Office Work Instruction

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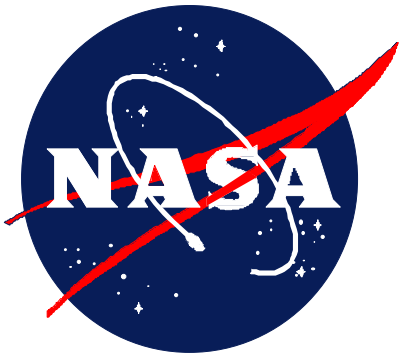

OFFICE WORK INSTRUCTION

FORMULATE THE ESE TECHNOLOGY DEVELOPMENT PROGRAM

(Conforming to ISO 9001 Quality System Requirements)

DOCUMENT HISTORY LOG

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PREFACE

The NASA Office Work Instruction (OWI) for Formulate the ESE Technology Development Program documents the tasks and activities in conformance with the International Organization for Standardization's (ISO) 9001 requirements for quality systems. The manual supplements the *NASA Strategic Plan*, *Strategic Management Handbook*, and other higher level NASA directives, which form the basis for how NASA conducts business.

This OWI is not intended to duplicate or contradict any other NASA policy, procedures or guidelines, which currently exist. As such, the OWI will reference prevailing documents where a topic is addressed and existing coverage is deemed adequate. Additional information provided within is intended to supplement existing documentation regarding Headquarters (HQ) implementation of strategic and program/project management, as well as HQ conformance with the ISO 9001 Quality Management System (QMS) requirements.

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1.0 PURPOSE

This OWI provides information for the organizational structure, responsibilities, procedures, processes, and resources for formulating the ESE Technology Development Program at NASA Headquarters in conformance with ANSI/ASQC Q9001-1994 and NPD 8730.3, *NASA Quality Management System Policy (ISO 9000)*. The OWI describes what is to be accomplished by the process, not how the work is to be performed. It addresses the overall policy, and references other documents which provide implementing guidance.

2.0 SCOPE

2.1 Scope. This work instruction describes procedures for formulating the NASA Earth Science Enterprise (ESE) Technology Development Program. This process includes developing the ESE technology strategy, developing and maintaining a Program Commitment Agreement (PCA), determining technology requirements, developing technology options and partnerships, developing a Needs Assessment Report, developing the *ESE Integrated Technology Development / Investment Plan*, and developing the *Technology Infusion Plan*.

2.2 Applicability. This work instruction for Formulate the ESE Technology Development Program applies to the NASA Office of Earth Science (OES, Code Y) offices and divisions. The Associate Administrator for Earth Science is responsible for maintaining this document. The controlled version of the manual is available on the World Wide Web (WWW) via the HQ ISO 9000 Document Library for the ISO 9000 QMS at http://hqiso9000.hq.nasa.gov. Any printed version of this OWI is uncontrolled (reference: HCP 1400.1, Document and Data Control). Proposed revisions of this manual will be accomplished by following HOWI 1410-Y15 (Approval of Quality Documents).

3.0 DEFINITIONS

In general, the definitions given in ISO 8402 apply. Appendix B of the *Earth Science Enterprise Management Handbook* provides additional ESE-specific terms and definitions.

4.0 REFERENCES

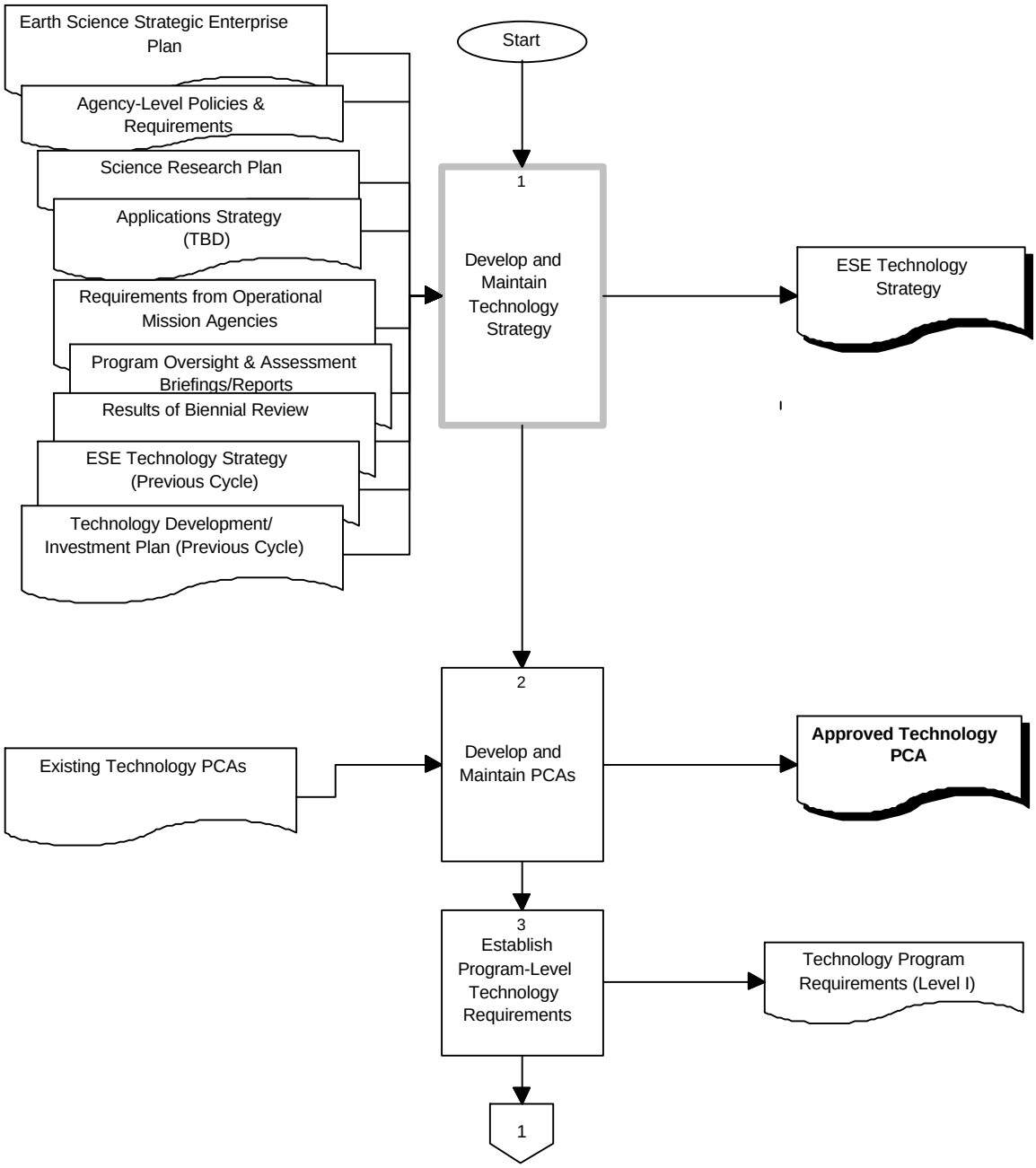
The following documents contain provisions that, through reference in this OWI or in policy or procedure documents, constitute the basis for the documented procedure:

NPD 1000.1	NASA Strategic Plan
NPG 1000.2	NASA Strategic Management Handbook
NPD 7120.4A	Program/Project Management
NPG 7120.5A	NASA Program and Project Management Processes and Requirements
ANSI/ASQC Q9001-1994	American National Standard, Quality Systems-Model for Quality Assurance in Design, Development, Production, Installation, and Servicing
ANSI/ASQC 8402:1994	Quality Management and Quality Assurance - Vocabulary
NPD 8730.3	NASA Quality Management System Policy (ISO 9000)

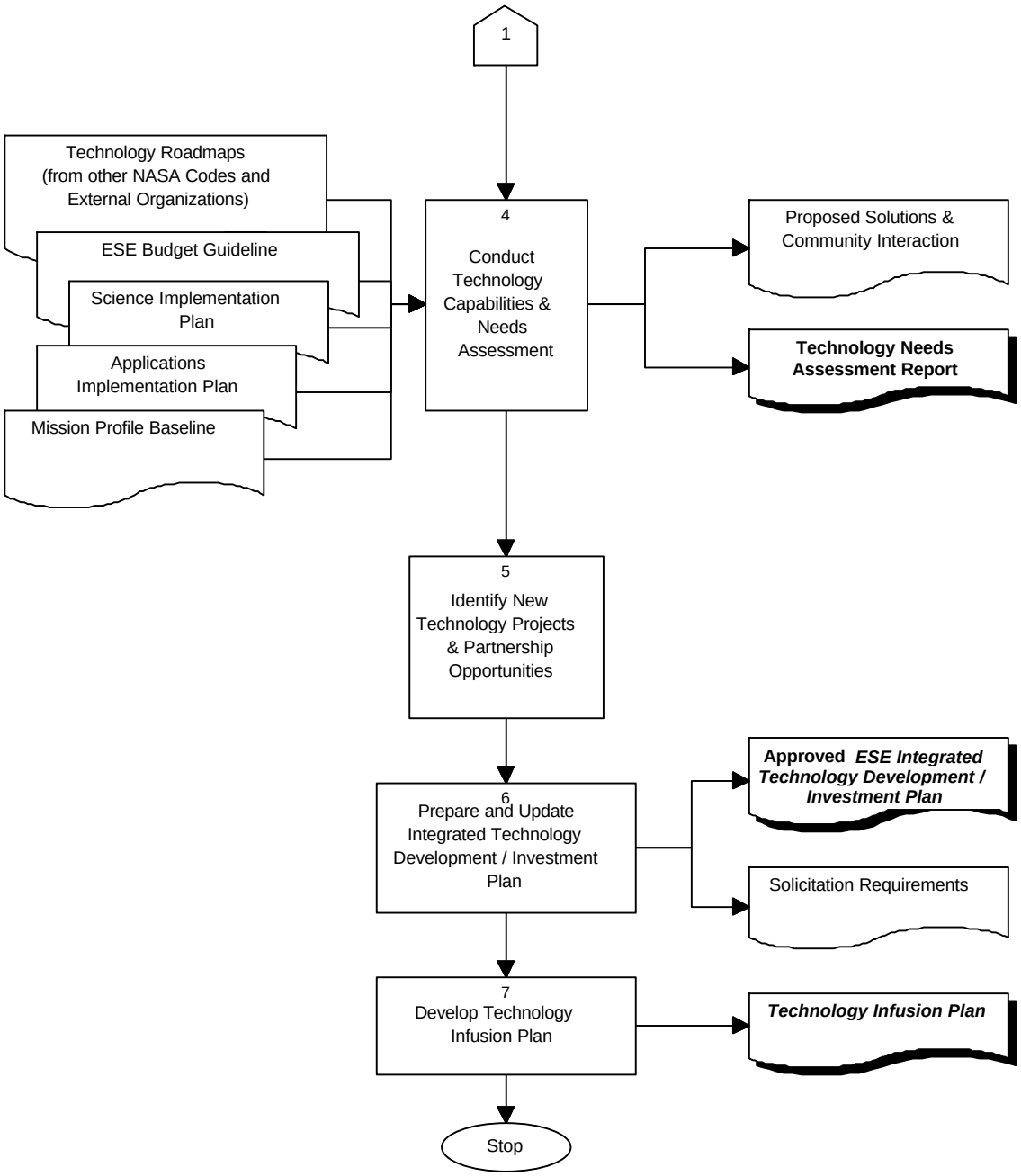
NHB 1101.3	NASA Organization Handbook
HOWI 8310-Y005	Solicit and Select Science, Applications, Education, and Technology (SAET) Investigations
HOWI 7120-Y003	Formulate and Approve Flight Mission

5.0 FLOW DIAGRAM

The following diagram depicts the process described in Section 6. Outputs in boldface type represent the quality records listed in Section 7. The activity box with the grayed boarder may move in future iterations to a different work instruction.



5.0 FLOW DIAGRAM (CONTINUED)



6.0 PROCESS DESCRIPTION

This work instruction covers developing ESE's technology strategy, formulating new technology development programs, and adding new projects to existing programs. The planning and formulation activities provide overall technology development requirements, a resultant annual Integrated Technology Development/Investment Plan, and a projected Technology Infusion Plan. The investment plans are coordinated with other NASA technology development efforts such as the Cross-Entreprise Technology Development Program managed by the Space Science Enterprise.

The ESE Program Planning and Development Division (Code YF) oversees the Earth Science Technology Program (ESTP) and is developing the New Millennium Program (NMP).

- The ESTP integrates a variety of ESE technology development programs/projects into a single comprehensive program. The ESTP identifies, evaluates, and invests in technologies early in their development life cycle to reduce the cost and time required to meet science program needs for advanced technology that can expeditiously be incorporated into spacecraft and their instrument payloads and into ground-based data, information, and instrumentation systems. Currently, the ESTP includes advanced concepts development, ESE core technology projects, technology studies, the Instrument Incubator Project (IIP), and information systems technology projects.
- The NMP provides for space demonstration of advanced measurement concepts. The objective is to conduct space flight validation of breakthrough technologies that significantly benefit future space science and earth science missions. The Space Science and Earth Science Enterprises jointly manage the NMP.

These ESE technology development program formulation activities take place within a larger framework as depicted in Appendix A. Specifically, technology strategy development preceeds technology program formulation. Processes that follow and use the results of technology program formulation include technology program oversight; flight mission formulation; and science, applications, education, and technology (SAET) investigation solicitations and selections.

This work instruction covers technology strategy development and technology program formulation. Solicitations for Advanced Technology missions for the NMP and ESE technology development proposals for focused programs are done under the Solicit and Select Science, Applications, Education, and Technology (SAET) Investigations work instruction, HOWI 8310-Y005. The Instrument Incubator Project is an example of a focused technology project.

The following describes the process flow diagram of Section 5.

Actionee		**Action**
Lead Technologist[1] Technology Strategy Team ESE Associate Administrator (AA)	1	Develop and Maintain Technology Strategy. The Technology Strategy is a document that complements the overall Enterprise Strategic Plan and provides an expanded vision, more focused policy guidance, and essential planning and investment concepts for those implementing the technology development program. Developed and maintained by the Lead Technologist and approved by the AA, it will be updated on a periodic cycle consistent with the Enterprise Strategic Plan.
Lead Technologist Technology Strategy Team ESE Associate Administrator (AA)	2	Develop and Maintain PCA. The PCA is a contract between the Enterprise Associate Administrator (AA) and the NASA Administrator to deliver specific technical, cost, and schedule commitments for a given program --for example, the ESTP or NMP. The PCA also establishes key policies and programmatic interfaces (such as complementary programs) which must be accommodated during program implementation. The PCA is written for the life-cycle of a program and is reviewed and updated annually. The PCA also is updated as new projects are initiated. Typically, an update involves the addition of an annex to an existing PCA covering new projects or budget revisions. The PCA outlines Enterprise-level technology requirements, near-to-mid (out to five years) and long-term (out to 10 years) goals, and metrics to measure program performance and ensure compliance with the Government Performance and Results Act (GPRA). Both the AA and the Administrator sign the PCA and are responsible for notifying the other in the event that a commitment cannot be met and to initiate the timely renegotiation of the terms. This activity includes the following major tasks: ❑ *Establish Enterprise Goals, Objectives, and Performance Metrics.* The lead technologist heads an ESE technology strategy team for the formulation of technology program goals, objectives, and performance metrics in accordance with established and anticipated technology needs, science requirements, and policy guidance. ❑ *Integrate and Write PCA*. New technology requirements, generated from NASA science and applications programs and missions and the NASA Institute for Advanced Concepts, along with NASA and ESE strategic plans, are the fundamental input for developing technology program PCAs. A technology program PCA includes the following key sections: • Program Objectives and Goals, • Program Overview, • Program Authority, • Technical Performance Commitments,

[1] The Program Planning and Development Division (Code YF) provides the lead technologist. The lead technologist conducts formulation activities on an annual basis in conjunction with the annual Program Operating Plan (POP) development activities.

Actionee		**Action**
		• Schedule Commitments, • Cost Commitments, • Acquisition Strategy, • High Risk Areas, • Internal NASA Agreements, • External Agreements, and • Independent Program Evaluation. Working with the Technology Program Manager, the lead technologist consolidates and writes the draft PCA for AA review and approval. ❑ *Forward to AA and Administrator for Revisions/Approval*. The lead technologist presents the final draft to the AA for approval. If requested, the lead technologist incorporates changes into the draft for final AA approval and signature. After the AA signs the PCA, the lead technologist sends it to the Administrator for signature. If requested, the lead technologist incorporates changes into the draft for final Administrator approval and signature.
Lead Technologist Technology Strategy Team	3	Establish Program-Level Technology Requirements. Program-level (Level I) technology requirements amplify those stated in the PCA and identify the science, applications, and supported operational measurement requirements which drive technology planning and development investments. The program-level requirements also identify key technology infusion need dates established as part of overall Enterprise planning efforts. Specific relationships and guidance with regard to complementary non-ESE technology development programs such as the Cross-enterprise Technology Development Program are established. These requirements are baselined by the ESE Control Board headed by the ESE AA at Headquarters. This activity includes the following major tasks: ❑ *Identify Scientific and Applications Measurement Objectives*. Scientific measurement objectives are generated through the Earth science community and are subject to annual management and peer reviews. The science and applications implementation plans document fundamental research themes. Generally, the science, applications, and technology communities identify the Earth system quantities that support the fundamental research themes. They then define the physical measurements that provide these quantities. ❑ *Coordinate with complementary non-ESE Technology Development Programs.* Establish formal interfaces and agreements with regard to how technology development requirements and investment planning will be coordinated and negotiated on a periodic (likely budget) cycle. Identify driving policies and joint requirements that will affect ESE technology investment planning. ❑ *Identify Mandated Technology Thrust Areas and Investment-driving goals.* Represent ESE in identified cooperating programs and in agency-levvel fora which establishes technology development focus (thrust) areas, investment targets, and success metrics to which the

Actionee		**Action**
		Enterprise must respond. Establish formal mechanisms and schedules essential for proper coordination and baselining of joint requirements. ❑ *Consolidated Scientific and Applications Measurement Objectives with Other Programmatic Drivers.* Information developed and complied in the previous tasks are consolidated into the Level I requirements document. The document is presented to the ESE Control Board for any modifications and concurrence. Requirements will be incorporated in the Technology Development Program Plan prepared by the Program Manager.
Lead Technologist Technology Strategy Team	4	Conduct Technology Capabilities and Needs Assessment. This assessment, performed for Headquarters by the ESTO organization, begins with a synthesis of science and applications requirement and identifies technology options that can or might achieve the Earth system quantity measurement. Information is gathered and presented in a consistent and format reflecting traceability from science requirements to technology solutions. This compilation of science and applications communities' technology needs, expressed as technology gaps, to address the measurement of Earth system science parameters. The assessment can be related to any of the ESE science themes, to specific Earth system quantities, to detection approaches, and to implementation options. The CNA Matrix traces ESE capability needs and opportunities from the fundamental science and applications research themes: • to the Earth system quantities that need to be established to support the research theme, • to the physical measurements that could be used to provide the Earth system quantity, • to the implementation options that could be used to achieve the measurement, • to the system requirements and challenges for the implementation option The quantitatively defined system requirements represent the unprioritized, comprehensive summary of ESE technology development candidates. Once an initial assessment has been performed the science, applications, and technology communities are periodically engaged in information exchanges to identify additional technology solutions, opportunities and programmatic priorities for use in annual technology investment planning. Formal advanced concept and engineering trade studies are conducted during this phase of activity. The Headquarters-sponsored Technology Strategy Team will be routinely involved throughout this process. The outcome is a prioritized Needs Assessment report that will be concurred with by the Headquarters Division Directors from Science, Applications, and Program, Planning and Development Division. This activity includes the following tasks:

Actionee	**Action**

- ❑ *Formulate Technology and Implementation Options*. The lead technologist and team formulate technology and implementation options to achieve the Earth system quantity measurements.
- ❑ *Identify Advanced Concepts, Thrust Areas and Information System Technologies*. Promising advanced science and/or technology concepts that are not already identified by the science community are identified and compiled. These requirements are assigned priorities based on periodic technical review by Agency technologists and science community representatives and are maintained in ESTP databases (see Activity 7).
- ❑ *Survey Science, Applications, and Technology Communities for Solutions to Technology Gaps*. The science community is periodically engaged in in-depth information exchanges with ESE science and technical management to reaffirm science priorities, to refine plans, and to address technology gaps to meeting near-, mid-, and long-term scientific objectives. To accomplish this ESE distributes technology gap information directly to a wide range of scientists, sponsors technology-oriented meetings, seminars, and symposia to distribute information and discuss technology gaps, and engages in in-depth exchanges with members of the science community identified as having potential solutions to technology gaps.
- ❑ *Conduct Trade Studies*. Trade studies translate the technology needs assessment implementation and technology gaps into technology performance requirements and compare the relative merits of competing approaches or options. Technologies that enable improved performance for spacecraft components, subsystems, and systems that satisfy measurement capability needs are examined along with feasible implementation options. Examples of trade studies include the following:
  - *Conceptual Mission Studies*. Studies that define mission, spacecraft, instrument, and information system requirements. These requirements are derived from scientific measurement objectives. Also identified are unique spacecraft requirements, including weight constraints, power limitations, and extremely high data rate throughput, and unique information system requirements, including rapid access to higher-level processed data products.
  - *Benefits-Costs Assessments*. Studies to analyze the relative benefits of implementing a specific technology versus the cost of the technology approach.
  - *Technology Readiness Level and Maturity Assessments*. Assessments of the readiness and maturity of specific technologies.
  - *Risk Assessments*. Studies to assess the risk of implementing a specific technology.
- ❑ *Assess and Prioritize Technology Options*. The most beneficial

Actionee		**Action**
		technology options are identified based on the results of the various studies conducted. Technology options are ranked in terms of their relevance to mission, spacecraft, instrument, and information system requirements; cost/benefit ratio; level of readiness and maturity; and risk potential. ❑ *Incorporate Priorities into the Technology Needs Assessment Report.* Information developed and complied in the previous tasks are incorporated into the technology needs assessment report.
Lead Technologist Technology Strategy Team	5	Identify New Technology Projects and Partnership Opportunities. Leveraging technology investments with new technology projects and partnerships within the Agency and with other government agencies is a critical activity for reducing costs. To accomplish this, the overall program must be communicated to, and well understood by, potential partners. This activity includes the following major tasks: ❑ *Distribute Information.* The technology strategy team distributes program information on technological advances to a wide range of potential partners. ❑ *Sponsor Events.* The lead technologist sponsors technology-oriented meetings, seminars, and symposia to distribute information and identify new, external technology projects and potential partners. ❑ *Conduct Joint Activities with Potential Partners.* Once potential partners are identified, the technology strategy team conducts joint activities to establish mutually beneficial leveraging programs. A partnership agreement with an external organization of other NASA code may result.
Lead Technologist Technology Strategy Team Program Manager, Earth Science Technology Office (ESTO)	6	Prepare and Update Integrated Technology Development / Investment Plan. Based on the results of the trade studies and partnership activities, priorities are established for near-, mid-, and long-term technology development goals. The goals guide ESE and NASA cross-enterprise investments. They also identify leverage opportunities within external technology development programs (Activity 5). The optimized plan for achieving the priority technology development goals within the range of available technology development programs/projects constitutes the *ESE Integrated Technology Development / Investment Plan*. This plan is prepared by the ESTO organization for Headquarters approval. This activity includes the following major tasks with ESTO and NMP support: ❑ *Prioritize Technology Development Goals*. Technology development goals are prioritized based on results from the trade studies. The prioritized goals include performance metrics and readiness dates projected out 5-years. ❑ *Identify Leveraging Opportunities*. Outside organizations developing technologies and available for leveraging synergistic investments -- initially identified in Activity 5 -- are down-selected and discussed. ❑ *Identify Agreements for Mutual Development Opportunities.* Agreements that would facilitate desired technology developments with both NASA and non-NASA organizations are evaluated.

Actionee		**Action**
		❑ *Develop Plans to Address Remaining Technology Goals.* Technology development goals that remain unmet after leveraging and agreement opportunities are identified. Plans are developed and/or revised to address these unmet goals. ❑ *Prepare Plan and Coordinate Review*. Results from the major tasks are consolidated into a draft *ESE Integrated Technology Development / Investment Plan*. The plan will include investments for both ESP and NMP. This draft plan is distributed to the appropriate science, applications, and mission programs for review and comment. The draft also is sent to the technology strategy team and the technology subcommittee of the NASA Advisory Council's Earth System Science and Applications Advisory Committee (ESSAAC) for review and comment. Comments are consolidated and incorporated into a final draft as required. This plan will identify solicitations required for technology subsystem developments to be implemented through the Instrument Incubator Program and for space-based technology demonstration missions to be implemented through the NMP. These particular solicitations will be conducted through Headquarters in accordance with processes defined in HOWI 7120-Y003 (Formulate and Approve Flight Mission) and HOWI 8310-Y005 (Solicit and Select Science, Applications, Education, and Technology (SAET) Investigations). Focused component technology research and advanced concept studies may be awarded directly by ESTO for the ESTP and by JPL for the NMP. ❑ *Present Plan to the Associate Administrator for Approval*. The final draft is presented to the AA for approval. If requested by the AA, changes are made to the draft prior to final approval. The approved *ESE Integrated Technology Development / Investment Plan* provides the program requirements and priorities required as input to the ESE budget formulation process. ❑ *Update Technology Inventory Databases*. The Program Manager, Earth Science Technology Office (ESTO), Goddard Space Flight Center (GSFC, Code 720) updates appropriate Agency-managed technology databases following previously established policies and protocols. The ESTO Program Manager will establish and periodically verify quality control measures with regard to these database(s).
Lead Technologist Technology Strategy Team ESE Associate Administrator	7	Develop *Technology Infusion Plan*. This plan documents the projected outcome of technology investments with regard to availability for infusion into planned future science and applications missions. It is based on the approved Integrated Technology Development/Investment Plan and the established need dates (Level I requirements). It reflects key technologies projected to be available by each need date. The Infusion Plan will be an input to the development of Candidate Flight Mission Profiles prepared through the Formulate and Approve Flight Missions OWI. The plan along with the outcome of the Candidate Flight Mission Profile development provides a major input to the next technology development planning cycle. This plan is prepared by the ESTO for ESE

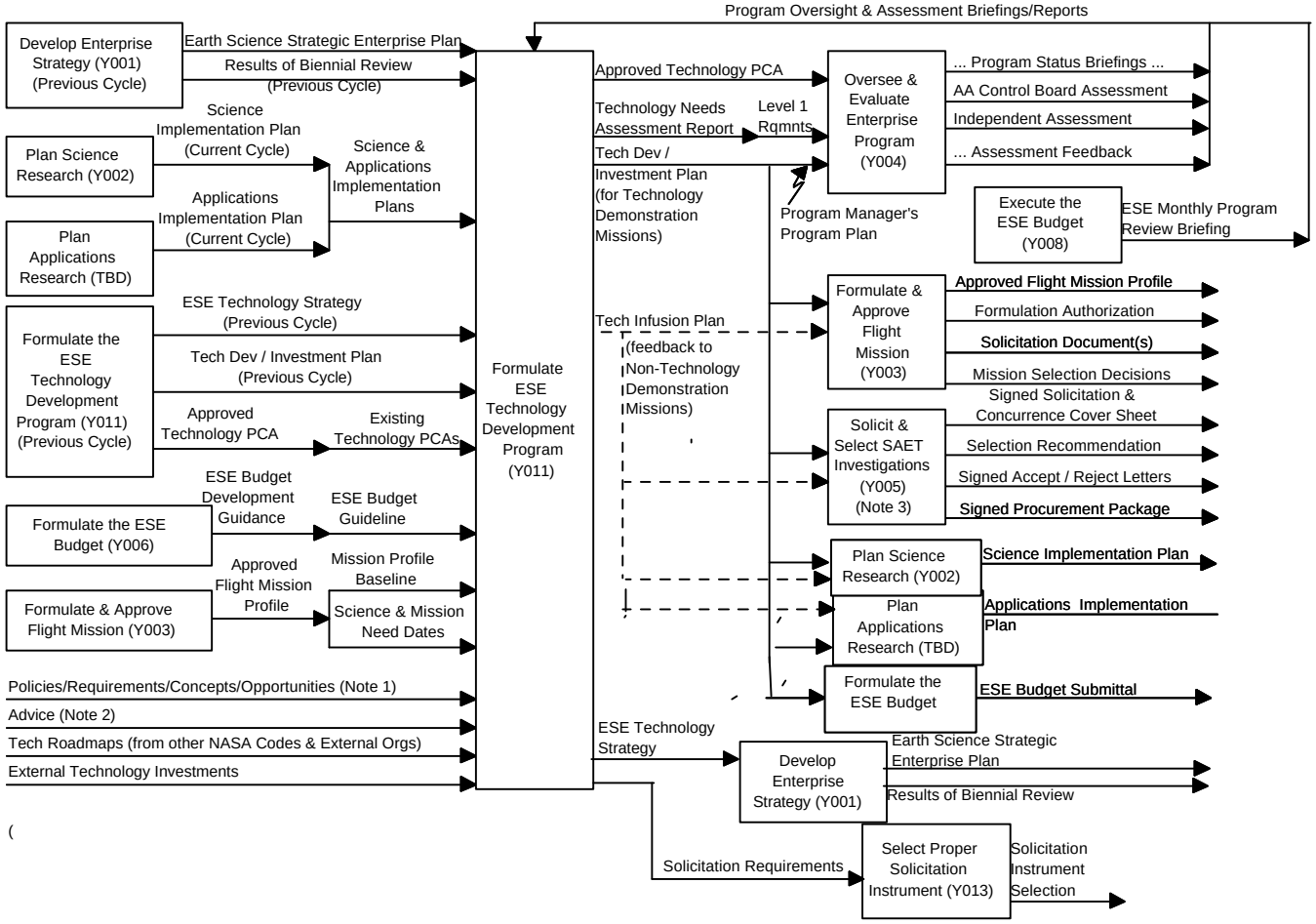
Actionee	**Action**
	AA approval. This activity includes the following major tasks: ❑ *Projection of Technology Readiness Dates*. This information is critical to future mission planning. ❑ *Identify Technologies for Maturity Advancement.* Technologies recognized as critical by potential mission proposers, mission implementers, and flight and ground system providers are identified for maturity advancement. Technologies deemed critical and not currently at an appropriate maturity level to allow for incorporation into missions within a 3-year timeline, are identified and selected for advancement. This task will be worked concurrently with the Develop and Approve Requirements Sets (Candidate Flight Mission Profiles) activity of HOWI 7120-Y003 in order to identify "mission-pull" critical needs and "technology-push" opportunities. ❑ *Validate New Technology Capabilities*. Technologies recognized as critical by potential mission proposers and reviewers, mission implementers, and flight and ground system providers are identified for validation. The new capabilities of technologies are validated as required to reduce risks to first-time users to an acceptable level. ❑ *Disseminate New Technology Information*. Information on the capabilities and maturity of new technologies is broadly disseminated to potential mission proposers and reviewers, mission implementers, and flight and ground system providers. ❑ *Ensure Technology Availability to Industry*. New technology capabilities are identified for transfer to Industry to ensure that resulting products and capabilities are truly available for user incorporation. Where appropriate, commercial standards and architectures are identified for adoption. ❑ *Prepare Technology Infusion Plan.* Information developed and complied in the above activity tasks are consolidated into the plan. ❑ *Present Plan to the Associate Administrator for Approval*. The final draft is presented to the AA for approval. If requested by the AA, changes are made to the draft prior to final approval.

7.0 QUALITY RECORDS

Record ID	Owner	Location	Media	Retention	Disposition
ESE Technology Strategy	Lead Technologist	Program Planning and Development Division (PPDD) Files	Hardcopy	Two (2) years	Destroy after retention period
Approved *Technology*	Lead	PPDD Files	Hardcopy	Two (2) years past the life of	Destroy after

PCA	Technologist			the program	retention period
Technology Needs Assessment Report	Lead Technologist	PPDD Files	Hardcopy	Two (2) years	Destroy after retention period
Approved *ESE Integrated Technology Development / Investment Plan*	Lead Technologist	PPDD Files	Hardcopy	Two (2) years	Destroy after retention period
Technology Infusion Plan	Lead Technologist	PPDD Files	Hardcopy	Two (2) years	Destroy after retention period

Appendix A. "Manage ESE Technology Development Program"



Appendix A Notes:

(1) Policies/Requirements/Concepts/Opportunities -- Agency-Level Policies & Requirements, Requirements from Operational Mission Agencies, & New Technology Requirements/Concepts/Opportunities.

(2) Advice -- Advice from National & International Scientific Communities & from Advisory Committees, Conferences, & Workshops.

(3) SAET -- Science, Applications, Education, and Technology.

(4) Solicit & Select SAET Investigations (Y005) -- Technology investigations include Instrument Incubator Program (IIP)projects, technology studies, and core technology development projects.

External Groups. ESE obtains information, advice, and guidance via conferences, workshops, information exchange meetings, and reports from the following organizations:

- *Committee on the Environment and Natural Resources (CENR), Subcommittee on Global Change Research (SGCR)*. This subcommittee coordinates the U.S. Global Change Research Program (USGCRP). The U.S. Global Change Research Program is an interagency effort to understand the processes and patterns of global change. ESE is NASA's contribution to this program. ESE may obtain science requirements from this subcommittee.
- *Intergovernmental Panel on Climate Change (IPCC)*. An international scientific forum, this group conducts assessments of the human influence on global climate and may influence nations' energy policies.
- *National Academy of Sciences/National Research Council (NAS/NRC)*. Conducts a wide range of reviews through, for example, the Board on Atmospheric Sciences and Climate (BASC), and provides advice on research priorities to ESE. ESE also works closely with the Academy's Board on Sustainable Development[2], which governs its environment and natural resources work, and the Space Studies Board which deals with issues of space programs.
- *NASA Advisory Council's Earth System Science and Applications Advisory Committee (ESSAAC)*. Established to work closely with ESE managers to ensure that ESE program planning and direction are consistent with the Enterprise's mission, national priorities, and interests of ESE commercial and international partners. Various ESSAAC subcommittees address ESE-related topics. For example, the ESSAAC Technology Subcommittee provides advice and recommendations to the NASA Advisory Council, through the ESSAAC, on the relationships between ESE science goals and potential solutions. This Subcommittee consists of individuals from universities, other federal agencies and laboratories, and private industry.

[2] Sustainable Development -- economic development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

- *Ad Hoc Working Groups*. On an as-needed basis, ad hoc working groups are formed for the purpose of reviewing special aspects of the *ESE Integrated Technology Development / Investment Plan*.
- *Special Interest DoD Technology Working Groups and Alliances*.

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