMC (section 2.3.3), Strategic Acquisition Planning (section 2.2.3), and Special Independent Assessments (sections 3.4.3 and 5.2.5.6.2).

5.1.1.4 General management requirements applicable to all projects within a program, such as the Dissenting Opinions process (section 3.6) and Technical Authority process (section 3.7), are found in Chapter 3.

5.1.1.5 For R&T Portfolio Projects, the governing PMC and the DA for each KDP shall be as defined in Table 2.3.2 and Table 5.1.1.

	Program Lead Led	**Research Director Led (Cross-Program Research)**
Manager *R&T Portfolio Project (Figure 2.2.2) and Portfolio Cycle (Figure 2.2.3)*	R&T Portfolio Project Lead	R&T Portfolio Project Lead
Approving Official for Start *R&T Portfolio Project (Figure 2.2.2)*	MDAA (or MSOD)[1]	MDAA (or MSOD)[2]
DA for KDP A (approve FAD) R&T Portfolio Project (Figure 2.2.2)	MDAA (or MSOD)[1]	MDAA (or MSOD)[2]
DA for KDP B (per DA discretion) R&T Portfolio Project (Figure 2.2.2)	MDAA (or MSOD)[1]	MDAA (or MSOD)[2]
DA for KDP C (approve Project Plan) R&T Portfolio Project (Figure 2.2.2)	MDAA (or MSOD)1	MDAA (or MSOD)[2]
DA for KDP D (per DA discretion) R&T Portfolio Project (Figure 2.2.2)	MDAA (or MSOD)[1]	MDAA (or MSOD)[2]

DA for KDP E (per DA discretion) R&T Portfolio Project (Figure 2.2.2)	MDAA (or MSOD)[1]	MDAA (or MSOD)[2]
DA for KDP F (R&T transfer or closure) R&T Portfolio Project (Figure 2.2.2)	MDAA (or MSOD)[1]	MDAA (or MSOD)[2]
Selecting Official for Independent Assessment Team(s)	MDAA (or MSOD)[1]	MDAA (or MSOD)[2]
Governing PMC	MD PMC or MSO equivalent	MD PMC or MSO equivalent
Governing Document(s)	R&T Portfolio Project Plan and Program Plan	R&T Portfolio Project Plan and Cross-Program Research Plan

[1] The MDAA or MSOD can delegate responsibility to the Program Lead.

[2] The MDAA or MSOD can delegate responsibility to the Research Director.

The Program, Project, and Cross-Program Research Plans must reflect modifications due to the comments above and document the attendant rationale for the change.

Table 5.1.1 R&T Portfolio Project Management Structure

5.2 R&T Portfolio Project

5.2.1 Project Life Cycle

5.2.1.1 The life cycle of an R&T Portfolio Project follows a structured process that involves KDPs for assessing progress. An R&T Portfolio Project shall follow the life cycle in Figure 2.2.2, including the minimum set of reviews and gate products specified in this NPR.

5.2.2 Project Pre-Formulation

5.2.2.1 The Project DA is responsible for initiating a new R&T Portfolio Project (see Figure 2.2.2) by entering into a project's Pre-Formulation phase. The Project DA is responsible for ensuring the start of a new R&T Portfolio Project is in line with the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan.

5.2.2.2 The Program Lead, in coordination with the MDAA or MSOD, shall assign an R&T Portfolio Project Lead, who is responsible for managing the R&T Portfolio Project.

5.2.2.2.1 If an R&T Portfolio Project Lead resides at a Center, the Program Lead shall coordinate the assignment of the R&T Portfolio Project Lead with the Center Director.

5.2.2.2.2 The Program Lead, in coordination with the MDAA or MSOD, should provide, in writing, a scope of the project to the R&T Portfolio Project Lead.

5.2.2.3 The R&T Portfolio Project Lead shall create an R&T Project FAD or an appendix to the Cross-Program Research Plan (see Appendix F), using the template in Appendix G. The R&T Project FAD is approved by the Project DA with concurrence by the Program Lead.

5.2.2.4 As a minimum, an R&T Project FAD shall:

a. Contain a statement of purpose for the proposed project and define its relationship to the Program's strategic goals and objectives.

b. Establish the scope of work to be accomplished.

c. Identify the R&T Portfolio Project Lead.

d. Identify the management process for the project.

e. Provide initial constraints, including resources, schedule and project participants within and external to NASA, including international partnerships.

f. Define the approach, resources, and reviews required to conduct project formulation.

g. Identify optional KDP B, if required by the DA, during Formulation or identify if optional KDP B is not needed.

5.2.2.5 KDP A (Figure 2.2.2) occurs when the Project DA approves the Project

FAD, which initiates the R&T Portfolio Project's movement from Pre-Formulation into the Formulation phase of the life cycle.

5.2.3 Project Formulation

5.2.3.1 In the Formulation phase, R&T needs are identified, a scientific/technical approach is defined, if appropriate, the funding availability is determined, the funding mechanisms are established, the need to use the R&T Portfolio Project is identified, and management plans are developed/updated to reflect the use of the R&T Portfolio Project.

5.2.3.2 During Formulation, the R&T Portfolio Project Lead should develop a preliminary WBS, project schedule, and the allocation of resources to perform the project (see section 5.2.5.2 for later life cycle requirements). The project's preliminary WBS and associated WBS should be consistent with Appendix K. In coordination with the OCFO, the R&T Portfolio Project Lead should identify and establish a WBS Element (level 3 or lower) specifically for capital assets, when purchase of capital assets is required. In coordination with the OCFO, the R&T Portfolio Project Lead shall complete the Alternative Future Use (AFU) Questionnaire (Form NF 1739) if any NASA owned equipment purchased on the project has an acquisition value of $100,000 or greater per item, has an estimated useful life of two years or more, and has a planned use on another project.

5.2.3.3 R&T Portfolio Project Plan

5.2.3.3.1 The R&T Portfolio Project Lead shall create the R&T Portfolio Project Plan or an appendix to the Cross-Program Research Plan (see Appendix F), using the template provided in Appendix I. The R&T Portfolio Project Plan is signed by the R&T Portfolio Project Lead and approved by the Project DA, with concurrence by the Program Lead. The R&T Portfolio Project Plan is used by the governing PMC in the review process to determine if the project is fulfilling its agreement.

5.2.3.3.2 As a minimum, an R&T Portfolio Project Plan shall:

a. State the area of specialty of the R&T Portfolio Project, the R&T Portfolio Project's objectives, and the relationship to the program objectives and goals.

b. Define a process for the solicitation, evaluation, and selection of proposals (including identifying Selection Official(s)) for competed portions of the R&T Portfolio Project. Note that this may be accomplished by referencing appropriate sections of standard R&T process documents, including the Guidebook for Proposers to NASA Research Announcements (http://www.hq.nasa.gov/office/procurement/nraguidebook) and any MD or

MSO omnibus NASA Research Announcements (NRA) (e.g., Research Opportunities in Space and Earth Sciences (ROSES) or Research Opportunities in Aeronautics (ROA)).

c. Establish evaluation criteria, including considerations of technical merit, relevance to the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan, and cost realism or reference existing documentation that defines this process. Describe how often reviews will be conducted and how the evaluation team will be formed.

d. Identify an integrated budget typically for three or five years, including appropriate WBS elements (see Appendix K) consistent with available R&T program resources.

e. Include a multi-year schedule for the R&T Portfolio Project.

f. Identify the R&T Portfolio Project Lead.

g. Identify a management and control structure to implement the R&T Portfolio Project.

h. Summarize the risk management approach to be used for the R&T Portfolio Project.

i. Define the project's resource requirements, including NASA personnel, facilities, and aircraft uses.

j. Define the specific reviews that will be conducted during the performance of the R&T Portfolio Project.

k. Document the project's approach to implementing IT security requirements in accordance with NPR 2810.1, Security of Information Technology.

l. Identify any optional KDPs (KDP B, D, and E) required by the DA.

5.2.3.3.3 If warranted by changes in the stated commitments or requirements, the R&T Portfolio Project Lead shall update the R&T Portfolio Project Plan. Each revised R&T Portfolio Project Plan is reviewed and approved using the same process as the original.

5.2.3.3.4 The R&T Portfolio Project Lead shall ensure the R&T Portfolio Project Plan and R&T Program Plan are consistent. If changes are required, the approval process for the applicable document(s) will be followed.

5.2.3.3.5 If the R&T Portfolio Project resides at one or more Centers, the R&T Portfolio Project Lead shall add the Center Director(s) or his/her designee(s)

responsible for committing workforce and facilities as concurrence signature(s) to the R&T Portfolio Project Plan.

5.2.3.3.6 During Pre-Formulation or Formulation, the Project DA may request a preliminary R&T Portfolio Project Plan from the R&T Portfolio Project Lead to document an agreement between project and program regarding the objectives and approach prior to full project approval.

5.2.3.4 The Project DA shall determine if the optional KDP (KDP B) is required during Formulation or if the optional KDP (KDP B) is not needed. This optional KDP is added at the Project DA's discretion and identified in the Project FAD. If the KDP B is required, the Project DA should determine the gate products required prior to this optional KDP.

5.2.3.5 Prior to KDP C, a Formulation Review shall be conducted. The Formulation Review has both an internal and external component. The internal component is a project review to ensure the project is ready to proceed to KDP C. The external component is an independent assessment and is optional per DA discretion. The selecting official identified in Table 2.3.2 assigns the IA to be performed by one or more organizations. The selecting official for the Formulation Review team (see Table 2.3.2) is responsible for the development and approval of the ToR for the Formulation Review. Conflicts during ToR development should be resolved in accordance with section 3.6.

5.2.3.6 For R&T Portfolio Projects proposing the construction of new or modification to existing NASA owned facilities using CoF funding, the R&T Portfolio Project Lead shall complete a preliminary business case analysis, in accordance with NPD 8820.2, Design and Construction of Facilities and NPR 8820.2, Facility Project Implementation Guide. A business case guide can be located at http://www.hq.nasa.gov/office/codej/codejx/codejx.html.

5.2.3.7 For R&T Portfolio Projects proposing the acquisition of new aircraft, the R&T Portfolio Project Lead shall plan and perform these acquisitions, in accordance with NPR 7900.3, NASA Aircraft Operations Management. The term aircraft includes both piloted and unmanned aerial vehicles.

5.2.3.8 The R&T Portfolio Project Lead shall ensure that proposals and plans for subordinate activities/tasks include documentation of (a) environmental compliance and permit considerations and (b) NEPA evaluation.

5.2.3.9 If an R&T Portfolio Project contains elements that include hardware used for flight (piloted or unpiloted), flight control software, wind tunnel testing, or systems that could result in potential harm to personnel or property, the R&T Portfolio Project Lead shall ensure a Safety and Mission Assurance (SMA) plan

is developed. The plan identifies and documents project element-specific SMA roles, responsibilities, and relationships, with appropriate Headquarters and/or Center- SMA organizations. The plan should reflect the SMA role in areas such as: procurement, management, design and engineering, design verification and test, software design, software verification and test, manufacturing, manufacturing verification and test, operations, and pre-flight verification and test. In many cases, these plans are already established by Center and/or facility procedures for operations such as wind tunnel tests and flight testing and do not need to be developed by the project. The R&T Portfolio Project Plan should be used to document when project elements or other entities will need to develop unique SMA plans. However, these plans should still be stand-alone documents.

5.2.3.10 If an R&T Portfolio Project contains elements that include hardware used for flight (piloted or unpiloted), flight control software, wind tunnel testing, or systems that could result in potential harm to personnel or property, the R&T Portfolio Project Lead shall ensure a risk management plan is developed. In many cases, these plans are already established by Center and/or facility procedures for operations such as wind tunnel tests and flight testing and do not need to be developed by the project.

5.2.3.11 If a risk management plan does not already exist for a project element containing hardware used for flight (piloted or unpiloted), flight control software, wind tunnel testing, or systems that could result in potential harm to personnel or property, the R&T Portfolio Project Lead shall ensure a stand-alone risk management plan is developed that includes the content shown in NPR 8000.4, Risk Management Procedural Requirements. The R&T Portfolio Project Plan should be used to document when unique risk plans need to be developed for project elements because existing plans are not sufficient or when no plan exists. However, these plans should still be stand-alone documents.

5.2.4 Project Approval

5.2.4.1 The Project DA has the authority to move an R&T Portfolio Project from the Formulation phase to the Implementation phase (KDP C). KDP C (Figure 2.2.2) occurs when the Project DA approves the R&T Portfolio Project Plan. The Project DA is responsible for ensuring the R&T Portfolio Project is in line with the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan.

5.2.5 Project Implementation

5.2.5.1 In the Implementation phase, the R&T Portfolio Project Lead executes

the R&T Portfolio Project Plan, which usually consists of one or more portfolio cycles (see section 5.2.5.7).

5.2.5.2 Use of accepted project management principles will increase the likelihood that the R&T Portfolio Project will be successful in achieving its technical objectives within cost and schedule constraints. At a minimum, the R&T Portfolio Project Lead shall establish a WBS, in accordance with Appendix K, a project schedule with milestones for each element in the WBS, and an allocation of the project's available resources necessary to achieve each milestone (see section 5.2.3.2 for preliminary requirements). The milestones should be chosen at intervals sufficient to demonstrate steady progress.

5.2.5.3 An R&T Portfolio Project Lead shall track progress against a baseline plan. The WBS, the project schedule, and the allocation of resources to milestones constitute the baseline plan for assessing technical, schedule, and cost performance. Note that it is not uncommon to re-baseline R&T Portfolio Projects due to the uncertain nature of research. It is possible that this may occur as a result of periodic assessments.

5.2.5.4 The Project DA shall determine if optional KDPs (KDP D and E) are required during Implementation or if the optional KDPs (KDP D and E) are not needed. These optional KDPs are added at the Project DA's discretion and identified in the Project FAD. If these optional KDPs are required, the Project DA should determine the gate products required prior to these optional KDPs.

5.2.5.5 R&T Portfolio Project Status Reviews.

5.2.5.5.1 The R&T Portfolio Project Lead shall conduct R&T Portfolio Project status reviews annually to assess progress towards the R&T Portfolio Projects goals and for NASA officials to gain better insight into the R&T work being performed. The R&T Portfolio Project status reviews are also utilized by the Program Lead and R&T Portfolio Project Lead to decide whether the R&T Portfolio Project should be continued for another year or transferred/closed for lack of sufficient progress (see section 5.2.6.1). These reviews can also be called by the MDAA, MSOD, or Program Lead at any time to determine the need to modify or end the project. The R&T Portfolio Project status reviews and the R&T Portfolio Cycle status reviews (see section 5.2.5.7.4) may be combined per R&T Portfolio Project Lead direction.

5.2.5.6 Independent Assessments.

5.2.5.6.1 Independent Assessments (IAs) occur as part of the R&T Portfolio Project life cycle. IAs during Implementation are performed periodically and should be documented in the R&T Portfolio Project Plan. These IAs may occur

as part of the normal peer review process within the Portfolio Cycle. The selection official for independent assessment team(s) is defined in Table 2.3.2. The selecting official for the independent assessment team (see Table 2.3.2) is responsible for the development and approval of the ToR for the IA. Conflicts during ToR development should be resolved, in accordance with section 3.6. The ToR for peer reviews are developed in accordance with NPR 1080.1, NASA Science Management, and do not need to be redeveloped as described above.

5.2.5.6.2 The NASA AA, MDAA, MSOD, AA for PA&E, Program Lead, or Research Director may authorize special independent assessments at any time in an R&T Portfolio Project's life cycle. A ToR should be developed for each special independent assessment. The ToR should be developed by the individual(s) who authorizes the special independent assessment in coordination with the MDAA or MSOD (or designee). Conflicts during ToR development shall be resolved in accordance with section 3.6.

5.2.5.7 Portfolio Cycle.

5.2.5.7.1 Each R&T Portfolio Project performs a process where R&T investigations are formulated, evaluated, approved, funded, implemented, and closed. This NPR refers to this process as the Portfolio Cycle and Figure 2.2.3 is used as a guide to establish this process. This process is referred to as a cycle, because typically only a portion of the R&T investigations under an R&T Portfolio Project go through this process at once and R&T Portfolio Projects perform this process on a cyclical basis; sometimes annually, when they solicit external R&T investigations through a Broad Agency Announcement (BAA) or some other vehicle. It is also typical for the R&T Portfolio Projects to perform a similar Portfolio Cycle on a cyclical basis to fund R&T internal to NASA. Some R&T Portfolio Projects combine the solicitation of internal and external R&T into a single Portfolio Cycle process.

5.2.5.7.2 The R&T Portfolio Project Lead should ensure that a process is in place to track and manage each Portfolio Cycle. The R&T Portfolio Project Plan defines the process to manage the Portfolio Cycle or reference to other Agency or Mission Directorate-specific document(s) that provides this information.

5.2.5.7.3 The R&T Portfolio Project Lead should ensure that the Portfolio Cycle includes sufficient reviews and assessments in formulation to ensure that a balanced and well constructed group of R&T investigations is developed. The R&T Portfolio Project Lead should solicit and select competed R&T investigations in accordance with NPR 1080.1, NASA Science Management. A key component to selecting competed investigations is the peer review of proposals, as described in NPR 1080.1, NASA Science Management. The R&T

Portfolio Project Lead should also ensure compliance with NPR 5100.4, Federal Acquisition Regulation Supplement (NASA/FAR Supplement) (special attention should be given to NPR 5100.4, Part 1835 and 1872) and NPR 5800.1, Grant and Cooperative Agreement Handbook, as applicable.

5.2.5.7.4 Status reviews (see Figure 2.2.3) typically occur annually during Portfolio Cycle implementation through the review of each group of R&T investigations and the progress reports submitted by the selected investigators. The status reviews are utilized by the Program Lead and R&T Portfolio Project Lead to decide whether each R&T investigation should be continued for another year or transferred/closed for lack of sufficient progress. The status reviews are used to:

a. Determine changes in scope that effect subsequent solicitations.

b. Provide information to support evaluation of performance, as specified in the R&T Portfolio Project Plan, R&T Program Plan, or Cross-Program Research Plan.

c. Determine if the results of any of the R&T investigations are ready to be transitioned to another project or to an organization outside the Agency.

d. Determine if any of the R&T investigations should be terminated.

5.2.5.7.5 Prior to the decision to terminate a contract or multiyear grant prior to completion of the terms of the document, the R&T Portfolio Project Lead should consult with the Contracting/Procurement Officer to understand the full legal and cost ramifications.

5.2.5.7.6 The status of publication of R&T investigations should be reported to the Project Lead on an annual basis. The R&T Portfolio Project Lead should ensure investigators are encouraged to publish the results of R&T investigations. The R&T Portfolio Project Lead should ensure that NASA investigators publish or disseminate the results of NASA R&T activities according to the data dissemination plans documented in the Program and Project Plans.

5.2.5.7.7 The R&T Portfolio Project Lead should ensure investigators submit final reports for investigations funded through grants and contracts, and ensure that final reports are archived in the NASA Scientific and Technical Information System, as specified in NPR 2200.2, Requirements for Documentation, Approval, and Dissemination of NASA Scientific and Technical Information.

5.2.6 R&T Portfolio Project Transition/Closure

5.2.6.1 R&T Portfolio Project status reviews (see section 5.2.5.5) are utilized by the Program Lead and R&T Portfolio Project Lead to recommend whether the R&T Portfolio Project should be continued for another year or discontinued. In addition, status reviews may be called by the MDAA, MSOD, or Program Lead at any time to determine the need to modify or end the R&T Portfolio Project. KDP F (Figure 2.2.2) occurs when the Project DA decides to transition the R&T to a different project or discontinue the R&T Portfolio Project. KDP F initiates the R&T Portfolio Project's movement from Implementation into the Transition/Closure phase of the life cycle.

5.2.6.2 In the R&T Portfolio Project Transition/Closure Phase, the results of R&T investigations are published and archived or transitioned to another project, and the investigations are then closed out. The R&T Portfolio Project Lead shall document lessons learned, in accordance with NPR 7120.6, Lessons Learned Process.

5.3 Requirements Flow Down for Project Elements

5.3.1 Portions or elements of R&T Portfolio Projects may be accomplished at different Centers. The R&T Portfolio Project Lead shall flow down requirements for this work sufficiently to ensure requirements are met at the R&T Portfolio Project level.

Appendix A. Definition of Terms

Agency Program Management Council (Agency PMC). The senior management group, chaired by the NASA Associate Administrator or designee, responsible for reviewing formulation performance, recommending approval, and overseeing implementation of programs and specified projects according to Agency commitments, priorities, and policies.

Approval. Authorization by a required management official to proceed with a proposed course of action. (When multiple approvals are required, all must be obtained in order to proceed.) Approvals must be documented.

Center Director. Person responsible for establishing, developing, and maintaining the institutional capabilities (processes and procedures, human capital, facilities, and infrastructure) required for the execution of programs and projects, including the system of checks and balances to ensure the technical and scientific integrity of programs and projects assigned to the Center.

Center Management Council (CMC). The council at a Center that performs oversight of programs and projects by evaluating all program and project work executed at that Center.

Component Facilities. Complexes that are geographically separated from the NASA Center or institution to which it is assigned.

Critical Technology Elements. Elements of a TD Project, which are absolutely essential in meeting overall technology requirements.

Cross-Program Research. Collective management of R&T Portfolio Projects taken from various Agency programs within the MD or MSO.

Cross-Program Research Plan. The document that establishes the Cross-Program Research's baseline for implementation, signed by the MDAA or MSOD and the Research Director.

Customer/Beneficiary. The intended beneficiary or user of the R&T results (i.e., knowledge, technology). Typically, a customer is a space flight project or the aeronautics community. Customers may also be other NASA-focused R&T projects where further development occurs to meet a specific mission requirement or industrial partners that NASA supplies with the results of the R&T to maintain a national aerospace capability.

Decision Authority. The Agency's responsible individual who authorizes the transition of a program/project to the next life-cycle phase.

Design Reference Missions. An array of hypothetical mission scenarios developed by potential customers or users of a mission to help guide mission design.

Earned Value Management (EVM). A tool for measuring and assessing project performance through the integration of technical scope with schedule and cost objectives during the execution of the project. EVM provides quantification of technical progress, enabling management to gain insight into project status and project completion costs and schedules. Two essential characteristics of successful EVM are EVM system data integrity and carefully targeted monthly EVM data analyses (i.e., risky WBS elements).

Evaluation. The continual, independent (i.e., outside the advocacy chain of the program/project) evaluation of the performance of a program or project and incorporation of the evaluation findings to ensure adequacy of planning and execution according to plan.

Formulation. The identification of how the program or project supports the Agency's strategic needs, goals, and objectives, the assessment of feasibility, technology and concepts, risk assessment, team-building, development of operations concepts and acquisition strategies, establishment of high-level requirements and success criteria, the preparation of plans, budgets and schedules essential to the success of a program or project, margins, and the establishment of control systems to ensure performance to plan and alignment with current Agency strategies.

Formulation Authorization Document (FAD). The document issued by the MDAA (or MSOD) to authorize the formulation of a program or project whose goals will fulfill part of the Agency's Strategic Plan, Mission Directorate Strategies, or Mission Support Office Functional Leadership Plans. In addition, a FAD or equivalent is used to authorize the formulation of a project.

Gap Analysis. An assessment of related technology development activities in other NASA programs, other Government agencies, and the commercial sector to eliminate unnecessary duplication of effort.

Gate Products. Appropriate supporting materials submitted to the DA at a KDP. These materials may include: the governing PMC review recommendation; the Independent Assessment (IA) report; the Program Lead's recommendation, Project Lead's recommendation; Cost Estimation reports; the CMC's recommendation; and any agreement(s) ready for signature (i.e., FAD, Program Plan, PCA, TD Project Plan, R&T Portfolio Project Plan, Selection Document, or updates).

Governing Program Management Council (Governing PMC). The senior management group responsible for providing management oversight of specific programs and projects. Each council has the responsibility of periodically evaluating the cost, schedule, risk, and performance of programs or projects under its purview. The evaluation focuses on whether the program or project is meeting its commitments to the Agency and is following appropriate management processes. The governing PMC is either the Agency PMC or Mission Directorate PMC (or MSO equivalent).

Implementation. The execution of approved plans for the development and operation of the program/project, and the use of control systems to ensure performance to approved plans and continued alignment with the Agency's strategic needs, goals, and objectives.

Independent Assessment or Review. A specific assessment or review that is conducted by an entity that is outside the advocacy chain of the program or project. These are of three types: relevance, quality and performance that are a result of the White House policy entitled the Research and Development (R&D) Investment Criteria, as described at http://www.whitehouse.gov/omb/part/fy2007/2007_guidance_final.pdf. An independent assessment for relevance determines that the program is relevant to national priorities, agency missions, relevant fields, and "customer" needs, and can justify its claim on taxpayer resources. An independent assessment for quality determines that a program will maximize the quality of the R&D they fund through the use of a clearly stated, defensible method for awarding a significant majority of their funding. Programs must assess and report on the quality of current and past R&D. Lastly, an independent assessment for performance determines that a program or project has met its high priority, multi-year R&D objectives with annual performance outputs, and milestones that show how one or more outcomes will be reached.

Institutional Requirements. Infrastructure and workforce needed to support programs and projects. Specifically, the human resources, real property, facilities, aircraft, personal property, equipment, information technology resources, and administrative and program support services (e.g., environmental management) required to support programs and projects.

Investment. A resource and financial commitment by the Agency, MD, MSO, or Center.

Key Decision Point (KDP). The event at which the Decision Authority determines the readiness of a program/project to progress to the next phase of the life cycle (or to the next KDP).

Key Performance Parameter (KPP). Measurable engineering parameters that would be readily understood and used by engineers concerned with the ultimate application of the results from the Technology Development Project. For each KPP, both a goal and a threshold will be specified. The goal is a performance level that the Technology Development Project is striving for, and the threshold is the minimum performance level that users agree is acceptable for the end item deliverable. Typically, the threshold KPP values are set beyond the current state-of-the art to warrant investment in the Technology Development Project. KPPs include information that enables an assessment of the advancement of the maturity of the technology throughout the development process. The definition of a KPP includes defining the appropriate environment and the component, subsystem, or system within which the KPP measurements are to be made.

Life-Cycle Cost (LCC). The total of the direct, indirect, recurring, nonrecurring, and other related expenses incurred, or estimated to be incurred, in the design, development, verification, production, operation, maintenance, support, and disposal of a project. The LCC of a project or system can also be defined as the total cost of ownership over the project or system's life cycle from formulation through implementation. It includes all design, development, deployment, operation and maintenance, and disposal costs.

Metric. A measurement taken over a period of time that communicates vital information about the status or performance of a system, process, or activity. A metric should drive appropriate action.

Mission Directorate Program Management Council (MD PMC). The senior management group, chaired by an MDAA or designee, responsible for reviewing project formulation performance, recommending approval, and overseeing implementation of specified projects according to Agency commitments, priorities, and policies.

Principal Investigator (PI). A person who conceives an investigation and is responsible for carrying it out and reporting its results. In some cases, PIs from industry and academia act as managers (Project Managers) for smaller development efforts with NASA personnel providing oversight.

Program. A strategic investment by a Mission Directorate or Mission Support Office that has a defined architecture and/or technical approach, requirements, funding level, and a management structure that initiates and directs one or more projects. A program defines a strategic direction that the Agency has identified as critical.

Program Commitment Agreement (PCA). The contract between the Associate Administrator and the cognizant MDAA or MSOD that authorizes transition from formulation to implementation of a program

Program Lead. A generic term that represents the position in charge of the program. A Program Lead could be designated as a Program Manager, Program Director, or some other term, as defined in the program's governing document. A Program Lead is responsible for the formulation and implementation of the R&T program, per the governing document with the sponsoring MDAA or MSOD.

Program Plan. The document that establishes the program's baseline for implementation, signed by the MDAA or MSOD, Center Director(s), and Program Manager.

Program (Project) Team. All participants in program (project) formulation and implementation. This includes all direct reports and others that support meeting program (project) responsibilities.

Project. A specific investment identified in a Program Plan having defined requirements, a life-cycle cost, a beginning, and an end. A project yields new or revised products that directly address NASA's strategic needs.

Project Lead. A generic term that represents the position in charge of the project. A Project Lead could be designated as a Project Manager, Portfolio Manager, Project Principal Investigator, Project Scientist, or some other term, as defined in the project's governing document. A Project Lead is responsible for the formulation and implementation of the R&T project, per the governing document with the Program Lead.

Project Plan. The document that establishes the project's baseline for implementation, signed by the cognizant Program Manager, Center Director, Project Manager, and the MDAA or MSOD.

Project Principal Investigator. Term used by some MDs and MSOs to describe a R&T Portfolio Project Lead.

R&T Misconduct. Fabrication, falsification, or plagiarism in proposing, performing, or reviewing research or technology, or in reporting research or technology results. R&T misconduct does not include honest error or differences of opinion.

R&T Portfolio Project Lead. A generic term that represents the position in charge of the R&T Portfolio Project. An R&T Portfolio Project Lead could be designated as a Portfolio Manager, Project Principal Investigator, or some other term, as defined in the R&T Portfolio Project's governing document.

R&T Portfolio Project. A specific R&T Project identified in an Agency Program Plan as an R&T Portfolio Project. An R&T Portfolio Project may be made up of one or more groups of R&T investigations that address the goals and objectives of the R&T Portfolio Project.

R&T Program. An Agency program that is strictly comprised of R&T projects.

R&T Project. An Agency project managed as either a Technology Development Project or an R&T Portfolio Project.

Real-Year Dollars. Real-year dollars are current fiscal year (FY) dollars adjusted to account for inflation in future years.

Research and Technology (R&T). Basic research, applied research, and technology development.

Research Director. Person responsible for the formulation and implementation of Cross-Program Research.

Safety. Freedom from those conditions that can cause death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment.

Safety and Mission Assurance Requirements. Requirements defined by the SMA organization related to safety and mission assurance.

Stakeholder. Any party that has an interest in the outcome of a program or project. Stakeholders of a project include customers, beneficiaries, and organizations that will work on or provide support to the program or project.

System. The combination of elements that function together to produce the capability required to meet a need. The elements include all hardware, software, equipment, facilities, personnel, processes, and procedures needed for this purpose.

Systems Engineering. A disciplined approach for the definition, implementation, integration, and

operation of a system (product or service). The emphasis is on achieving stakeholder functional, physical, and operational performance requirements in the intended use environments over its planned life within cost and schedule constraints. Systems engineering includes the engineering processes and technical management processes that consider the interface relationships across all elements of the system, other systems, or as a part of a larger system.

Technical Authority. The individual who specifically maintains technical responsibility over establishment of, changes to, and waivers of requirements in a designated area.

Termination Review. A review initiated by the Decision Authority for the purpose of securing a recommendation as to whether to continue or terminate a program or project. Failing to stay within the parameters or levels specified in controlling documents will result in consideration of a termination review.

Terms of Reference (ToR). A document specifying the nature, scope, schedule, and ground rules for an independent review or independent assessment.

Technology Development Project. A specific R&T Project identified in an Agency Program Plan that has defined technical requirements, a life-cycle cost that incorporates a specific beginning and ending and a management structure. A Technology Development Project yields new or revised technology that addresses NASA's strategic needs.

Technology Development Project Lead. A generic term that represents the position in charge of the Technology Development Project. A TD Project Lead could be designated as a Project Manager, Project Principal Investigator, or some other term, as defined in the TD Project's governing document. Waiver. A documented authorization intentionally releasing a program or project from meeting a requirement.

Work Breakdown Structure (WBS). A product-oriented hierarchical division of the hardware, software, services, and data required to produce the program/project's end product(s), structured according to the way the work will be performed, and reflective of the way in which program/project costs, schedule, and technical and risk data are to be accumulated, summarized, and reported.

Appendix B. Acronyms

AA	Associate Administrator
AD2	Advancement Degree of Difficulty
AFU	Alternative Future Use
APA	Allowance for Program Adjustment
ASM	Acquisition Strategy Meeting
ASP	Acquisition Strategy Planning
ATD	Advanced Technology Development
BAA	Broad Agency Announcement
BAR	Basic and Applied Research
CD	Center Director
CFR	Code of Federal Regulations
CHMO	Chief Health and Medical Officer
CIO	Chief Information Officer
CMC	Center Management Council
CoF	Construction of Facilities
DA	Decision Authority
DRM	Design Reference Mission
EAV	Experimental Aerospace Vehicles
EM	Electromagnetic
EVM	Earned Value Management
FAD	Formulation Authorization Document
FAR	Federal Acquisition Regulation
G&A	General and Administration
HMA	Health and Medical Authority

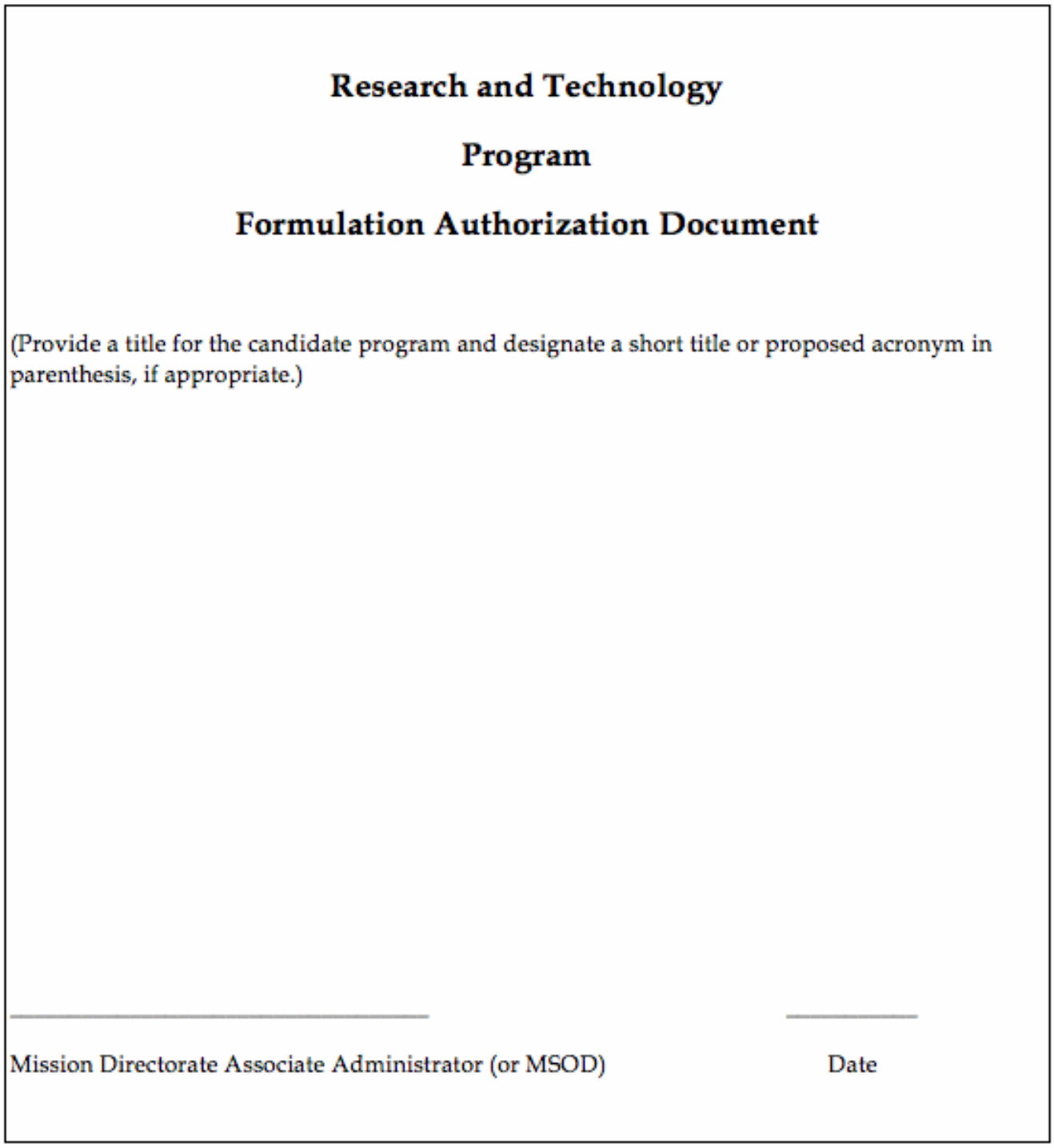
HQ	Headquarters
IA	Independent Assessment
IBPD	Integrated Budget and Performance Document
IFM	Integrated Financial Management
IPAO	Independent Program Assessment Office
IT	Information Technology
KDP	Key Decision Point
KPP	Key Performance Parameter
LCC	Life-Cycle Cost
LSP	Launch Services Program
MD	Mission Directorate
MDAA	Mission Directorate Associate Administrator
MdM	Meta-Data Manager
MSO	Mission Support Office
MSOD	Mission Support Office Director
NASA	National Aeronautics and Space Administration
NESC	NASA Engineering and Safety Center
NEPA	National Environmental Policy Act
NFS	NASA Federal Acquisition Regulation (FAR) Supplement
NOA	New Obligational Authority
NPD	NASA Policy Directive
NPR	NASA Procedural Requirements
NRA	NASA Research Announcement
NRC	National Research Council
OCE	Office of the Chief Engineer
OCFO`	Office of the Chief Financial Officer

OSMA	Office of Safety and Mission Assurance
OSO	Office of Space Operations
PA&E	Program Analysis and Evaluation
PCA	Program Commitment Agreement
PI	Principal Investigator
PMC	Program Management Council
PRA	Probabilistic Risk Assessment
PSM	Procurement Strategy Meeting
R&D	Research and Development
R&M	Reliability and Maintainability
R&T	Research and Technology
RF	Radio Frequency
RFP	Request for Proposal
ROA	Research Opportunities in Aeronautics
ROSES	Research Opportunities in Space and Earth Sciences
RTOPS	Research and Technology Objectives and Plans Summary
SEHB	Systems Engineering Handbook
SI	Systeme Internationale (commonly known as Metric System)
SMA	Safety and Mission Assurance
STI	Scientific and Technical Information
TA	Technical Authority
TD	Technology Development
TMI	Technology Maturity Index
ToR	Terms of Reference
TRL	Technical Readiness Level
V&V	Verification and Validation

WBS Work Breakdown Structure

Appendix C. R&T Program Formulation Authorization Document (FAD) Template

C.1 R&T Program FAD Title Page



Research and Technology

Program

Formulation Authorization Document

(Provide a title for the candidate program and designate a short title or proposed acronym in parenthesis, if appropriate.)

_____ _____

Mission Directorate Associate Administrator (or MSOD) Date

Figure C-1 R&T Program Formulation Authorization Document Title Page

C.2 R&T Program FAD Template

RESEARCH AND TECHNOLOGY PROGRAM
FORMULATION AUTHORIZATION DOCUMENT
(PROGRAM TITLE)

1.0 Purpose

- Briefly describe the purpose of the program and define its relationship to the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan.
- Establish the scope of work to be accomplished.
- Define the approach and resources required to conduct program formulation.

2.0 Authority

- Identify the Program Lead to manage the Formulation effort.
- Describe any Center involvement, including lines of authority, coordination, and reporting.
- Identify the management process (NPR 7120.8, etc.) for the program.
- Identify the initial program elements that follow a Technology Development Project life cycle and those elements that follow an R&T Portfolio Project life cycle.

3.0 Funding

- Identify, by fiscal year, the funding that will be committed for Program Formulation.

4.0 Constraints

- Provide initial constraints, including resources, schedule, and program participants within and external to NASA, including international partnerships.

5.0 Reviews

- Describe any reviews, including independent reviews required during the formulation phase. Describe the criteria for triggering a termination during formulation.

Appendix D. R&T Program Commitment Agreement (PCA) Template

D.1 R&T PCA Title Page

Research and Technology

Program Commitment Agreement

(Provide a title for the candidate program and designate a short title or proposed acronym in parenthesis, if appropriate.)

It is the responsibility of each of the signing parties to notify the other in the event that a commitment cannot be met and to initiate the timely renegotiations of the terms of this agreement.

_____ _____

Mission Directorate Associate Administrator (or MSOD) Date

_____ _____

NASA Associate Administrator Date

Figure D-1 R&T Program Commitment Agreement Title Page

D.2 R&T PCA Template

RESEARCH AND TECHNOLOGY
PROGRAM COMMITMENT AGREEMENT
(PROGRAM TITLE)

1.0 R&T Program Objectives

Identify the broad program objectives. Describe the program's relationship to the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan. Convey the public good of the program to the taxpayer, stated in a way that can be understood by the average citizen.

2.0 R&T Program Overview

Describe the strategy to achieve the above-mentioned objectives. Relationships with external organizations, other Government agencies, or international partners should be addressed if achievement of the program objectives is dependent on their performance. Identify the associated projects governed by the program.

3.0 R&T Program Authority

Describe the NASA organizational structure for managing the program and projects

from the MDAA or MSOD to the project leads. Include any NASA Center involvement. Include lines of authority and reporting, Center(s) responsibilities, the governing PMC for the oversight of the program and its projects, and the approving official for new projects. Identify the management process (NPR 7120.8, etc.) this program and any initial program elements will adhere to. Identify the Program Lead in charge of the program. Identify whether R&T Projects will be managed as Technology Development Projects or as R&T Portfolio Projects.

4.0 Technical Performance Commitment

Summarize the performance metrics with goals and minimum thresholds needed to achieve the program objectives. If the objectives include a technical performance target (goal) in addition to a threshold requirement, the commitment could be stated as a range.

5.0 Schedule Commitment

Identify the key target schedule milestones for the program and for each project in the program. Identify key target milestones such as:

a. Start of Formulation.

b. Target date or time frame for the Program's Formulation Review.

c. Start of Implementation.

d. Start of operations.

e. End of prime operations and/or disposal requirements, if applicable.

f. Other milestones or time periods, as appropriate for a specific program/project.

6.0 Cost Commitment

Provide the estimated cost range for the program for the five-year period beginning in the current fiscal year at a level of detail that identifies the approved individual projects. Identify the constraints and assumptions used to develop this estimated cost range and specifically identify those assumptions that drive the range. This cost range should contain all costs necessary to perform the program, including, but not limited to, standard project activities, required technology developments, facilities costs, infrastructure costs, operations and sustainment, data analysis, and disposal. Reference the annual budget contained in the Integrated Budget and Performance Document (IBPD) for cost phasing. The cost range should be updated when program content changes, such as the addition of new projects entering implementation.

7.0 Acquisition Strategy

Provide a brief statement of the proposed acquisition strategy for major program elements.

8.0 High-Risk Areas

Identify the areas of highest risk for the program (covering safety, technical, institutional, cost, or schedule issues) in which failure may result in changes to the program/project baseline cost, schedule, or technical performance requirements. This section should identify, where possible, the specific risk drivers, such as high-risk technologies upon which the program is dependent.

9.0 Internal Agreements

If the program is dependent on other NASA activities outside of the MDAA or MSOD's control to meet program objectives, identify the required support and list any formal agreements required.

10.0 External Agreements

Explain the involvement of external organizations, other Government agencies, or international support necessary to meet the program objectives. Include a brief overview of the program/project relationships with such external organizations. Include an identification of the commitments being made by the external organizations, other Government agencies, or international partners and a listing of the specific agreements to be concluded. Any unique considerations affecting implementation of required NASA policies and processes necessitated by the external involvement should be clearly identified.

11.0 Independent Assessments and Optional KDPS

Specify the type of independent assessments that will be performed during the life cycle of the program.

Define any optional KDPs (KDP II, III, IV, etc.) required by the DA during Implementation or determine that these optional KDPs are not needed. This should include determination of gate

products required prior to the optional KDPs.

12.0 Outcomes

Identify the discrete set of expected deliverables (outcomes) that flow from the Agency's goals and objectives, as defined in the Agency's strategic roadmaps, architecture, and plan.

13.0 Waivers

Identify known waivers that will be sought for the program. Provide rationale consistent with program characteristics such as scope, complexity, visibility, cost, safety, and acceptable risk.

14.0 R&T PCA Activities Log

Provide and maintain a log of all R&T PCA activities, including revisions that reflect all changes and waivers to the original R&T PCA. This log includes the information shown in Figure B-2 and may be supplemented with an attached addendum for each change, describing the change. The R&T PCA should be updated to add approved projects or whenever substantial change makes it necessary.

Date	Event	Change	Addendum	Cancellation Review Req'd	MDAA Signature	Associate Administrator Signature
dd/mm/yy	Revalidation	None	N/A	No		
dd/mm/yy	Revalidation	None	N/A	No		
dd/mm/yy	Approval of new Project	Addition of Project N	Ref. #1	No		

Figure D-2 Sample R&T Program Commitment Agreement Activities Log

Appendix E. R&T Program Plan Template

The MDAA or MSOD may authorize use of an alternative format with compatible content.

E.1 R&T Program Plan Title Page

Research and Technology

Program Plan

(Provide a title for the candidate program and designate a short title or proposed acronym in parenthesis, if appropriate.)

It is the responsibility of each of the signing parties to notify the other in the event that a plan cannot be met and to initiate the timely renegotiations of the terms of this agreement.

_____ _____

Program Lead Date

_____ _____

Mission Directorate Associate Administrator (or MSOD) Date

Figure E-1 R&T Program Plan Title Page

E.2 R&T Program Plan Template RESEARCH AND TECHNOLOGY PROGRAM PLAN (PROGRAM TITLE)

1.0 R&T Program Overview

1.1 Introduction

Briefly state the background of the program and its current status, including the results of formulation activities, decisions, and documentation.

1.2 Program Goals, Objectives and Metrics

State the program goals and specific objectives with clear traceability to the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan. Performance goals, and performance indicators, and their relationship to the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan, should be expressed in an objective, quantifiable, and measurable form. Goals and objectives should include commitment to safety and mission success.

1.3 Customer/Beneficiary and Stakeholder Definition and Advocacy

State the main customers/beneficiaries and stakeholders of the program (e.g., PI, science community, technology community, public, education community, Chief Information Officer (CIO), MD, MSO, OCE, OSMA, OCFO, and NASA Centers) and the process to be used to ensure customer/beneficiary and stakeholder advocacy.

1.4 Program Authority and Management Structure

Identify the Program Lead. Identify the location (Center or Headquarters) where the Program Lead resides and each Center's responsibilities, if relevant. Identify the Governing Program Management Committee or Council(s) for oversight of the projects within the program and the approving official for projects.

Define the management process (NPR 7120.8, etc.) this program and any initial program elements will adhere to. Identify whether each associated R&T Project will be managed as a Technology Development Project or as an R&T Portfolio Project.

Briefly describe the architecture of the program and its major components. If applicable, describe how the major components are intended to operate together and with legacy systems. Describe the way the program will relate to other institutions within NASA as well as outside of NASA. Identify the responsibilities of each NASA Center as they relate to their respective requirement allocations referenced in PROGRAM REQUIREMENTS/OBJECTIVES below, if relevant. Describe the process by which projects are formulated, approved, or terminated.

Organization. Describe the NASA organizational structure for managing the program and projects from the MDAA or MSOD to the Project Leads. Include lines of authority and reporting; illustrate the organization graphically. If elements or the entire program are managed collectively within a MD (or MSO) as Cross-Program Research, reference the MDAA or MSOD approved Cross-Program Research Plan (see Appendix F) in lieu of providing the detailed organizational structure.

Responsibilities. Define management responsibilities of the MD or MSO, the Program Lead, and Project Lead, including the authority of these persons, as described in NPR

7120.8, NASA Research and Technology Program and Project Management Requirements. Indicate their responsibilities for developing, concurring, and approving principal program documents, such as the Formulation Authorization Document, the Program Plan, Project Plan, NRAs, Request for Proposals (RFPs) and other contract-related documents, reports associated with major reviews, and other key activities.

2.0 R&T Program Baseline

2.1 Program Requirements/Objectives

Document the program requirements/objectives, including performance requirements/objectives, and technical success criteria, in an objective, quantifiable, and measurable form. For multiple projects within a program, describe the way in which the program requirements will be allocated to the respective projects, if applicable. The approving authority is required to document high-level requirements/objectives and how these requirements/objectives flow down from the program to each project as they are formulated. If the program characteristics indicate a greater emphasis is necessary on maintaining either technical, cost, or schedule, then this section should also identify which is more important to be considered (e.g., it should address if the program is cost capped, or if schedule is paramount, or if it is critical to accomplish all of the technical objectives.) Programmatic success criteria such as KPPs, outcomes, and other accompanying performance indicators should be expressed in objective, quantifiable, and measurable form, where applicable. Include any safety requirements, where applicable.

2.2 Program Schedule

Provide a schedule of program activities and events covering the life of the program. Include all applicable events, such as approval dates for major program and project documents, dates of major project reviews, launch dates (or equivalent system "delivery" dates), and other NASA AA, MDAA, or MSOD decisions. Include all PCA milestones. Include the strategy for addressing schedule updates when impacts to the schedule occur.

2.3 Program Resources

All elements in full cost are to be included for each participating NASA Center, identify yearly New Obligational Authority (NOA) full cost estimates for system development and operations, facility construction, institutional support (including safety and mission assurance), and management (if applicable). Address Civil Service workforce levels. Once program approval has been completed, this section will be a reference for reconciliation to Integrated Budget and Performance Document (IBPD) and Integrated Financial Management (IFM) data.

3.0 Subplans

3.1 Controls and Compliance

Describe the process by which the program assures compliance with NASA policies and directives, as well as other applicable requirements. Describe the process by which project requirements/objectives are validated for compliance with the program requirements/objectives. Describe the process for controlling changes and for updating the R&T PCA as a result of any changes. Indicate key program parameters (cost, schedule, and technical) which will require NASA AA, MDAA, MSOD, or Program Lead approval for change. Identify the reserves management strategy and approval authority to include identification of an Allowance for Program Adjustment (APA), if applicable. Describe the strategy for supporting and/or implementing independent assessments.

3.2 Relationships to Other Programs and Organizations

3.2.1 Internal: Describe the way the program will relate to other institutions within NASA (e.g., crosscutting technology efforts, space communications, and launch services). List the internal agreements necessary for program success and projected dates of approval. This list may be maintained as a separate document that is referenced by the Program Plan and may be updated separate from the Program Plan (i.e., updates do not require formal revision to the Program Plan). This list should include those agreements that are concluded with the authority of the Program Lead, and reference those agreements concluded with the authority of the MDAA or MSOD.

3.2.2 External: Describe the way the program will relate to entities outside of NASA (e.g., interagency or international). List the external agreements necessary for program success and projected dates of approval. This list may be maintained as a separate document that is referenced by the Program Plan and may be updated separate from the Program Plan (i.e., updates do not require formal revision to the Program Plan). This list should include those agreements that are concluded with the authority of the Program Lead, and reference those agreements concluded with the authority of the NASA AA, MDAA, and/or MSOD.

3.3 Budget and Acquisition Strategy

Briefly describe the budget and acquisition approach to be applied at the program level toward each project. The respective roles, responsibilities, and relationships between the Government and its contractors, vendors, and/or partners are addressed, including a description of integration and surveillance responsibilities. If applicable, the use of cost caps or other cost control strategies should be addressed, as well as the strategy for initiation of new program elements. The amount of yearly funding reserves and at what level the reserves will be held should be stated, if applicable.

3.4 Cooperation and Commercialization

Identify opportunities for establishing partnerships with private industry, academia, or other governmental organizations to conduct dual use research, develop mutually beneficial technologies, and transfer results into NASA for mission use and the private sector for commercial application (if applicable).

3.5 Data Management and Distribution

Program data management planning is provided as either a section of this Program Plan or as a separate document (if applicable). It should address the data being captured by all projects within the program and their availability. The plan should document how the results of R&T efforts will be disseminated, and it should also document if there are restrictions that limit or prevent the ability to disseminate data in accordance with NPR 2200.2, Requirements for Documentation, Approval, and Dissemination of NASA Scientific and Technical Information.

3.6 Risk Management Strategy

Summarize the risk management approach to be used for the program, including appropriate actions to mitigate risk and program de-scope plans. Also, identify primary risks. If required, list any program elements that will develop their own stand alone risk and safety plans (see section 3.3.3.7, 3.3.3.8, and 3.3.3.9).

3.7 Reviews and Optional KDPs

List the reviews that the program will conduct, including Independent Assessments, program status reviews, and others in response to MDAA, MSOD, or governing PMC requirements. Include the timeline for these reviews. Provide the technical, scientific, schedule, cost, and other criteria, which will be utilized in the reviews. Identify any optional KDPs (KDP II, III, IV, etc.) required by the DA during Implementation. This should include determination of gate products required prior to the optional KDPs. Further, discuss how any projects associated with the program will be held to independent reviews as well.

3.8 Waivers

Identify known waivers that the program will obtain against NASA policies, directives, or other applicable external requirements. Provide rationale and risk impact for the waivers, include characteristics such as scope, complexity, visibility, cost, and safety.

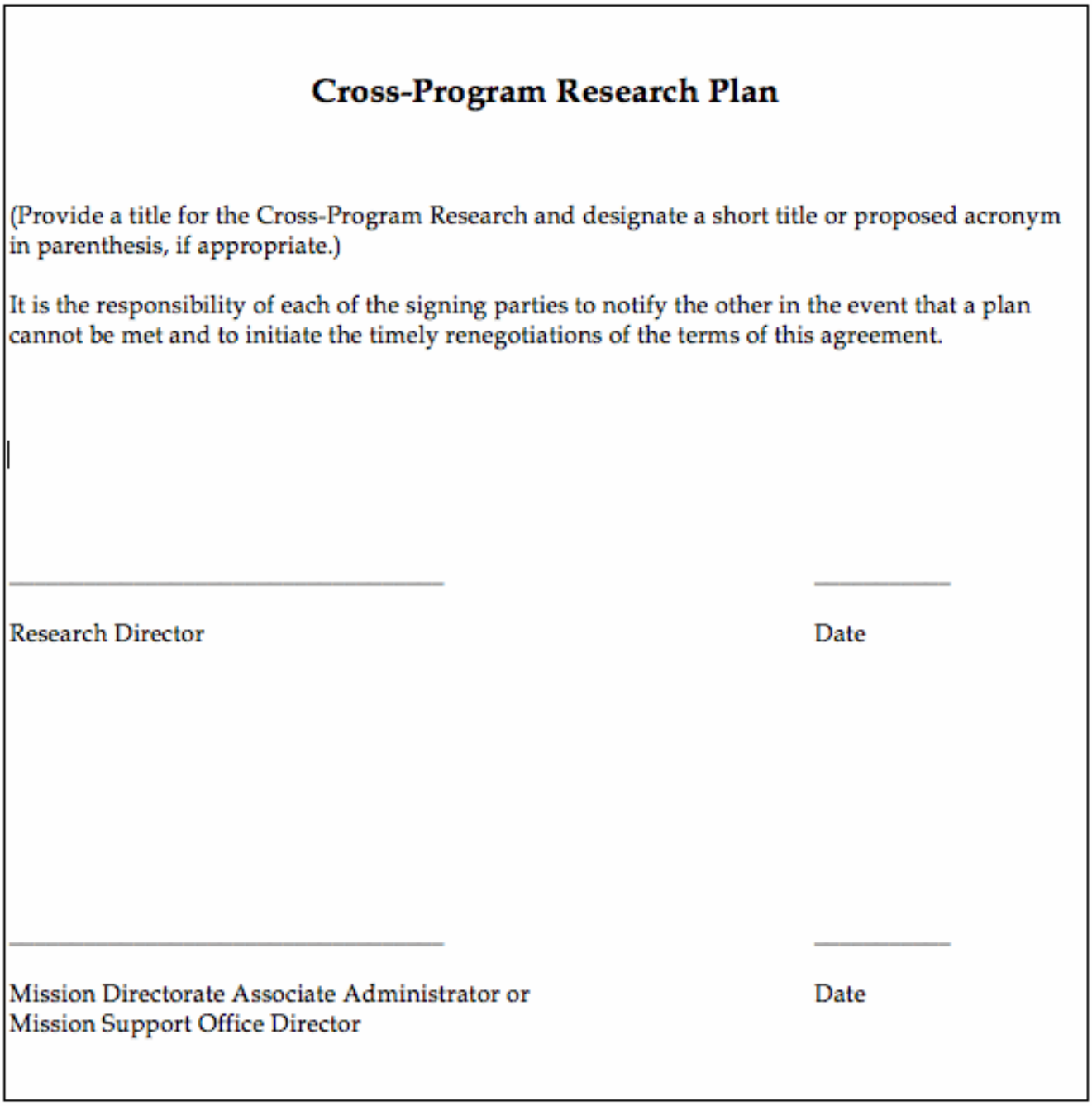
3.9 Change Log

Document changes to the Program Plan.

Appendix F. Cross-Program Research Plan Template

The MDAA or MSOD may authorize use of an alternative format with compatible content.

F.1 Cross-Program Research Plan Title Page



Cross-Program Research Plan

(Provide a title for the Cross-Program Research and designate a short title or proposed acronym in parenthesis, if appropriate.)

It is the responsibility of each of the signing parties to notify the other in the event that a plan cannot be met and to initiate the timely renegotiations of the terms of this agreement.

_____ _____

Research Director Date

_____ _____

Mission Directorate Associate Administrator or Mission Support Office Director Date

Figure F-1 Cross-Program Research Plan Title Page

F.2 Cross-Program Research Plan Template

CROSS-PROGRAM RESEARCH PLAN
(CROSS-PROGRAM RESEARCH TITLE)

1.0 Cross-Program Research Overview

1.1 Introduction

Briefly state the area of specialty of the Cross-Program Research and its current status, including the results of formulation activities, decisions, and documentation.

1.2 Cross-Program Research Goals and Objectives

State the goals and specific objectives of the Cross-Program Research and associated R&T Portfolio Projects with clear traceability to the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan.

1.3 Customers/Beneficiaries and Stakeholders

Identify the main customers and stakeholders of the Cross-Program Research (e.g., PI, science community, technology community, public, education community, MD, MSO, OCE, OSMA, CIO, and NASA Centers) and the process to be used to ensure customer/beneficiary and stakeholder advocacy.

1.4 Cross-Program Research Authority and Management Structure

Identify the location (Center or Headquarters) where the Research Director resides and any Center responsibilities, if relevant. Identify the oversight council responsibilities and the approving official for projects. Identify the Research Director who manages the Cross-Program Research.

Briefly describe the management structure of the Cross-Program Research and associated R&T Portfolio Projects. Describe the process by which Cross-Program Research is formulated, approved, reviewed, and terminated. Include lines of authority and reporting and illustrate the organization graphically. Define management responsibilities for developing, concurring, and approving principal documents related to the Cross-Program Research and R&T Portfolio Projects. Define the selection process for awarding R&T, including the Selection Official. Define any reports associated with major reviews and other key activities.

2.0 Cross-Program Research Baseline

2.1 Cross-Program Research Requirements

Document the Cross-Program Research requirements and technical success criteria, in an objective, quantifiable, and measurable form, to the maximum extent practical. The Research Director is required to document R&T Portfolio Project objectives and flow down of high-level requirements to each group of R&T investigations as it is formulated. R&T Portfolio Project success criteria such as KPPs, outcomes, and other accompanying performance indicators should be expressed in objective, quantifiable, and measurable form, where applicable. Include KPP thresholds and KPP goals, where applicable.

2.2 Cross-Program Research Schedule

Provide a multi-year schedule for the R&T Portfolio Projects in the Cross-Program Research, including all applicable events, such as scheduled dates for reports, and other NASA AA, MDAA, or MSOD decisions. Include the strategy for addressing schedule updates when impacts to the schedule occur.

2.3 Cross-Program Research Resources

All elements in full cost are to be included for each participating NASA Center, where applicable. Once program approval has been completed, this section will be a reference for reconciliation to IBPD and IFM data.

3.0 Cross-Program Research Process Description

3.1 Controls and Compliance

Describe the process by which the Cross-Program Research assures compliance with NASA policies, directives, as well as other applicable requirements. Describe the process for controlling changes to Cross-Program Research and associated R&T Portfolio Projects. Describe the strategy for supporting and/or implementing Independent Assessments.

3.2 Relationships to Other Programs and Organizations

3.2.1 Internal: Describe the way the Cross-Program Research will relate to other institutions within NASA. List the internal agreements necessary for Cross-Program Research success and projected dates of approval. This list may be maintained as a separate document that is referenced by the Cross-Program Research Plan and may be updated separate from the Cross-Program Research Plan (i.e., updates do not require formal revision to the Cross-Program Research Plan). This list should include those agreements that are concluded with the authority of the Research Director, and reference those agreements concluded with the authority of the MDAA or MSOD.

3.2.2 External: Describe the way the Cross-Program Research will relate to entities outside of NASA (e.g., interagency or international). List the external agreements necessary for Cross-Program Research success and projected dates of approval. This list may be maintained as a separate document that is referenced by the Cross-Program Research Plan and may be updated separate from the Cross-Program Research Plan (i.e., updates do not require formal revision to the Cross-Program Research Plan). This list should include those agreements that are concluded with the authority of the Research Director, and reference those agreements concluded with the authority of the NASA AA, MDAA, and/or MSOD.

3.3 Budget and Acquisition Strategy

Briefly describe the budget and acquisition approach to be applied at the

Cross-Program Research level toward each R&T Portfolio Project. Identify an integrated budget typically for three or five years, including appropriate WBS elements (see Appendix K) consistent with available R&T program resources.

Define a process for determining openly competed, internally competed, and directed investments. Define a process for the solicitation, evaluation, and selection of proposals (including identifying Selection Official(s)). Establish evaluation criteria, including considerations of technical merit, and relevance to the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan, and cost realism. If applicable, the Cross-Program Research Plan should incorporate by reference appropriate sections of standard R&T process documents, including the Guidebook for Proposers to Responding to a NASA Research Announcement (NRA) (http://www.hq.nasa.gov/office/procurement/nraguidebook) and any MD or MSO omnibus NASA Research Announcements (e.g., ROSES or ROA).

3.4 Cooperation and Commercialization

Identify opportunities for establishing partnerships with private industry, academia, or other governmental organizations to conduct dual use research, develop mutually beneficial technologies, and transfer results into NASA for mission use and the private sector for commercial application.

3.5 Data Management and Distribution

Data management planning is provided as either a section of the Cross-Program Research Plan or as a separate document. It should address the data being captured by all R&T Portfolio Projects within the Cross-Program Research and define plans for data rights and services. The plan should document how the results of R&T efforts will be disseminated, and it should also document if there are restrictions that limit or prevent the ability to disseminate data in accordance with NPR 2200.2, Requirements for Documentation, Approval, and Dissemination of NASA Scientific and Technical Information.

3.6 Risk Management Strategy

Summarize the risk management approach to be used for the Cross-Program Research, including appropriate actions to mitigate risk and Cross-Program Research/R&T Portfolio Project de-scope plans.

3.7 Reviews and Optional KDPs

Describe the reviews that the Cross-Program Research will conduct, including Formulation Reviews, peer reviews, and other independent assessments, in response to MDAA, MSOD, or governing PMC requirements. Include the timeline for these reviews. Provide the technical, scientific, schedule, cost, and other criteria, which will be utilized in the reviews. Define any optional KDPs (KDP II, III, IV, etc.) required by the DA during Implementation or determine that these optional KDPs are not needed.

This should include determination of gate products required prior to the optional KDPs. Further, discuss how any projects associated with the program will be held to independent reviews as well.

3.8 Waivers

Identify known waivers that the Cross-Program Research will obtain against NASA policies, directives, or other applicable external requirements. Provide rationale and risk impact for the waivers, include characteristics such as scope, complexity, visibility, cost, and safety.

3.9 Change Log

Document changes to the Cross-Program Research Plan.

3.10 Cross-Program Research Plan Appendices

Each appendix of the Cross-Program Research Plan includes information on the specific programs and projects that are transferring R&T Portfolio Project management to the Research Director. FADs for new R&T Portfolio Projects may be attached as appendices to the Cross-Program Research Plan.

Appendix G. R&T Project Formulation Authorization (FAD) Document Template

G.1 R&T Project FAD Title Page

Research and Technology

Project

Formulation Authorization Document

(Provide a title for the candidate project and designate a short title or proposed acronym in parenthesis, if appropriate.)

_____ _____

Program Lead or Research Director — Date

_____ _____

Mission Directorate Associate Administrator or Mission Support Office Director — Date

Figure G-1 R&T Project Formulation Authorization Document Title Page

G.2 R&T Project FAD Template

RESEARCH AND TECHNOLOGY
PROJECT

FORMULATION AUTHORIZATION DOCUMENT
(PROJECT TITLE)

1.0 Purpose

- Briefly describe the purpose of the project and define its relationship to the program's strategic goals and objectives.
- Establish the scope of work to be accomplished.
- Define the approach and resources required to conduct project formulation.

2.0 Authority

- Identify the Project Lead.
- Describe any Center involvement, including lines of authority, coordination, and reporting.
- Identify the management process (NPR 7120.8, etc.) for the project.

3.0 Funding

- Identify, by fiscal year, the funding that will be committed for Project Formulation.

4.0 Constraints

- Provide initial constraints, including resources, schedule, and project participants within and external to NASA, including international partnerships.

5.0 Reviews and Optional KDPs

- Describe any reviews, including independent reviews required during the formulation phase. Describe the criteria for triggering a termination during formulation. Identify optional KDP B if required by the DA during Formulation or identify optional KDP B is not needed. This should include determination of gate products required prior to the optional KDP B.

Appendix H. Technology Development Project Plan Template

The MDAA or MSOD may authorize use of an alternative format with compatible content.

H.1 Technology Development Project Plan Title Page

Technology Development Project Plan

(Provide a title for the candidate project and designate a short title or proposed acronym in parenthesis, if appropriate.)

It is the responsibility of each of the signing parties to notify the other in the event that a plan cannot be met and to initiate the timely renegotiations of the terms of this agreement.

_____	_____
TD Project Lead	Date
_____	_____
Center Director(s) or designee (if applicable)	Date
_____	_____
Program Lead	Date
_____	_____
Mission Directorate Associate Administrator or Mission Support Office Director	Date

Figure H-1 Technology Development Project Plan Title Page

H.2. Technology Development Project Plan Template

TECHNOLOGY DEVELOPMENT PROJECT PLAN
(PROJECT TITLE)

1.0 Objectives

State the specific TD Project's objectives and performance goals and their relationship to the program's objectives and goals. Performance goals should be stated in an objective, quantifiable, and measurable form. Include project-specific high-level requirements. State the TD Project's relevance to the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan. State the full mission success criteria clearly and concisely in a form suitable for objective verification and validation. State the minimum mission success criteria associated with the high-level project requirements that, if not met, trigger a possible Termination Review.

2.0 Technical Approach

Present a technical description of the TD Project. This includes R&T, facilities, flight plans, operations and logistics concepts, and planned results analysis and reporting. Define any technical milestones. Document an assessment (Gap Analysis) of related technology development activities in other NASA programs, other Government agencies, and the commercial sector to eliminate unnecessary duplication of effort.

3.0 Performance

Describe the project specific KPPs and establish quantitative values (goal and threshold values) for each to be achieved at each milestone. The relationship may be in the form of a matrix that show the KPP range (threshold and goal) and the TRL to be achieved at each major demonstration. Define the initial or state-of the art in the KPPs and TRL at the beginning of the project. Document the initial gap analysis to assess related technology development activities in other NASA programs, other Government agencies, and the commercial sector to minimize duplication of effort. Define the specific factors that will be used in the TRL assessment. For example, the term "relevant environment" should be specifically defined for the technology needs that this specific project is developing.

4.0 Management Approach

Identify the TD Project Lead. Describe the project management structure consistent with the project WBS, including organization and responsibilities, its integration into the program management structure, and NASA Center participation. Include clear lines of authority and reporting; illustrate the organization graphically. Describe how the project interacts with applicable NASA Center(s). Identify all significant interfaces with other contributing organizations. Describe the process for problem reporting and subsequent decision making, clearly describing the roles and responsibilities of all organizations. Identify specific management tools to support management in planning

and controlling the project. Describe any use of special boards and committees. This section should indicate if a greater emphasis is necessary on maintaining technical objectives, cost, or schedule. Explain how the project will ensure identification, control, and disposition of project records in accordance with NPD 1440.6, NASA Records Management, and NPR 1441.1, Records Retention Schedules.

5.0 Resource Requirements

a. Funding Requirements: Document the initial life-cycle cost (LCC) consistent with the TD Project WBS, schedule, and performance parameters to form the project estimate baseline. Present a funding requirements chart. Indicate the NOA in full-cost, real-year dollars for the prior, current, and remaining fiscal years. The displayed detail should cover major elements of cost (typically reflecting at least at the second level of the WBS or its equivalent). (For more information on full cost and practices, see Volume 7 of the NASA Financial Management Requirements.)

b. Institutional Requirements: Present the infrastructure requirements (use or development of real property/facilities, aircraft, personal property, information technology) for the entire project throughout its life cycle. The business case includes full LCC (including operations, sustainment, and disposal); benefit estimates; alternative and sensitivity analyses; and risk assessment. Identify means of meeting infrastructure requirements through synergy with other programs and projects, thus avoiding costly duplication of support facilities and capabilities. Identify any necessary upgrades or new developments, including those needed for environmental compliance. Present the workforce requirements. Include full-cost civil service workforce requirements on the providing organizations for the prior (e.g., actuals), current, and remaining years. If use of NASA aircraft is planned, address here or address in a separate aircraft utilization plan the projected ground and flight utilization, modification requirements, planned deployments, aerobatics requirements, estimated costs, and other applicable requirements.

c. Environmental Management Requirements: Describe any activities specific to the project to be conducted with support from the cognizant Environmental Management Office (EMO) to comply with NPR 8580.1, Implementing the National Environmental Policy Act and Executive Order 12114.

6.0 Schedule

Document the TD Project's Integrated Master Schedule for all major events, independent reviews, and other activities throughout the life cycle of the project. Include approval dates for principal project documentation, life-cycle transitions, major reviews, program-controlled milestones, and significant contract milestones. Identify lower-level schedules to be developed and maintained. Project Leads are encouraged to identify alternative development paths in order to maximize the

probability of success.

7.0 Work Breakdown Structure

A TD Project work breakdown structure (WBS) (see Appendix K) will be defined accompanied by a WBS dictionary. The WBS should be defined to the level required to identify issues associated with technical progress and resource utilization in a timely manner. The WBS level should be consistent with effective tracking of major milestones and earned value management reporting.

8.0 Strategy for Technology Transition

Identify the NASA crosscutting or other technology thrusts to be utilized by the TD Project as well as the sources of the technologies. Describe how the TD Project will remove remaining technology gaps, including maturation, validation, and insertion plans, quantifiable milestones, decision gates, and resources required. Describe how and when the TD Project will evaluate the feasibility, readiness, cost, risk, and benefits of the new technologies. Also provide alternative development strategies for technologies that do not mature as expected. Identify distribution restrictions on the software, hardware, or data. Describe how the technology end item deliverable (product or service) will transition to the customer/beneficiary application (i.e., a technology transfer strategy). Demonstrate close interaction with the application community, and provide an exit strategy following technology transfer.

Document strategy for closure of contracts, archival of data, and disposition of residual property associated with the TD Project when the project ends.

9.0 Risk Management

Summarize the risk management approach to be used for the TD Project, including appropriate actions to mitigate risk and TD Project de-scope plans. Risk mitigation should be balanced with the need to conduct challenging technology development that will realize significant gains. If required, list any project elements that will develop their own stand alone risk and safety plans (see section 4.3.6.10, 4.3.6.11, and 4.3.6.12).

10.0 Project Evaluation And Optional KDPs

Provide details for the Formulation Reviews and periodic assessments or status reviews that will be used to evaluate progress. The schedule of reviews, as well as the composition of the review body, should be defined. This includes defining the role of the customer/beneficiary in the review process. Define the factors (including TRLs)

that will be used to perform the technology assessment. Identify any optional KDPs (KDP B, D, and E) required by the DA or determine that these optional KDPs are not needed. This should include determination of gate products required prior to the optional KDPs.

11.0 Security Plan

Document the TD Project's approach to implementing IT security requirements in accordance with NPR 2810.1, Security of Information Technology.

Appendix I. R&T Portfolio Project Plan Template

The MDAA or MSOD may authorize use of an alternative format with compatible content.

I.1 R&T Portfolio Project Plan Title Page

R&T Portfolio Project Plan

(Provide a title for the R&T Portfolio Project and designate a short title or proposed acronym in parenthesis, if appropriate.)

It is the responsibility of each of the signing parties to notify the other in the event that a plan cannot be met and to initiate the timely renegotiations of the terms of this agreement.

_____	_____
R&T Portfolio Project Lead	Date
_____	_____
Center Director(s) or designee (if applicable)	Date
_____	_____
Program Lead or Research Director	Date
_____	_____
Mission Directorate Associate Administrator or Mission Support Office Director	Date

Figure I-1 R&T Portfolio Project Plan Title Page

I.2 R&T Portfolio Project Plan Template

R&T PORTFOLIO PROJECT PLAN
(R&T PORTFOLIO PROJECT TITLE)

1.0 Objectives

State the area of specialty of the R&T Portfolio Project. State the specific project objectives and their relationship to the program objectives and goals. State the project's relevance to the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan. Identify the main customers/beneficiaries and stakeholders of the R&T Portfolio Project.

2.0 Technical Approach

Present a technical description of the R&T Portfolio Project. This includes R&T, facilities, flight plans, operations and logistics concepts, and planned results analysis and reporting. Document any analysis to assess related research activities in other NASA programs, other Government agencies, and the commercial sector to minimize duplication of effort.

3.0 Performance

Document the R&T Portfolio Project requirements/objectives and technical success criteria in an objective, quantifiable, and measurable form. The R&T Portfolio Project Lead is required to document the flow down of high-level objectives and requirements to the R&T Portfolio Project. This section should indicate if a greater emphasis is necessary on maintaining technical objectives, cost, or schedule. R&T Portfolio Project success criteria such as KPPs, milestones, outcomes, or other accompanying performance indicators should be expressed in objective, quantifiable, and measurable form.

4.0 Management Approach

Identify the R&T Portfolio Project Lead. Describe the project management structure consistent with the R&T Portfolio Project WBS, including organization and responsibilities, its integration into the program management structure, and NASA Center(s) participation. Include clear lines of authority and reporting; illustrate the organization graphically. Describe how the project interacts with applicable NASA Center(s). Identify all significant interfaces with other contributing organizations. Describe the process for problem reporting and subsequent decision making, clearly describing the roles and responsibilities of all organizations. Identify specific management tools to support management in planning and controlling the project. Describe any use of special boards and committees.

Define management responsibilities for developing, concurring, and approving

principal documents related to the R&T Portfolio Project. Define the selection process for awarding R&T, including the Selection Official. Document strategy for closure of contracts, archival of data, and disposition of residual property associated with the R&T Portfolio Project when the project ends.

5.0 Resource Requirements

a. Funding Requirements: Briefly describe the budget and acquisition approach to be applied to the R&T Portfolio Project. Identify an integrated budget typically for three or five years, including appropriate WBS elements (see Appendix K) consistent with available R&T program resources. The respective roles, responsibilities, and relationships between the Government and its contractors, vendors, and/or partners are addressed, including a description of integration and surveillance responsibilities.

All elements in full-cost are to be included for each participating NASA Center. Identify yearly NOA full-cost estimates for system development and operations, facility construction, institutional support (including safety and mission assurance), and management (if applicable). Address civil service workforce levels. An R&T Portfolio Project work breakdown structure (WBS) will be defined accompanied by a WBS dictionary (see Appendix K). The WBS should be defined to the level required to identify issues associated with technical progress and resource utilization in a timely manner.

b. Institutional Requirements: Present the infrastructure requirements (use or development of real property/facilities, aircraft, personal property, information technology) for the portion of the R&T Portfolio Project covered by this plan (usually no more than five years). The business case includes full LCC (including operations, sustainment, and disposal); benefit estimates; alternative and sensitivity analyses; and risk assessment for new institutional requirements (if applicable). Identify means of meeting infrastructure requirements through synergy with other programs and projects, thus avoiding costly duplication of support facilities and capabilities. Identify any necessary upgrades or new developments, including those needed for environmental compliance. Present the workforce requirements. Include full-cost civil service workforce requirements on the providing organizations for the prior (e.g., actuals), current, and remaining years. If use of NASA aircraft is planned (piloted or unmanned aerial vehicles), address here or address in a separate aircraft utilization plan the projected ground and flight utilization, modification requirements, planned deployments, aerobatics requirements, estimated costs, and other applicable requirements.

c. Environmental Management Requirements: Describe any activities specific to the R&T Portfolio Project to be conducted with support from the cognizant Environmental Management Office (EMO) to comply with NPR 8580.1, Implementing the National Environmental Policy Act and Executive Order 12114.

d. Acquisition Strategy: Define a process for determining openly competed, internally competed, and directed investments. Define a process for the solicitation, evaluation, and selection of proposals (including identifying Selection Official(s)). Establish evaluation criteria, including considerations of technical merit, relevance to the Agency's vision and mission, as defined by NPD 1001.0, NASA Strategic Plan, and cost realism. If applicable, the R&T Portfolio Project Plan should incorporate by reference appropriate sections of standard R&T process documents, including the Guidebook for Proposers to NASA Research Announcements (http://www.hq.nasa.gov/office/procurement/nraguidebook) and any MD or MSO omnibus NASA Research Announcements (e.g., ROSES or ROA).

6.0 Schedule

Document the R&T Portfolio Project's Integrated Master Schedule for all major events, independent reviews, and other activities for the period covered by this plan (usually no more than five years). Include approval dates for principal project documentation, life-cycle transitions, major reviews, program-controlled milestones, and significant contract milestones.

7.0 Work Breakdown Structure

An R&T Portfolio Project work breakdown structure (WBS) (see Appendix K) will be defined accompanied by a WBS dictionary. The WBS should be defined to the level required to identify issues associated with technical progress and resource utilization in a timely manner. The WBS level should be consistent with effective tracking of major milestones and earned value management reporting.

8.0 Data and Knowledge Management and Distribution

Data management planning is provided as either a section of the Program Plan, Cross-Program Research Plan, or as a separate document (if applicable). It should address the data or knowledge being developed or captured by the R&T Portfolio Project and define plans for data rights and services. The plan should demonstrate close interaction with the application community, and provide an exit strategy following technology or knowledge transfer. In addition, it should explain how the project will ensure identification, control, and disposition of project records in accordance with NPD 1440.6, NASA Records Management, and NPR 1441.1, Records Retention Schedules. The plan should document how the results of R&T efforts will be disseminated, and it should also document if there are restrictions that limit or prevent the ability to disseminate data in accordance with NPR 2200.2, Requirements for Documentation, Approval, and Dissemination of NASA Scientific and Technical Information.

9.0 Risk Management

Summarize the risk management approach to be used for the R&T Portfolio Project, including appropriate actions to mitigate risk and R&T Portfolio Project de-scope plans. Risk mitigation should be balanced with the need to conduct challenging research that will realize significant gains. If required, list any project elements that will develop their own stand alone risk and safety plans (see section 5.2.3.9, 5.2.3.10, and 5.2.3.11).

10.0 Project Evaluation and OptionaL KDPs

Describe the reviews that the R&T Portfolio Project will conduct, including Formulation Reviews, peer reviews, and other Independent Assessments, in response to MDAA, MSOD, or governing PMC requirements. Include the timeline for these reviews. Provide the technical, scientific, schedule, cost, and other criteria, which will be utilized in the reviews.

Identify any optional KDPs (KDP B, D, and E) required by the DA or determine that these optional KDPs are not needed. This should include determination of gate products required prior to the optional KDPs.

11.0 Relationships to Other Projects and Organizations

a. Internal: Describe the way the R&T Portfolio Project will relate to other institutions within NASA (e.g., crosscutting technology efforts, space communications, and launch services). List the internal agreements necessary for the R&T Portfolio Project's success and projected dates of approval. This list may be maintained as a separate document that is referenced by the R&T Portfolio Project Plan and may be updated separate from the R&T Portfolio Project Plan (i.e., updates do not require formal revision to the R&T Portfolio Project Plan). This list should include those agreements that are concluded with the authority of the Program Lead or Research Director, and reference those agreements concluded with the authority of the MD or MSO (if applicable).

b. External: Describe the way the R&T Portfolio Project will relate to entities outside of NASA (e.g., interagency or international). List the external agreements necessary for R&T Portfolio Project success and projected dates of approval. This list may be maintained as a separate document that is referenced by the R&T Portfolio Project Plan and may be updated separate from the R&T Portfolio Project Plan (i.e., updates do not require formal revision to the R&T Portfolio Project Plan). This list should include those agreements that are concluded with the authority of the Program Lead or Research Director and reference those agreements concluded with the authority of the

NASA AA, MDAA, and/or MSOD (if applicable).

12.0 Security Plan

Document the R&T Portfolio Project's approach to implementing IT security requirements in accordance with NPR 2810.1, Security of Information Technology.

13.0 Waivers

Identify known waivers that the R&T Portfolio Project will obtain against NASA policies, directives, or other applicable external requirements. Provide rationale and risk impact for the waivers, include characteristics such as scope, complexity, visibility, cost, and safety.

14.0 Change Log

Document changes to the R&T Portfolio Project Plan

Appendix J. Technology Readiness Levels (TRLs)

J.1 Technology Readiness Levels

TRL	Definition	Hardware Description	Software Description	Exit Criteria
1	Basic principles observed and reported.	Scientific knowledge generated underpinning hardware technology concepts/applications.	Scientific knowledge generated underpinning basic properties of software architecture and mathematical formulation.	Peer reviewed publication of research underlying the proposed concept/application.
2	Technology concept and/or application formulated.	Invention begins, practical application is identified but is speculative, no experimental proof or detailed analysis is available to support the conjecture.	Practical application is identified but is speculative, no experimental proof or detailed analysis is available to support the conjecture. Basic properties of algorithms, representations and concepts defined. Basic principles coded. Experiments performed with synthetic data.	Documented description of the application/concept that addresses feasibility and benefit.
3	Analytical and experimental critical function and/or characteristic proof of concept.	Analytical studies place the technology in an appropriate context and laboratory demonstrations, modeling and simulation validate analytical prediction.	Development of limited functionality to validate critical properties and predictions using non-integrated software components.	Documented analytical/experi-mental results validating predictions of key parameters.
4	Component and/or breadboard validation in laboratory environment.	A low fidelity system/component breadboard is built and operated to demonstrate basic	Key, functionally critical, software components are integrated, and functionally	Documented test performance demonstrating agreement with analytical predictions.

		functionality and critical test environments, and associated performance predictions are defined relative to the final operating environment.	validated, to establish interoperability and begin architecture development. Relevant Environments defined and performance in this environment predicted.	Documented definition of relevant environment.
5	Component and/or breadboard validation in relevant environment.	A medium fidelity system/component brassboard is built and operated to demonstrate overall performance in a simulated operational environment with realistic support elements that demonstrates overall performance in critical areas. Performance predictions are made for subsequent development phases.	End-to-end software elements implemented and interfaced with existing systems/simulations conforming to target environment. End-to-end software system, tested in relevant environment, meeting predicted performance. Operational environment performance predicted. Prototype implementations developed.	Documented test performance demonstrating agreement with analytical predictions. Documented definition of scaling requirements.
6	System/sub-system model or prototype demonstration in a relevant environment.	A high fidelity system/component prototype that adequately addresses all critical scaling issues is built and operated in a relevant environment to demonstrate operations under critical environmental conditions.	Prototype implementations of the software demonstrated on full-scale realistic problems. Partially integrate with existing hardware/software systems. Limited documentation available. Engineering feasibility fully demonstrated.	Documented test performance demonstrating agreement with analytical predictions.

7	System prototype demonstration in an operational environment.	A high fidelity engineering unit that adequately addresses all critical scaling issues is built and operated in a relevant environment to demonstrate performance in the actual operational environment and platform (ground, airborne, or space).	Prototype software exists having all key functionality available for demonstration and test. Well integrated with operational hardware/software systems demonstrating operational feasibility. Most software bugs removed. Limited documentation available.	Documented test performance demonstrating agreement with analytical predictions.
8	Actual system completed and "flight qualified" through test and demonstration.	The final product in its final configuration is successfully demonstrated through test and analysis for its intended operational environment and platform (ground, airborne, or space).	All software has been thoroughly debugged and fully integrated with all operational hardware and software systems. All user documentation, training documentation, and maintenance documentation completed. All functionality successfully demonstrated in simulated operational scenarios. Verification and Validation (V&V) completed.	Documented test performance verifying analytical predictions.
9	Actual system flight proven through successful mission operations.	The final product is successfully operated in an actual mission.	All software has been thoroughly debugged and fully integrated with all operational hardware/software systems. All documentation has been completed. Sustaining software engineering support	Documented mission operational results.

			is in place. System has been successfully operated in the operational environment.	

Generic TRL descriptions are found in NPR 7123.1, NASA Systems Engineering Processes and Requirements, Table G-19.

J.2 Technology Development Terminology

Proof of Concept:

Analytical and experimental demonstration of hardware/software concepts that may or may not be incorporated into subsequent development and/or operational units.

Breadboard:

A low fidelity unit that demonstrates function only, without respect to form or fit in the case of hardware, or platform in the case of software. It often uses commercial and/or ad hoc components and is not intended to provide definitive information regarding operational performance.

Brassboard:

A medium fidelity functional unit that typically tries to make use of as much operational hardware/software as possible and begins to address scaling issues associated with the operational system. It does not have the engineering pedigree in all aspects, but is structured to be able to operate in simulated operational environments in order to assess performance of critical functions.

Proto-type Unit:

The proto-type unit demonstrates form, fit, and function at a scale deemed to be representative of the final product operating in its operational environment. A subscale test article provides fidelity sufficient to permit validation of analytical models capable of predicting the behavior of full-scale systems in an operational environment

Engineering Unit:

A high fidelity unit that demonstrates critical aspects of the engineering processes involved in the development of the operational unit. Engineering test units are intended to closely resemble the final product (hardware/software) to the maximum extent possible and are built and tested so as to establish confidence that the design will function in the expected environments. In some cases, the engineering unit will become the final product, assuming proper traceability has been exercised over the components and hardware handling.

Mission Configuration:

The final architecture/system design of the product that will be used in the operational environment. If the product is a subsystem/component, then it is embedded in the actual system in the actual configuration used in operation. Laboratory Environment:

An environment that does not address in any manner the environment to be encountered by the system, subsystem, or component (hardware or software) during its intended operation. Tests in a laboratory environment are solely for the purpose of demonstrating the underlying principles of technical performance (functions), without respect to the impact of environment.

Relevant Environment:

Not all systems, subsystems, and/or components need to be operated in the operational environment in order to satisfactorily address performance margin requirements. Consequently, the relevant environment is the specific subset of the operational environment that is required to demonstrate critical "at risk" aspects of the final product performance in an operational environment. It is an environment that focuses specifically on "stressing" the technology advance in question.

Operational Environment:

The environment in which the final product will be operated. In the case of space flight hardware/software, it is space. In the case of ground-based or airborne systems that are not directed toward space flight, it will be the environments defined by the scope of operations. For software, the environment will be defined by the operational platform.

Appendix K. Research and Technology Project Work Breakdown Structure (WBS)

1.0 Introduction

1.1 The Project Work Breakdown Structure (WBS) is a key element of project management. The purpose of a WBS is to divide the project into manageable pieces of work to facilitate planning and control of cost, schedule, and technical content. Research and Technology (R&T) projects are either Technology Development Projects (formerly referred to as Advanced Technology Development (ATD)) or R&T Portfolio Projects (formerly referred to as Basic and Applied Research Portfolio (BAR)).

2.0 Assumptions

2.1 The WBS standard elements defined in this appendix are only applicable to R&T projects.

3.0 Project Business Rules

3.1 Purpose: The standardization of WBS elements for R&T projects is being driven by requirements for more effective cost estimating and consistency of project work packages across the Agency. WBS elements only apply to projects, not programs.

3.2 Business Rules:

a. The standard R&T project WBS applies to new projects established from the issue date for NPR 7120.8. It is not intended to be applied retroactively to existing projects.

b. The standard R&T project WBS applies to the entire life cycle of the project.

c. R&T projects will use the standard Level 1/2 WBS elements (see section I.4 and I.5). Specifically:

(1) The project name will be WBS Level 1 (corresponds to Agency Project 6 digit alpha numeric designators).

(2) The title of each WBS Level 2 element can be modified to facilitate project-unique titles, such as adding the name of the project in front of the title. However, the content and definition of each WBS element remain the same and if the linkage of the project-unique title to the standard title is not intuitive, the project-unique title is cross-referenced to the standard.

(3) If the set of standard WBS Level 2 elements does not comprise an exhaustive set of WBS elements, additional WBS elements may be added horizontally (i.e., at Level 2) as long as their content does not fit into the content of any existing standard WBS elements.

(4) For each standard WBS Level 2 element and the subordinate WBS elements at Level 3 and lower, Project Leads should work in coordination with the OCFO to ensure there is visibility to which elements within the structure will result in the fabrication and/or acquisition of a capital asset.

(5) The WBS Level 3 and lower elements are established by the projects and can differ from project to project, but will include only work that rolls up to the standard WBS Dictionary definition of the

Level 2 element.

(6) If there is no work to fit into a standard WBS element, then an inactive placeholder element (and an inactive placeholder financial code) will be established.

(7) The financial WBS will align with the technical WBS.

(8) The management assigned to each WBS element may differ from project to project.

4.0 Technology Development (TD) Project (formerly Advanced Technology Development Project)

4.1 Technology Development Project WBS
(formerly Advanced Technology Development Project WBS)

Standard Level 2 WBS elements for TD projects are shown in Figure I-1. The standard WBS template below assumes a typical TD project with no flight elements. For TD projects, additional WBS elements may be added horizontally (i.e., at Level 2) as long as their content does not fit into the content of any existing standard WBS elements. The elements that are not applicable do not need to be used (entered into MdM). For TD projects managed in accordance with NPR 7120.5, NASA Space Flight Program and Project Management Requirements, the Space Flight Project WBS will be used.

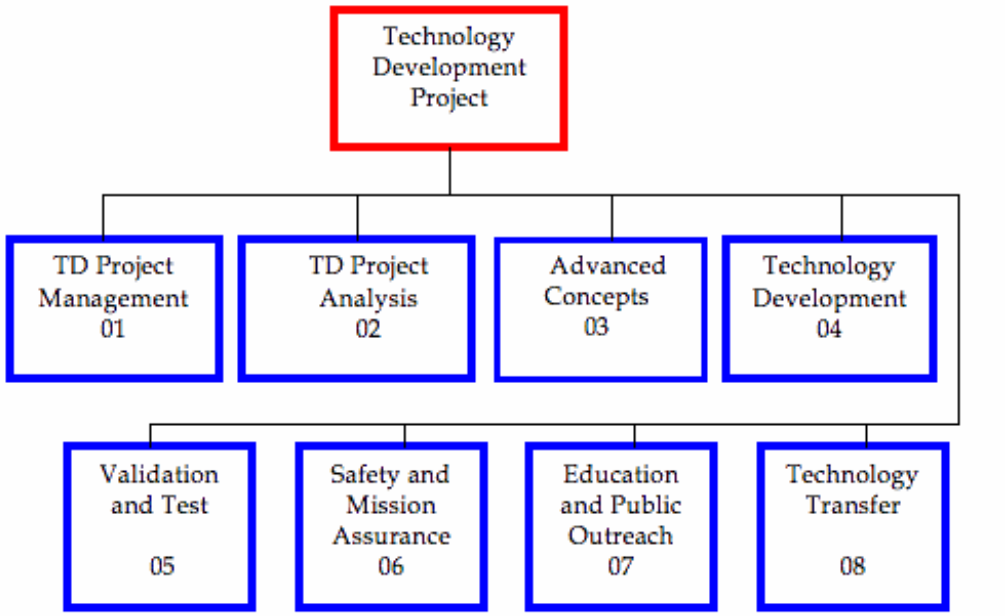


Figure K-1 TD Project WBS
(formerly Advanced Technology Development WBS)

4.2 TD Project Standard WBS Dictionary
(formerly Advanced Technology Development Project Standard WBS Dictionary)

Element 1 -- TD Project Management: The business and administrative planning, organizing, directing, coordinating, controlling, and approval processes used to accomplish overall project objectives, which are not associated with specific hardware or software elements. This element includes project reviews and documentation, non-project owned facilities, and project reserves. It

excludes costs associated with technical planning and management and costs associated with delivering specific engineering, hardware, and software products.

Element 2 -- TD Project Analysis: System and Portfolio Analysis includes the process of developing qualitative and quantitative understanding of key technical issues and drivers, including current limitations and challenges. These analyses are the foundations that support development and assessment of: goals, requirements, scope, risk/feasibilities, costs, design, integration, and operations. Based on the systems analysis, the process further identifies and tracks the investment trade spaces and supports the project's ability to optimize its resources to maximize the return on investment within acceptable risk exposure, budget, schedule, and performance requirements.

Element 3 -- Advanced Concepts: This WBS element encompasses low-level studies (possibly including laboratory experiments) intended to explore the feasibility of new ideas or approaches to accomplish programmatic or technical objectives. Often they are inspired by new scientific or technical breakthroughs that open up new avenues for technological investigation. Advanced concept activities can be an integral part of a specific technology project, or they can be separate technology activities focused on broad topics. Typically, advanced concept activities are tied to long-term objects, though this is not required, and due to their speculative nature, are generally considered high-risk. Also, they tend to be managed in a looser manner than technology development. Advanced concept studies are a principal means for identifying promising new opportunities for high payoff technology development.

Element 4 -- Technology Development: This WBS element encompasses the execution phase of implementing a TD project plan. Typically, most of the lower level (Level 3 and below) WBS elements associated with achieving the technical objectives (e.g., performance metrics) of the project are contained within this element. TD projects span the gap from advanced concepts to engineering or advanced development (TRL 2/3 to TRL 6/7) and can begin and end anywhere within this range. As such, it can be driven by specific requirements or more general objectives. Once a project has started, technology development will include the continual assessment of progress, redistribution of resources and schedule updates necessary to meet key milestones within the planned budget and time frame. When the intended outcome cannot be met within plan, the function of re-planning at the project level falls within Project Management. The primary project deliverables, including technical progress reports and documenting technical accomplishments, are part of this WBS element.

Element 5 -- Validation and Test: This element provides for a focus on specific activities to test and validate products of technology development when those activities represent a critical aspect of the overall technology development plan. Not all technology projects require this level of attention on test and validation. Typically, a separate test and validation element will be part of the project that intends to achieve TRL 6/7. The element encompasses the development hardware/software test validation articles; development or acquisition of special test or validation equipment or procedures; scheduling and staffing facilities or ranges; as well as the development and execution of the test or validation plan. Often the full context and content of test and validation may not be known at the beginning of the project and will be developed as required. In some cases, if extensive use of large-scale facilities is required or the test/validation takes on the characteristics of a flight project (e.g., space-flight project), it will be conducted as a flight project (e.g., space-flight project) within this WBS element or transferred to a space flight project in accordance with NPR 7120.5, NASA Space Flight Program and Project Management Requirements.

Element 6 -- Safety and Mission Assurance: The technical and management efforts of directing and controlling the safety and mission assurance elements of the project. This element includes design, development, review, and verification of practices and procedures and success criteria intended to assure that the delivered product meets performance requirements and function for their

intended lifetimes. This element excludes mission and product assurance efforts at partners/subcontractors other than a review/oversight function.

Element 7 -- Education and Public Outreach: Provide for the education and public outreach (EPO) responsibilities of NASA's missions, projects, and programs in alignment with the Strategic Plan for Education, including management and coordinated activities, formal education, informal education, public outreach, media support, and Web site development.

Element 8 -- Technology Transfer: This WBS focuses principally on three types of activities:

(1) transferring knowledge and technology development products developed within the project to non-NASA entities that are not part of the project either as direct participants or as direct beneficiaries of the project, (2) acting on behalf of the project to identify and transfer into the project knowledge or technology from sources not directly participating in the project or benefiting from the project, and (3) providing supporting expertise to transfer knowledge and technology products between NASA and non-NASA entities, including project participants. Typically, technology transfer requires special expertise not associated with any specific project or required to accomplish primary technical objectives/milestones/metrics. Also, technology transfer activities are often an integral part of the overall project plan but not necessarily an integral part of the technology development process. As such, it is often appropriate to fund, implement, and manage technology transfer as a distinct element of a TD project.

5.0 R&T Portfolio Project (formerly Basic and Applied Research Portfolio)

5.1 R&T Portfolio Project WBS (formerly Basic and Applied Research Portfolio WBS)

Standard Level 2 WBS elements for R&T Portfolio Projects are shown in Figure I-2. The template is used to specify the integrated budget within the R&T Portfolio Project Plan. For R&T Portfolio Projects, additional WBS elements may be added horizontally (i.e., at Level 2) as long as their content does not fit into the content of any existing standard WBS elements. The elements that are not applicable do not need to be used. For R&T Portfolio Projects managed in accordance with NPR 7120.5, NASA Space Flight Program and Project Management Requirements, the Space Flight Systems Project WBS will be used.

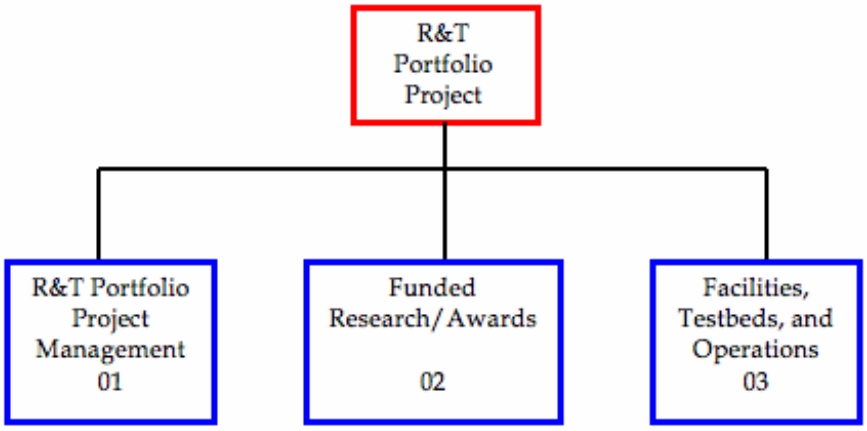


Figure K-2 R&T Portfolio Project WBS (formerly Basic and Applied Research Portfolio WBS)

5.2 R&T Portfolio Project Standard WBS Dictionary (formerly Basic and Applied Research Portfolio Standard WBS Dictionary)

Element 1 -- R&T Portfolio Project Management: The management activity is paid for with R&T Portfolio Project dollars. This includes salaries and travel (e.g., civil service personnel, Intergovernmental Personnel Act assignees, detailees), peer review management (contractor support, travel, and honoraria), and meetings and conferences.

Element 2 -- Funded Research/Awards: The awards from either competed or directed elements of the R&T Portfolio Project. This includes but is not limited to grants, Independent Assessment Teams, Research and Technology Objectives and Plans Summaries (RTOPs), and contracts. This element may also include awards for Education and Public Outreach.

Element 3 -- Facilities, Testbeds, and Operations: The non-award infrastructure costs that support the R&T Portfolio Projects.

Appendix L. References

NASA programs/projects and Centers are required to comply with all applicable Agency directives, not limited to those listed in this Appendix. The documents listed in this appendix are provided as a guide to help program and project leads determine the requirements imposed on them outside this document. The terms program and project managers may be referenced in the documents below in lieu of program and project leads. Applicable directives not cited in this document should be identified in Center processes and practices.

Similarly, not all related references or other resources for program/project management teams are identified.

L.1 Code of Federal Regulations

1. 14 CFR, Aeronautics and Space
2. 48 CFR, Federal Acquisition Regulations

L.2 NASA Policy Directives

1. NPD 1000.0, Strategic Management and Governance Handbook
2. NPD 1080.1, NASA Science Policy
3. NPD 1200.1D, NASA Internal Control and Accountability
4. NPD 1400.2, Publication of NASA Documents in the Federal Register
5. NPD 1440.6, NASA Records Management
6. NPD 1600.2, NASA Security Policy
7. NPD 2110.1, Foreign Access to NASA Technology Transfer Materials
8. NPD 2190.1, NASA Export Control Program
9. NPD 2200.1, Management of NASA Scientific and Technical Information (STI)
10. NPD 2570.5, NASA Electromagnetic (EM) Spectrum Management
11. NPD 2800.1, Managing Information Technology
12. NPD 2810.1, NASA Information Security Policy
13. NPD 2820.1, NASA Software Policy
14. NPD 2830.1, NASA Enterprise Architecture
15. NPD 5000.2, Uniform Methodology for Determination of Small Disadvantaged Business Subcontracting Goals
16. NPD 5101.1, Requirements for Legal Review of Procurement Matters
17. NPD 5101.32, Procurement
18. NPD 7100.8, Protection of Human Research Subjects
19. NPD 7120.4, Program/Project Management
20. NPD 7330.1, Approval Authorities for Facility Projects (Revalidated 10/19/04)
21. NPD 7410.1, Management of Contract and Grant Support Services Obtained From External Sources
22. NPD 7500.1, Program and Project Logistics Policy
23. NPD 7500.2, NASA Technology Commercialization Policy
24. NPD 7900.4, NASA Aircraft Operations Management
25. NPD 8010.2, Use of the SI (Metric) System of Measurement in NASA Programs
26. NPD 8010.3, Notification of Intent to Decommission or Terminate Operating Space Systems and Terminate Missions

27. NPD 8020.7, Biological Contamination Control for Outbound and Inbound Planetary Spacecraft
28. NPD 8070.6, Technical Standards
29. NPD 8610.23, Launch Vehicle Technical Oversight Policy
30. NPD 8610.24, Launch Services Program (LSP) Pre-Launch Readiness Reviews
31. NPD 8610.7, Launch Services Risk Mitigation Policy for NASA-Owned and/or NASA-Sponsored Payloads/Missions
32. NPD 8610.12, Office of Space Operations (OSO) Space Transportation Services for NASA and NASA-Sponsored Payloads
33. NPD 8700.1, NASA Policy for Safety and Mission Success
34. NPD 8700.2, NASA Policy for Safety and Mission Assurance (SMA) for Experimental Aerospace Vehicles (EAV)
35. NPD 8700.3, Safety and Mission Assurance (SMA) Policy for NASA Spacecraft, Instruments, and Launch Services
36. NPD 8710.3, NASA Policy for Limiting Orbital Debris Generation
37. NPD 8710.5, NASA Safety Policy for Pressure Vessels and Pressurized Systems
38. NPD 8720.1, NASA Reliability and Maintainability (R&M) Program Policy
39. NPD 8730.2, NASA Parts Policy
40. NPD 8730.5, NASA Quality Assurance Program Policy
41. NPD 8820.2, Design and Construction of Facilities
42. NPD 8900.4, NASA Use of Global Positioning System Precise Positioning Service
43. NPD 8900.5, NASA Health and Medical Policy for Human Space Exploration
44. NPD 8910.1, Care and Use of Animals
45. NPD 9050.3, Administrative Control of Appropriations and Funds
46. NPD 9501.1, NASA Contractor Financial Management Reporting System
47. NPD 9800.1, NASA Office of Inspector General Programs
48. NPD 9910.1, Government Accountability Office/NASA Office of Inspector General Audit Liaison, Resolution, and Followup

L.3 NASA Procedural Requirements

1. NPR 1080.1, NASA Science Management
2. NPR 1400.1, NASA Directives System Procedural Requirements
3. NPR 1441.1, NASA Records Retention Schedules
4. NPR 1600.1, Security Program Procedural Requirements
5. NPR 2190.1, NASA Export Control Program
6. NPR 2200.2, Requirements for Documentation, Approval, and Dissemination of NASA Scientific and Technical Information
7. NPR 2210.1, External Release of NASA Software
8. NPR 2570.1, NASA Radio Frequency (RF) Spectrum Management Manual
9. NPR 2800.1, Managing Information Technology
10. NPR 2810.1, Security of Information Technology
11. NPR 2830.1, NASA Enterprise Architecture Procedures
12. NPR 5100.4, Federal Acquisition Regulation Supplement (NASA/FAR Supplement) [48 CFR 1800-1899]
13. NPR 5101.33, Procurement Advocacy Programs
14. NPR 5800.1, Grant and Cooperative Agreement Handbook
15. NPR 5810.1, Standard Format for NASA Research Announcements (NRAs) and other Announcements for Grants and Cooperative Agreements
16. NPR 5900.1, NASA Spare Parts Acquisition

17. NPR 6000.1, Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems, Equipment, and Associated Components
18. NPR 6200.1, NASA Transportation and General Traffic Management
19. NPR 7100.1, Protection of Human Research Subjects
20. NPR 7120.5, NASA Space Flight Program and Project Management Requirements
21. NPR 7120.6, Lessons Learned Process
22. NPR 7123.1, NASA Systems Engineering Processes and Requirements
23. NPR 7150.2, NASA Software Engineering Requirements
24. NPR 7500.1, NASA Technology Commercialization Process
25. NPR 7900.3, Aircraft Operations Management
26. NPR 8000.4, Risk Management Procedural Requirements
27. NPR 8020.12, Planetary Protection Provisions for Robotic Extraterrestrial Missions
28. NPR 8580.1, Implementing the National Environmental Policy Act and Executive Order 12114.
29. NPR 8621.1, NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping
30. NPR 8705.2, Human-Rating Requirements for Space Systems
31. NPR 8705.3, Safety and Mission Assurance (SMA) Requirements for Experimental Aerospace Vehicles (EAV)
32. NPR 8705.4, Risk Classification for NASA Payloads
33. NPR 8705.5, Probabilistic Risk Assessment (PRA) Procedures for NASA Programs and Projects
34. NPR 8705.6, Safety and Mission Assurance Audits, Reviews, and Assessments
35. NPR 8715.3, NASA General Safety Program Requirements
36. NPR 8715.5, Range Safety Program
37. NPR 8735.1, Procedures for Exchanging Parts, Materials, and Safety Problem Data Utilizing the Government-Industry Data Exchange Program and NASA Advisories
38. NPR 8735.2, Management of Government Quality Assurance Functions for NASA Contracts
39. NPR 8820.2, Facility Project Implementation Guide
40. NPR 8910.1, Care and Use of Animals
41. NPR 9501.2, NASA Contractor Financial Management Reporting

L.4 Related References

1. Guidebook for Proposers to NASA Research Announcements (http://www.hq.nasa.gov/office/procurement/nraguidebook)