4.2 Integrated Technical Planning

4.2.1 Introduction to Integrated Technical Planning

Planning determines in advance what tasks are needed to complete a project. A plan, as a minimum, contains the tasks to be done, when they need to be done, and who is responsible for accomplishing them. A plan is incomplete if it does not define the complementary physical and financial resources. **Integrated Technical Planning is the tactical and strategic means of defining problems, forecasting conditions, and coordinating program elements to maximize program focus on providing superior products and services.**[1] Integrated Technical Planning provides the guidance and tools to track and manage program activity, as well as the program-specific process tailoring to optimally satisfy program needs.

This System Engineering (SE) element has two primary areas: (1) Plans and (2) Technical Monitoring and Control. The plans include the System Engineering Management Plan (SEMP); supporting technical plans (e.g., Master Verification Plan and the Lifecycle Plan); and the OMB Circular 15, Exhibit 300, Attachment 3, Implementation Strategy and Planning (ISAP) document. The Technical Monitoring and Control section discusses measurement, assessments, and quality gates (or milestones) designed to determine progress toward a successful project completion. This section includes guidance for all planning documents. Specific planning development details and templates are in Appendix E. Control and Monitoring development details and templates are in Appendix C.

Integrated Technical Planning applies to all programs/projects regardless of size, complexity, or program status (i.e., new or legacy). The size, complexity, and stage of the system lifecycle of a program determine which SE elements need to be supported by more detailed planning documents. The scope of planning changes throughout the lifecycle to meet program needs. A change to a program with an existing ISAP, SEMP, or other plans requires documentation only to the extent that existing plans don't support the changes.

In the Acquisition Management System (AMS), the Exhibit 300, Attachment 3, ISAP details the minimum program planning required. The ISAP includes the system implementation strategy, the programmatic planning, and a subset of SE planning.

In addition to the planning contained in the SEMP and ISAP, certain specialty domains require additional planning. For example, the NAS Modernization System Safety Management Plan governs system safety efforts conducted in the AMS and requires each program to develop an Integrated System Safety Program (ISSP) tailored to the program's safety needs. This is discussed in the Safety Management System (SMS) documentation on the FAA Acquisition System Toolset Web site.

---

[1] Visualizing Project Management: Models and Frameworks for Mastering Complex Systems (Hardcover) by Kevin Forsberg, Hal Mooz, Howard Cotterman, John Wiley & Sons; 3rd edition, September 1, 2005, page 196.

4.2.1.1 Integrated Technical Planning Objective

Integrated Technical Planning provides program management a sound, repeatable plan for executing requirements-based programs in a structured manner.

4.2.1.2 Process-Based Management

The Process-Based Management (PBM) chart appears in Figure 4.2-1.

Process:
Perform Integrated Technical Planning

ID No.: 4.2 (iCMM PA 11 & EIA 731 FA 2.1)
Date: April 25, 2000
Revision Date: August 30, 2006

Next Higher Level Process:
Perform System Engineering

Process Owner:
System Engineering Council

Process Objective:
Provide program management with a sound, repeatable method for the execution of a requirements based and structurally managed program.

Inputs

a) FAA Policy, Integrated Master Schedule, Corporate Strategy and Goals, NAS Enterprise Architecture
b) Planning Criteria
c) Requirements
d) Concepts
e) Physical Architecture
f) Analysis Criteria
g) SE Processes, SE Best-Practices Documentation (SEM), SEBOK

Providers

a) EXT
b) RM, FA, SYN, TS, IM, SpecEng, IA, RSK, CM, V&V, LCE
c) RM
d) FA
e) SYN
f) IA
g) MSE

PROCESS TASKS

Beginning Boundary Task
Collect Plan Inputs

- Analyze planning inputs
- Define Activities and Efforts
- Baseline Plan
- Interface with other plans
- Update and maintain plans

Ending Boundary Task
Technical monitoring and control

Lifecycle Phase

- [x] Mission Analysis
- [x] Investment Analysis
- [x] Solution Implementation
- [x] In-Service Management
- [ ] Disposal

Outputs

a) SE Input Exhibit 300, Atch. 3, Implementation Strategy and Planning
b) NAS Enterprise Architecture
c) SEMP
d) Constraints
e) Concerns/issues
f) Supporting SE plans, if separate from SEMP
 – Master verification plan (MVP)
 – Lifecycle plan (LCP)
 – CM Plans
g) Audit results
 – Approved SE documents
 – Updated Plans
 – Approved Reports
h) Work Breakdown Structure (WBS)

Customers

a) EXT, RM, FA, SYN, TS, IM, SpecEng, IA, RSK, CM, V&V, LCE
b) RM, IM, SpecEng, CM, V&V, LCE, SYN
c) EXT, RM, FA, SYN, TS, IM, SpecEng, IA, RSK, CM, V&V, LCE
d) TS
e) RSK
f) V&V, LCE, RM, SpecEng, TS, CM, EXT
g) EXT
h) EXT, RM, SYN

Figure 4.2-1. Integrated Technical Planning Process-Based Management Chart

4.2.1.3 Inputs to Integrated Technical Planning

The inputs to the process appear in the PBM chart. Although most inputs are internal to System Engineering, some are external (e.g., law, regulation, and policy).

FAA policy	Provides constraints and boundaries to planning
Integrated master schedule	Provides program milestones and associated dates to aid in developing completion dates for planned SE tasks
Corporate strategy and goals	Provides constraints and boundaries to planning
Planning criteria	Contains detailed information from other SE elements that defines scope of planning
Concept of operations	Describes how the system will be used including information on environment
NAS CONOPS	Describes how the system fits into the NAS
Analysis criteria	Ensures credible analysis results
Requirements	Bounds the Work Breakdown Structure (WBS)
FAA Enterprise Architecture	Describes the FAA enterprise architecture, of which the NAS Enterprise Architecture is an integral part

4.2.1.4 Outputs of Integrated Technical Planning

This table lists the outputs for this process.

SE Input to ISAP	Provides summarized planning for SE elements included in ISAP
NAS Enterprise Architecture	Describes the “as is” NAS and the planned future NAS
SEMP	Serves as primary SE planning document
Constraints	To other SE elements based on analyses performed during planning activities
Concerns and Issues	Provided to Risk Management for mitigation
Supporting SE Plans	Includes Master Verification Plan (MVP), Lifecycle Plan (LCP), Configuration Management (CM) Plan and other SE plans
From Technical Monitoring and Control	
Approved SE or Design Documents	Design-to-package, build-to-package, etc.
Updated Plans	Risk Management Plans, SEMP, LCP, Test plans, etc.
Approved Reports	Test, Technical Performance Measurement, Risk Management, etc.

4.2.1.5 Key Program Decisions

Key program decisions required for this process are:

- Request by stakeholders and/or program management for Integrated Technical Planning (usually included in the SEMP and ISAP)
- Identification of necessary planning elements by program system engineering and the project team
- Program management acceptance that the identified planning elements are necessary

- Baseline plan accepted by the program management, stakeholders, and Enterprise-level decision makers
- Program management's approval of the SEMP and ISAP and any other supporting technical plans (e.g., MVP and Lifecylce Plan (LCP))
- Enterprise-level approval of ISAP at final investment decision

4.2.1.6 Key Process Interfaces

Integrated Technical Planning interfaces with all other SE processes, either receiving inputs from them or providing outputs to them.

4.2.1.7 Acquisition Management System Process Interface

Chapter 3 describes the interface of the AMS process and SE milestones. AMS process activities that most strongly interact with SE must be considered in the Integrated Technical Planning process. All plans are living documents and are subject to continuous review and update to satisfy program needs and changes. All available plans should be reviewed at each AMS milestone and as part of subsequent system baseline modifications throughout the program lifecycle.

4.2.2 System Engineering Management Plan

The SEMP is the only implementing document that integrates all SE activities. It unambiguously ties together all elements of SE required to attain program/project cost, performance, and schedule objectives. It identifies and ensures control of the overall SE process and provides greater SE implementation detail than the ISAP. The preliminary issue of the SEMP typically occurs in the first phase of Investment Analysis, with a completed version released for Final Investment Decision (formerly JRC 2b). A scheduled update occurs in System Implementation, with additional updates issued as necessary to reflect changing input conditions throughout the program/project.

4.2.2.1 Inputs to System Engineering Management Plan

The SEMP relates the technical requirements to program requirements, providing the structure to guide and control integration of engineering activities to achieve the SE objectives consistent with a top-level management plan for the program. The SEMP includes more detailed planning than the ISAP for all SE elements to be executed as part of the program. It helps execute the system development by defining the organizational structure; establishing the responsibilities, authority, and accountability of each; and clearly defining structural interfaces. It is recommended that this be an iterative process.

Information and data needed to begin preparing a SEMP include:

- Knowledge of corporate strategy and goals
- Description and understanding of the overall program/project, usually found in an ISAP (may be a draft)
- Identification of top-level program/project requirements, usually taken from the Service Level Mission Need (SLMN), Program Requirements, change requests, or one of the outputs developed during Mission Analysis
- Contract documents

- Any issues or constraints

4.2.2.2 System Engineering Management Plan Steps

The following steps shall be used to develop a SEMP.

4.2.2.2.1 Step 1: Collect Inputs

SEMP development relies on information from both technical and nontechnical documents. Inputs are also gathered from the Screening Information Request (SIR), Statement of Work (SOW), Integrated Master Schedule (IMS), and draft ISAP.

4.2.2.2.2 Step 2: Analyze Inputs

To determine the SE effort required and committed to by program management, review the ISAP that reflects the nature and magnitude of the program/project. For example:

- Large and complex system developments demand full SE application to ensure success
- Small-scale projects may be run under a subset process
- SE coordinates with the Service Organization, as its concurrence ensures compliance with the SEMP

4.2.2.2.3 Step 3: Define Activities and Efforts

After evaluating all inputs, determine how to integrate activities. Decisions that should be made involve:

- Tailoring the SE process
- Selecting an approach to ensure integration of engineering specialties
- Determining how program team members interact and communicate to execute technical program planning and control
- Identifying the explicit SE responsibilities, accountability, and authority, accounting for all planned tasks
- Developing the structure of the comprehensive SE inputs to the IMS (included in the ISAP) for scheduled tasks

4.2.2.2.4 Step 4: Baseline

Prepare a draft SEMP for review and comment, using input from all affected SE elements, enterprise management, and, when appropriate, the stakeholders. The draft may also include contractual SE requirements, such as a Contract Data Requirements List (CDRL) Item and/or Data Item Description, with which all affected parties shall comply.

4.2.2.2.5 Step 5: Interface With Other Processes/Plans

The SEMP interfaces with, and forms a roadmap to, any other SE and engineering specialty standalone plans (e.g., Master Verification Plan). The SEMP addresses all SE elements:

- Integrated Technical Planning (Section 4.2)

- Requirements Management (Section 4.3)
- Functional Analysis (Section 4.4)
- Synthesis (Section 4.5)
- Trade Studies (Section 4.6)
- Interface Management (Section 4.7)
- Specialty Engineering (Section 4.8)
- Integrity of Analyses (Section 4.9)
- Risk Management (Section 4.10)
- Configuration Management (Section 4.11)
- Validation and Verification (Section 4.12)
- Lifecycle Engineering (Section 4.13)
- System Engineering Process Management (Section 4.14)

4.2.2.2.6 Step 6: Update and Maintain the Plan

It is recommended that throughout the lifecycle of the program/project, SE monitors inputs (especially to the ISAP) and, when there is a significant change in one or more inputs, revises the SEMP (by repeating steps 1–5 above).

4.2.2.3 System Engineering Management Plan

Table 4.2-1 is a SEMP outline.

Table 4.2-1. System Engineering Management Plan Outline

SECTION 1	INTRODUCTION
1.1	Scope
1.2	Purpose of the System Engineering Management Plan
1.3	Organization of the System Engineering Management Plan
1.4	SEMP Overview
1.5	Program/Project Name, System Description, Scope, Status, and Life cycle stage (or segment)
1.6	Program Organization
1.7	System Engineering Responsibility Assignments
1.8	System Engineering Environment and Tools
1.9	System Engineering Metrics

Table 4.2-1. System Engineering Management Plan Outline—Continued

1.10	Applicable Documents
SECTION 2	SYSTEM ENGINEERING
2.1	System Engineering Process
2.2	Integrated Technical Planning
2.3	Requirements Management
2.3.1	Concept and Requirements Definition (system)
2.4	Functional Analysis
2.5	Synthesis
2.6	Trade Studies
2.7	Interface Management
2.7.1	Establish Interface Working Group
2.8	Specialty Engineering
2.8.1	System Safety Engineering
2.8.2	Human Factors Engineering (summarized in ISAP Section 17)
2.8.3	Quality Engineering (summarized in ISAP Section 5.2)
2.8.4	Reliability, Maintainability, and Availability
2.8.5	Electromagnetic Environmental Effects/Spectrum
2.8.6	Information System Security
2.8.7	Hazardous Materials Management/Environmental Engineering
2.9	Integrity of Analysis
2.10	Risk Management
2.11	Configuration Management (summarized in ISAP Section 9)
2.11.1	Data Management
2.11.2	Establish CCB
2.12	Validation and Verification (summarized in ISAP Section 12)
2.13	Lifecycle Engineering
2.13.1	Real Property Management
2.13.2	Deployment and Transition
2.13.3	Integrated Logistics Support
2.13.3.1	Maintenance Planning
2.13.3.2	Maintenance Support Facility
2.13.3.3	Direct-Work Maintenance Staffing
2.13.3.4	Supply Support

Table 4.2-1. System Engineering Management Plan Outline—Continued

2.13.3.5	Support Equipment
2.13.3.6	Training, Training Support, and Personnel Skills
2.13.3.7	Technical Data
2.13.3.8	Packaging, Handling, Storage, and Transportation
2.13.3.9	Computer Resources Support
2.13.4	Sustainment/Technology Evolution
2.13.4.1	Sustainment
2.13.4.2	Technology Evolution
2.13.5	Disposal
2.14	System Engineering Process Management
2.2	Master Verification Plan
2.21	Validation
2.22	Verification
SECTION 3	
3.1	System Engineering Master Schedule (use Program Integrated Master Schedule as guidance)
3.2	Reviews and Audits
3.3	Work Breakdown Structure

4.2.2.3.1 SEMP Planning Details

The SEMP includes planning for all SE elements that the program requires, including specialty elements. The planning details for each SE element are in Appendix E. Some SE planning information in the SEMP will be summarized and inserted in the ISAP (see subsection 4.2.5 below).

The Work Breakdown Structure (WBS) is a key element of planning that details the activities to be performed. It is a deliverable-oriented grouping of project elements, which organizes and defines the total scope of the project. Each descending level represents an increasingly detailed definition of a project component. Project components may be projects or services.[2] However, for highly time-dependent projects with organizational "checkpoints" or "gates" that allow for progress from phase to phase, the task-oriented WBS may be the most effective.[3] WBS numbering schema follows the functional analysis standard (see Functional Analysis (Section 4.4)), with the highest level being the project level and the lowest level being the work package.

[2] Guide to Project Management Body of Knowledge. PMI Standards Committee. Project Management Institute, PA, 1996.

[3] How to Build a Work Breakdown Structure, The Cornerstone of Project Management, Carl Prichard, ESI International, Arlington, VA 22203, 1998.

The WBS is an exhaustive, hierarchical (from general to specific) tree structure of deliverables and tasks that need to be performed to complete a project. The WBS identifies terminal elements (i.e., the actual items to be done in a project). Therefore, the WBS serves as the basis for much of project planning. An example of a work breakdown for painting a room (activity oriented) follows:

- Develop room-painting plan
- Prepare materials
  - Buy paint
  - Buy a ladder
  - Buy brushes/rollers
  - Buy wallpaper remover
- Prepare room
  - Remove old wallpaper
  - Remove detachable decorations
  - Cover windows with old newspapers
  - Cover outlets/switches with tape
  - Cover furniture with sheets
- Paint the room
- Clean up the room
  - Dispose or store leftover paint
  - Clean brushes/rollers
  - Dispose of old newspapers
  - Remove covers
  - Unpaint dog

The WBS provides the framework for organizing and managing work, including large, complex projects. It entails breaking the projects into progressively smaller pieces until they are a collection of defined "work packages" that may include a number of tasks. A $1 billion project is simply a number of $50,000 projects joined together. The size of the WBS should generally not exceed 100–200 terminal elements. If more terminal elements seem to be required, use subprojects.) The WBS should be at least three to four levels deep, with each level five to nine elements broad.

Tip

A WBS is not a "to do" list. Developing the WBS as such gives no foundation for clear assignments, close tracking, or tight scope control. This leads to a project taking about 50 percent longer than it should, as the team spends hours in status meetings discussing what to do next. It also leads to micromanagement.

For various programmatic reasons, any element in the SEMP may require a more detailed standalone plan (e.g., risk management plan, configuration management plan, or concept and requirement definition (CRD) plan. A plan must define the tasks and products of the process and assign responsibilities to various subprocesses. A plan must also describe the deliverables and include the schedule for completion of each task and delivery of each product. Sometimes, a SEMP element needs a separate plan. Details for these standalone plans (for each individual SE element) appear in Appendix E. The most likely to be standalone plans are the Master Verification Plan, the Lifecycle Plan, the Risk Management Plan; the Configuration Management Plan; the Concepts and Requirements Definition Plan, and the Program Safety Plan.

Appendix E also contains detailed input and format information for the planning associated with all of the SE elements discussed in Section 2 of the SEMP (as in the outline above.)

4.2.3 Verification Planning

Although verification planning may be contained in the SEMP, it is most often a standalone MVP, which contains validation and verification planning as well as test and evaluation planning. (See Section 4.12, Validation and Verification, for definitions of these terms.) This plan includes all the activities to ensure that the right system is being built and to confirm that evolving system solutions comply with functional, performance, and design requirements, as well as performance and characteristics of the delivered system. Validation activities dominate the early phases of the lifecycle, while verification activities dominate the later phases. The MVP defines all validation and verification activities that demonstrate the system's capability. Details for a standalone MVP appear in Appendix E.

4.2.4 Lifecycle Planning

Although the lifecycle planning may be included in the SEMP, it is usually a separate LCP. In either case, the plan (or planning section) describes the tasks to perform lifecycle activities. It provides the content and depth of detail necessary for full visibility of all lifecycle activities. The plan fully defines and describes each major activity and provides a general schedule and sequence of events. The plan includes the following planning sections: Integrated Logistics, Deployment and Transition, Real Property Management, Sustainment and Technology Evolution, and Disposal. The Integrated Logistics Planning section includes these subsections: maintenance; maintenance support facilities; direct-work maintenance staffing; supply support; support equipment; training, training support, and personnel skills technical data; packaging, handling, storage, and transportation; and computer resources support. The format for a standalone LCP is in Appendix E.

4.2.4.1 Integrated Logistics Support

This planning section will include maintenance; the maintenance support facility; direct-work maintenance staffing; supply support; support equipment; training, training support, and personnel skills; technical data; packaging, handling, storage, and transportation; and computer resources support. Detailed information on these activities is in Appendix E (13.1).

4.2.4.2 Deployment and Transition

This section includes all tasks to prepare for and assess the readiness of a solution to be implemented into the National Airspace System (NAS). Deployment planning tools (such as a tailored In-Service Review Checklist) shall be used to assist in identifying, documenting, and resolving deployment and implementation issues. Methods and techniques include, but are not limited to, a tailored application of generic tools; integration of checklist risks with other emerging risks (such as problem test reports from program tests and evaluation); development of action plans for resolution of checklist and other items; and documentation of the results of issue resolution and mitigation. Consistent deployment planning shall be visible in the contractor's "statement of work" and associated efforts.

4.2.4.3 Real Property Management

This section includes resources to determine if real property is required, acquisition costs, and acquisition strategy (buy or lease). If real property is being acquired, it must be included as real property in the Real Estate Management System and in any activities in the real property inventory process.

4.2.4.4 Sustainment and Technology Evolution

This section shall include both sustainment and technology evolution activities as follows:

- Sustainment
  - Tracking and evaluating Reliability, Maintainability and Availability (RMA) performance and supportability issues
  - Analyzing supportability issues caused by market-driven products
  - Evaluating system or subsystem obsolescence
- Technology Evolution
  - Evaluating [c1]system or subsystem obsolescence, if evolving technology is appropriate
  - Determining the most cost-effective means of avoiding projected supportability shortfalls
  - Assessing integration of obsolescence-driven system changes with new requirements
  - Evaluating the impact of engineering changes, performance shortfalls, or technological opportunities on integrated logistics support products and support services
  - Supporting revalidation or development of SLMN

4.2.4.5 Disposal

This section shall include all activities associated with disposal management; dismantling/demolition/removal; restoration; degaussing or destruction of storage media; and salvaging of decommissioned equipment, systems, or sites. The systems, assemblies, and other components that will be removed, disposed of, or cannibalized must be identified—as well as the agent responsible for disposal. An assessment of the system to determine the need to salvage usable parts/subsystems from facilities to be decommissioned must be included in the planning. (This is particularly important for items that are no longer being manufactured.) An evaluation of environmental issues (including any hazardous materials), determination of disposition location, and removal of the system from the operational inventory must also be factored into the planning.

4.2.5 Exhibit 300, Attachment 3, ISAP

The ISAP is the primary document within the AMS for planning the actions and activities to execute the program within the cost schedule, benefits, and performance baselines. A draft ISAP is completed before the Initial Investment Decision milestone, and the final ISAP is approved at the Final Investment Decision. The ISAP is reviewed and updated at all subsequent SE and acquisition reviews and reflects changes throughout the program's lifecycle.

4.2.5.1 Introduction to Exhibit 300, Attachment 3, ISAP

The ISAP is the recognized plan used to manage a project and contains the program Integrated Master Schedule, which includes milestones (events), accomplishments, and criteria. The ISAP relates tasks to program events and demonstrates a logical, event-driven sequence of effort. It is directly traceable to the WBS, which is produced and owned by SE, and the SOW. The ISAP provides vertical and horizontal task integration through its task statements and numbering system and identifies task relationships. It facilitates resource planning, measures progress against planned efforts, ensures problem identification, and provides time-phased tasks and a framework to develop recovery and workaround plans. The ISAP establishes contractual requirements and unique programmatic requirements. The planning elements in the tailored SEMP will be summarized in the ISAP to ensure that ALL planning is referenced in the ISAP. Table 4.2-2 lists the sections of an ISAP with the associated SEM section referenced where applicable. The planning content for these SE elements will be a summarized extract from the SEMP to ensure consistency.

Tip

Although the ISAP reflects selected SEMP planning elements, complete SE planning content is in the SEMP (or subordinate planning documents). Additional SE planning beyond that mandated in the ISAP ensures a more accurate costing of the program and a higher likelihood of success. Performance of these planned elements will significantly reduce the percentage of requirements found in Operational Test and Evaluation. Although this additional SE planning can be included in the ISAP at a summary level, it must be included in depth in the SEMP.

Table 4.2-2. Implementation Strategy and Planning Table of Contents

1	BACKGROUND
1.1	Mission Need (See SEM 4.3)
1.2	Status
2	OVERVIEW
2.1	Description

Table 4.2-2. Implementation Strategy and Planning Table of Contents—Continued

Table 4.2-2. Implementation Strategy and Planning Table of Contents—Continued

12.5	Master Verification Plan
13	PRODUCTION
14	FACILITIES
15	PHYSICAL INTEGRATION (See SEM 4.13)
15.1	Real Property
15.2	Environmental Requirements
15.3	Energy Conservation
15.4	Heating, Ventilation, and Air-Conditioning
15.5	Grounding, Bonding, Shielding, and Lightning Protection
15.6	Cables
15.7	Hazardous Materials (See SEM 4.8.3)
15.8	Power Systems and Commercial Power
15.9	Telecommunications
15.10	Special Considerations
16	FUNCTIONAL INTEGRATION (See SEM 4.4)
16.1	Integration With Other NAS and Non-NAS Elements
16.2	Software Integration
16.3	Spectrum Management (See SEM 4.8.4)
16.4	Standardization
17	HUMAN INTEGRATION (See SEM 4.8.2)
17.1	Human/Product Integration
17.2	Employee Health and Safety
17.3	Specialized Skills and Capabilities
18	INTEGRATED LOGISTICS SUPPORT (See SEM 4.13)
18.1	Staffing
18.2	Supply Support
18.3	Support Facilities and Equipment
18.4	Technical Data
18.5	Training and Training Support
18.6	First and Second Level Repair
18.7	Packaging, Handling, Storage, and Transportation
19	DEPLOYMENT
20	IN-SERVICE MANAGEMENT
21	SUPPORTING SE PLANS
21.1	MASTER VERIFICATION PLAN
221	INTEGRATED LIFECYCLE PLAN (SE lifecycle elements not contained in 15 and18 above)

4.2.5.2 Inputs to Attachment 3, Implementation Strategy and Planning

The following inputs are necessary to develop the ISAP:

- Program objective as reflected in the Service-level Mission Need (SLMN) and Exhibit 300, Attachment 1, Program Requirements, which detail the operational environments in which the system is expected to operate
- Program-specific guidelines
- Top-level program constraints and assumptions, including program-specific organizational constraints and assumptions to be used on the program
- Program-specific schedule constraints and events
- Concept approach, including top-level conceptual alternatives, functional analyses, design support alternatives, and initial system evaluations
- Investment (or program) WBS
- Any specified government or external standards to be employed in the program
- Any other supporting technical plans (e.g., MVP and SEMP) to be presented at the Final Investment Decision

Perform tailoring on planning documents only by deleting planning requirements; a rationale shall be provided for each deletion. The only allowable additions are those unique to the program.

4.2.5.3 Implementation Strategy and Planning Steps

An ISAP is the responsibility of program management, who may delegate the writing and coordinating to SE. The ISAP is developed using the same basic planning steps used in developing the SEMP (see subsection 4.2.2.2 above).

4.2.5.4 Implementation Strategy and Planning

4.2.5.5 Integrated Technical Planning Inputs to the Implementation Strategy and Planning (Attachment 3 to Exhibit 300)

SE planning directly relates to implementation of the relevant elements of the SE process defined in this SEM and is included as sections of the ISAP. It describes how the SE process is applied to the given program or project at a summary level with detailed SE implementation activities discussed in supporting technical plans (e.g., SEMP, MVP, RMP, etc). These planning sections become the tailored process that is implemented on a given program. All SE planning not included in other sections of the ISAP will be included at a summary level in the SE management planning section of the ISAP, with the details in the SEMP. All ISAP sections apply to every program; however, stakeholder direction or the nature of the program may dictate elimination of a planning section. For example, a program that deploys into a current facility rarely requires a real property section. The rationale for eliminating any ISAP sections or tailoring any process must be documented, and the program manager must approve these actions. It is recommended that, as part of the ISAP, these planning sections be reviewed and changed whenever dictated by a change in the program or discovery of a discrepancy in the ISAP. Changes to any planning sections shall be coordinated with the SEMP and other associated plans. All plans shall be reviewed before each JRC milestone. After any plan is created following the SEM, it is recommended that the plan be provided as reference material for future plan developers. It is also recommended that, along with the plan to be achieved, comments are provided to continue improvement of the plan development process. Table 4.2-3 lists the sections of an ISAP and the SE elements from the SEMP that provide summary-level inputs to the applicable ISAP sections with a brief textual explanation of each entry after the table. The ISAP summarizes SE activities, while the SEMP and other supporting technical plans describe the implementation detail.

Table 4.2-3. SE Inputs to the Exhibit 300, Attachment 3

Implementation Strategy and Planning		System Engineering Element
1	BACKGROUND	
1.1	Mission Need	Requirements Management
1.2	Status	Integrated Technical Planning (ITP)
2	OVERVIEW	
2.1	Program Scope	ITP
2.2	Products	ITP
3	INTEGRATED PROGRAM FUNDING	EXTERNAL
	INTEGRATED PROGRAM SCHEDULE	ITP
5	PERFORMANCE	
5.1	Core Work Activities	ITP; Functional Analysis (FA); Synthesis (SYN); Trade Studies (TS); Interface Management (IM); Integrity of Analyses (IA); Specialty Engineering (SpecEng) — Reliability, Maintainability, and Availability (RMA) and Quality Engineering))
5.2	Program Management Work Activities	Requirements Management (RM); SpecEng (System Safety); Risk Management (RSK); Technical Monitoring and Control (ITP)
5.3	Procurement Work Activities	ITP
6	BENEFITS	RM, RSK, LCE
7	PHYSICAL INTEGRATION	Lifecycle Engineering (LCE — real property; deployment and transition); SpecEng (Hazardous Materials Management/Environmental Engineering and Electromagnetic Environmental Effects (E^3))
8	FUNCTIONAL INTEGRATION	IM
9	HUMAN INTEGRATION	SpecEng (Human Factors Engineering)
10	SECURITY	SpecEng (Information Security Engineering)
11	SAFETY	SpecEng (Safety)
12	IN-SERVICE SUPPORT	LCE (Integrated Logistics Support; Sustainment/Technology Evolution)

Implementation Strategy and Planning		System Engineering Element
13	VALIDATION (INCLUDES TEST AND EVALUATION) AND MASTER VERIFICATION PLAN	Validation and Verification (V&V)
14	IMPLEMENTATION AND TRANSITION	LCE (Deployment and Transition; Disposal)
15	QUALITY ASSURANCE	SpecEng (Quality Engineering)
16	CONFIGURATION MANAGEMENT	Configuration Management (CM)
17	IN-SERVICE MANAGEMENT	LCE (Integrated Logistics Support (ILS); Sustainment/Technology Evolution)
18	SYSTEM ENGINEERING MANAGEMENT PLAN	ITP, FA, RM, SYN, TS, IA, RSK, IM, SpecEng,
19	LIFECYCLE PLAN	LCE
20	MASTER VERIFICATION PLAN	V&V

4.2.5.5.1 Background

Integrated Technical Planning (ITP) is the source of information for summarizing the mission need and program status.

4.2.5.5.2 Overview

ITP is the source of information about the scope of the program and the primary deliverables.

4.2.5.5.3 Integrated Program Funding

ITP is the source for WBS, level-of-effort, and schedule/duration information in sufficient detail to enable cost estimators to identify funding requirements.

4.2.5.5.4 Integrated Program Schedule

ITP is the source for WBS, milestone, and SE activity information to allow for a logical networking of program activities to achieve program objectives.

4.2.5.5.5 Performance

The Performance section of the ISAP contains planning information on the “Core Work Activities,” the “Program Management Work Activities,” and the Procurement Work Activities. The “Core Work Activities” describes SE elements that are not specifically broken out as separate work activities. SE elements such as Integrated Technical Planning, Functional Analysis, Synthesis, Trade Studies, Interface Management, Integrity of Analyses, and Specialty Engineering sub-elements—including Electromagnetic Environmental Effects and Reliability, Maintainability, and Availability—can be addressed to the extent that they apply. The “Program Management Work Activities” identifies specific SE elements such as Requirements Management, Specialty Engineering (e.g., System Safety), and Risk Management as work activities requiring discussion. It also describes Program monitoring and control (including metrics), with Integrated Technical Planning as the source. The “Procurement Work Activity” identifies those SE resources required to support Screening Information Request (SIR) release, Request for Proposal development, proposal evaluations, and contractor requirements definition.

4.2.5.5.6 Benefits

Requirements Management is the source for technical or performance benefits. Risk Management is the source of the risks incurred in pursuing these benefits.

4.2.5.5.7 Physical Integration

SE inputs to this ISAP section identify activities (e.g., space, facility, environment, power, and hazardous materials) that require planning.

4.2.5.5.8 Functional Integration

SE inputs to this ISAP section include planning for function analyses to identify functions needed to perform system tasks and development of a functional architecture.

4.2.5.5.9 Human Integration

SE inputs to this ISAP section include the individual human factors engineering work tasks that must be done during program implementation. For each task, the ISAP assigns the responsible individual and organization, identifies any output and the approval authority, specifies when the task should be completed, and allocates resources.

4.2.5.5.10 Security

SE inputs to this ISAP section include tasks to ensure that security is fully integrated into the system. The section addresses the key physical and information security tasks, including identifying security requirements, assessing system alternatives and analyzing security risks, and evaluating security features and controls for continuity of operations and disaster response to ensure appropriate availability.

4.2.5.5.11 Safety

SE inputs to this ISAP section include tasks needed to ensure that safety is fully integrated into the system.

4.2.5.5.12 In-Service Support

The preliminary In-Service Decision (ISD) activities of the deployment planning process focus on preparing for the ISD meeting. The post-ISD activities focus on documenting the ISD, establishing a periodic review, and tracking progress of completing the ISD Action Plan.

4.2.5.5.13 Verification

See the SEMP (Section 4.2.2) and MVP (subsection 4.2.3 above).

4.2.5.5.14 Implementation and Transition

This ISAP section includes all tasks to prepare for and assess the readiness of a solution to be implemented into the NAS. Deployment planning tools (such as a tailored In-Service Review

Checklist) shall be used to assist in identifying, documenting, and resolving deployment and implementation issues. Methods and techniques include, but are not limited to, a tailored application of generic tools; integration of checklist risks with other emerging risks (such as problem test reports from program tests and evaluation); development of action plans for resolution of checklist and other items; and documentation of the results of issue resolution and mitigation. Consistent deployment planning shall be visible in the contractor's "statement of work" and associated efforts.

4.2.5.5.15 Quality Assurance

This ISAP planning section includes developing high-level quality requirements, providing constraints for risk management, and identifying development and deployment metrics. The quality assurance planning also includes supporting contract activities by providing evaluation criteria, assisting in estimating cost, and evaluating proposals.

4.2.5.5.16 Configuration Management

This ISAP section includes the CM tasks for ensuring that CM is performed throughout the lifecycle and for all aspects of the program.

4.2.5.5.17 In-Service Management

This ISAP section includes maintenance, staffing, supply support, support equipment, computer resources, training, and required personnel skills.

4.2.5.6 Concept and Requirements Definition Plan

Another plan that AMS requires is the concept and requirements definition plan. This plan specifies the scope, assumptions, constraints, methods, data sources, resources, control strategy, team composition, roles and responsibilities, schedule, and deliverables for a CRD activity that addresses a priority service need within the Service-Level Mission Need and develops the information necessary for an Investment Analysis Readiness Decision (IARD). Specifics on this plan are in Appendix E (E.11).

4.2.6 Technical Monitoring and Control

Technical monitoring and control is used to generate information or data needed to make technical decisions. It is a risk-reduction approach that manages the progress of the technical aspects of a system development or deployment. This topic includes both techniques and mechanisms to help ensure that results happen as planned and that unplanned results don't happen. In other words, it measures or assesses progress against a plan, identifies variances, and provides sufficient information for informed decision making on corrective action(s) to take.

Technical monitoring is accomplished using techniques. An example of a technique is the measurement of certain technical characteristics of the system compared against a predetermined baseline or set of standards. Several management tools and techniques are available to manage the program, mainly in the area of cost (resources) and schedule (time). An example of this approach is the application of Earned Value Management (EVM) to measure and analyze the cost and schedule performance of an investment program. While these measures may differ in their focus (technical versus nontechnical), they share a common basis of reference: the WBS.

The control aspect of the process is accomplished through use of mechanisms. **A mechanism is a control gate that assesses the progress of the system against criteria established for a given point in the system's lifecycle.** Early in the system's lifecycle, these gates (or milestones) determine the degree and rate of system maturation. Later in the lifecycle, they focus on the adequacy of the system from a user's perspective. These gates typically take the form of technical reviews and audits and should have predefined entry and success criteria that contribute to the eventual realization of program objectives.

Each technical review or audit establishes the readiness of a program to proceed to the next phase of the system's lifecycle. Typically, they focus on the development phases, where SE provides the largest benefit to the investment. Reviews and audits occur at strategic points in the development cycle, and they are usually conducted in conjunction with, or in preparation for, a lifecycle phase milestone at which the decision to advance to the next phase is made. Technical reviews employ specific criteria tailored to each phase of the lifecycle. These criteria verify the extent of technical progress made toward solving the identified capabilities shortfall.

Certain reviews and audits directly support an AMS phase exit decision point. Others provide interim benchmarks on the progress and maturity of the effort associated with the given phase. The reviews and audits are shown in Figure 4.2-2, which contains the same information as Figure 3.3-1 (see Chapter 3), and are grouped by the FAA AMS phase and decision points they support. Each SE milestone in Figure 4.2-2 is summarized in subsection 4.2.6.2.3 along with its objectives and scope related to the lifecycle phase it is supporting. Further details on each milestone are found in Appendix C and include an expanded discussion tailored to each milestone, including entry/exit criteria, process steps, and preparation checklists where appropriate. For the purposes of this SEM, the AMS lifecycle phases and their related reviews and audits are shown in Figure 4.2-2, which is based on the AMS policy as of November 2005.

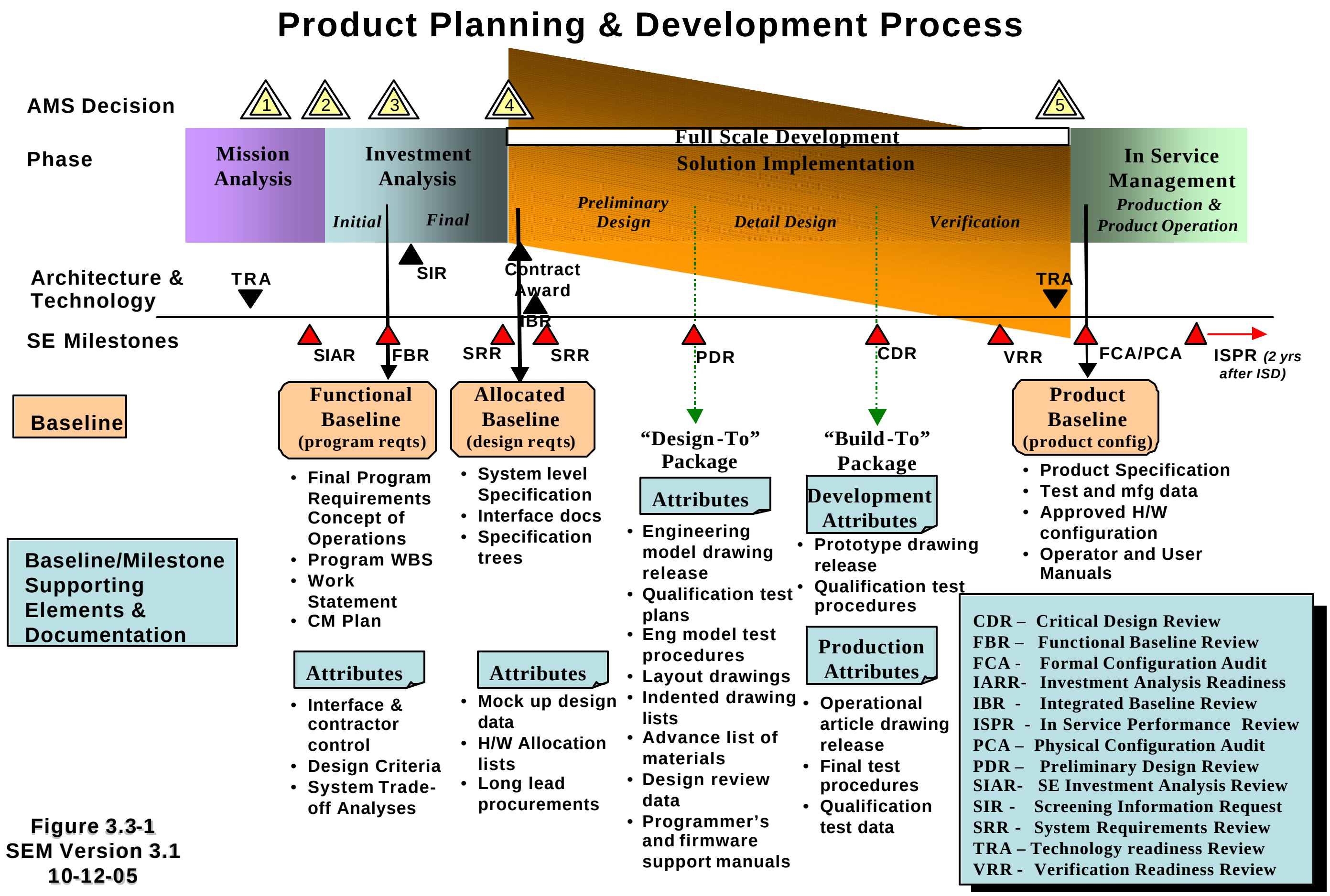

Figure 4.2-2 Product Planning and Development Process

4.2.6.1 Technical Measurement

Technical Performance Measurement (TPM) is the key technique used in monitoring and assessing technical progress throughout a development program. **TPM is a process to continuously assess and evaluate the adequacy of architecture and design as they evolve to satisfy program requirements and objectives**. In other words, TPM is a quantitative way to pinpoint emerging design deficiencies, monitor progress relative to satisfying requirements, and developing trend information to assess program risks. Critical technical criteria or parameters are tracked as the analysis, design, and development activities progress from inception through system Initial Operational Capability (IOC). The assessment and evaluation is used to identify deficiencies that jeopardize the system's ability to meet preestablished performance requirements. Technical Performance Management produces periodic (typically monthly) trend and variance reports for all levels of management. For identified deficiencies, analysis is performed to determine the root cause and assess the impact on higher level parameters, interface requirements, and system cost-effectiveness. Alternate recovery plans are developed with cost, schedule, and performance impacts fully explored. Risk assessments and analyses are updated to reflect changes in the TPM profiles and current estimates, and impacts on related parameters. The SEMP establishes how technical assessments are accomplished and what measures will be used.

The parameters used in a TPM program are called Technical Performance Parameters (TPP). They are critical technical performance requirements that support critical operational needs and essentially measure the extent of success or failure of a design to meet those needs. It must be possible to project the evolution (or maturation) of TPPs over time toward the desired value at completion of development. The projection can be based on verification, validation, planning or historical data. Not all TPPs are created equal. A subset of the TPPs characterizes the significant total system performance qualities, sometimes referred to as Key Performance Parameters (KPP), or simply "design drivers." The critical requirements are either selected or derived from Measures of Effectiveness (MOE), which reflect operational or performance requirements, usually from the preliminary Program Requirements (pPR). These should be identified as part of the exit criteria for the Mission Analysis phase, usually as an outcome of the Investment Analysis Readiness Review (IARR). The balance of the TPPs are established during the Investment Analysis phase. These TPPs are revised and refined when the final Program Requirements (fPR) is finalized and could be further expanded or refined as the specific solution takes shape.

Tip

In selecting a TPP, a critical performance value or limit is identified. This represents the absolute limit for the final as-built design. For the purposes of minimizing technical risk associated with the TPP, a target performance value is established that is within the critical performance limit and that provides a contingency or reserve to cover unexpected design problems and changes. The values of the parameter between this target value and the critical limit can be divided into ranges with different associated risk levels as shown in Figure 4.2-3. As the design progresses, the value of the TPP at completion is projected based on the current state of the design. As the design approaches completion and realization, the projected value of the TPP will converge to the final as-built design value. Accurate projections of the TPP along with trend analysis will help identify risks and provide opportunities to mitigate those risks more efficiently and effectively. A properly selected TPP should exhibit the following characteristics:

- **Stated as quantifiable requirements in specification(s)**
- **Assessable through engineering analysis**
- **Can be verified by test and analysis**

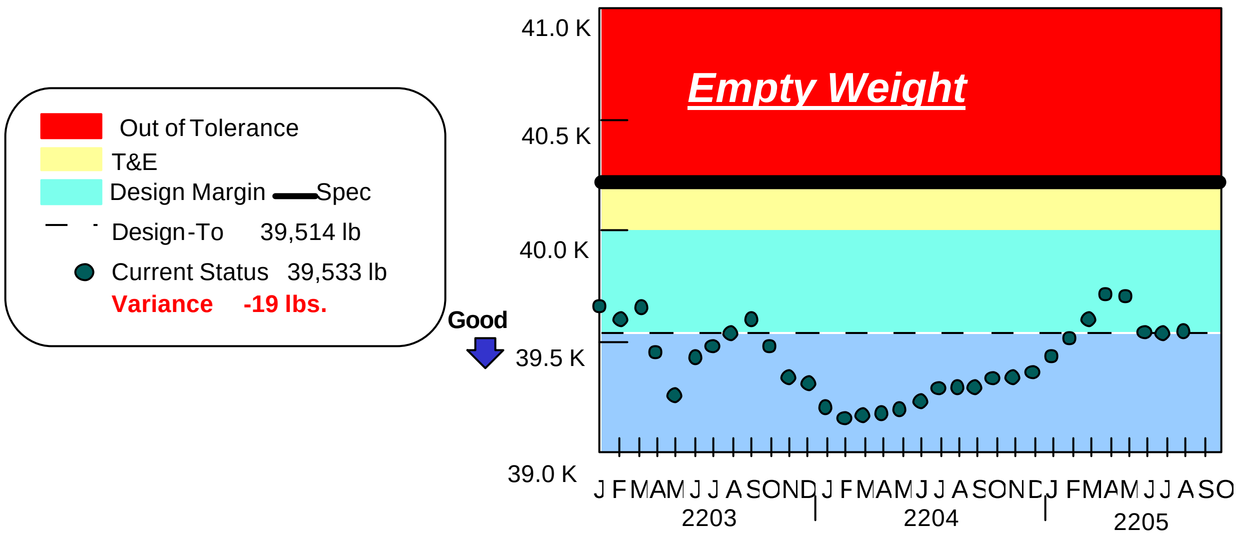

Figure 4.2-3. TPM Status Example

An effective TPM program provides an early warning regarding the adequacy of a design in terms of satisfying selected key performance parameter requirements of a system or end product. TPM examines marginal cost benefit of performance in excess of requirements. It also includes sensitivity analysis. Successful use of TPMs on the project includes:

- Identifying the technical performance measures that will be used to determine the success of the system, or portion thereof, and that will receive management focus and be tracked using TPM procedures. This would include incremental measures taken to assess the probability of meeting the objectives. It could include specific measures to determine reliability, maintainability, availability, testability, safety, electromagnetic properties, weight, balance, and manufacturability.
- Defining product and process metrics. These include: (1) product metrics to evaluate the quality of the product; (2) process metrics to evaluate efficiency and effectiveness of the tasks of the technical effort; and (3) frequency and methods to collect product and process metrics.

Tip

The linkage between a critical requirement and the TPP is often overlooked or forgotten over time. Requirements are changed to fit the evolving needs of the project, and the link to the TPP is often broken. A simple technique to maintain the linkage between the originating requirement and the associated TPP is to visually highlight that linkage directly in the requirements document. This can be done by bolding the requirement, putting it in italics, or otherwise annotating the association.

Project metrics are measures that both the project manager and the systems engineer use to track and monitor the project and the expected technical performance of the system's development effort. Identifying and monitoring metrics are important so that the team can determine if the project is "on-track" both programmatically and technically. For project metrics, the analog to TPM is Program Performance Measurement (PPM). This is a process used to track the current status of meeting selected Program Performance Requirements. The nontechnical equivalent to TPPs are Program Performance Parameters (PPP). Figure 4.2-4 shows examples of TPPs and PPPs for an aircraft design and manufacturing program.

The most common application of PPM is the use of Earned Value Management (EVM). To objectively define the program baseline cost objectives and track them against performance and schedule, an EVM system is established. Earned Value is a management technique for integrating cost, schedule, technical performance measurement, and risk management.

For Earned Value to be effective, planning, budgeting, and scheduling the authorized work scope (defined in the WBS) must be accomplished in a time-phased plan. As work is accomplished, it is “earned”. The earned value is compared with the planned value for that same effort, providing a comparison of work accomplished against the plan. Any deviations to the plan are noted as cost or schedule variance. Actual costs are compared to the Earned Value to indicate an over or under run condition. Earned Value methodology provides an objective measure of performance, enabling trend analysis and evaluation of cost estimates at completion for multiple levels and stages of a project. ANSI/EIA-748 is the industrywide standard for a viable EVM system.

Technical Performance Parameter (TPP)	**Specification Value**		**Program Performance Parameter (PPP)**	**Target Value *(Examples)***
Weight Empty			***(Program Performance)***	
Return Payload			Personnel Skill/Staffing Level	100% (Plan)
Specific Thrust			Drawing Release/Change Status	+/- (Schedule)
Avg Production Airframe/Contractor – Furnished Equipment (CFE) Cost			Quality Indicators	< x % change
ILS Airframe/CFE Cost			Organization/Counterparts	% match
Operating and Support Cost			Shortages	< x %
Detection range			Tools/Parts Fabricated	+/- (Schedule)
Thermal Management — Heat			Action Tracking System	# open, # days
Reliability			CDRL Status	# late/in review
Maintainability			Schedule Performance Index (SPI) and Cost Performance Index (CPI)	Percentage

Growth Provisions — Volume				
Growth Provisions — Electrical			***(Risk Trend Indicators)***	
Growth Provisions — Liquid Cooling			90 Day Look Ahead	# realized
False Alarm Rate			High Risk Items	# active
Fault Detection			Mitigation Plans	# Unapproved
Fault Isolation			Transition to Production	# Open areas
Central Processing Unit (CPU) Throughput			Overall Program Risk Status	Profile (trend)

Figure 4.2-4. Performance Measures (Aircraft Manufacturing Example)

4.2.6.2 Technical Controls

Control gates are formal decision points along the lifecycle that the system owner and stakeholders use to determine if the current phase of work has been completed and the team is ready to move into the next phase of the lifecycle. By setting entrance and exit criteria for each phase of work, the control gates are used to review and accept the work products completed for the current phase of work and also evaluate the readiness for moving to the next project phase. The System Engineering control gates (or milestones) in Figure 4.2-2 (above) are typically in the form of technical reviews or audits.

4.2.6.2.1 Technical Reviews

Technical reviews assess the maturity of the product or service under consideration. While the mandatory reviews are identified in the following subsections, additional reviews can be performed based on the program's specific needs. Technical reviews, which are scheduled at strategic points within the development cycle, employ specific criteria tailored to the development effort. These criteria verify the extent of technical progress made toward solving the identified capabilities shortfall.

Figure 4.2-2 discusses the relationship of the technical reviews and the AMS phases. In the Mission Analysis and Investment Analysis phases, the goal is to ensure that the definitions of the need and its derived operational requirements are complete and accurate and that all design constraints have been identified. In the Solution Implementation phase, the goal is to monitor the technical progress of the development to ensure that it remains consistent with the established operational requirements and design constraints. An additional goal during Solution Implementation is to assist program management to assess the maturity of the design in order to identify risks and form the basis for determining overall progress in the program.

In each case, a well-structured technical review includes defined entry criteria (inputs for conducting a successful review), a basic set of common steps for every review, a predefined set of outcomes expressed in terms of exit criteria, and a set of metrics to measure success.

All technical reviews have the same characteristics at a rudimentary level, as shown in Figure 4.2-5 below. The figure shows inputs, outputs, and process steps involved in performing a technical review. These characteristics are as follows:

4.2.6.2.1.1 Entrance Criteria (Inputs)

Inputs to a review depend on the nature of the review and the point at which the review occurs in the development cycle. Accordingly, the primary inputs to a review consist of new products that have been generated since the previous review that reflect the advancement of the development toward completion. In addition, inputs will include products and documents that were completed in previous development phases, along with any proposed changes, to ensure that the information they contain is adequate and appropriate to proceed to the next phase. Once TPPs (or PPPs) have been established for a program, the status of these TPPs will be included as inputs to enable measurement and tracking of the maturity of the design and risks to meeting the requirements. Each review must consider the constraints under which the system is being developed, including constraints imposed by risk mitigation plans defined in previous stages.

Typical inputs to reviews include:

- Previously completed documents and products
- Service Level Mission Need
- Technical planning documents (used to define the scope, objectives, and timing of the review)
- Requirements documents and specifications, including Interface Requirements Documents (IRD) and Interface Control Documents (ICD)
- Architectures
- List of allocated TPPs and associated critical performance limits and target values
- Constraints
- Risk Mitigation Plans
- Test plans
- Proposed changes to previously completed documents and products
- Draft products and documents
- Design Analysis Reports (DAR)
- Functional analyses
- Technical Performance Measurement (TPM) reports
- Test, evaluation, verification, and validation reports

- Risk management reports

4.2.6.2.1.2 Process

A prerequisite for conducting a review is the approval of the technical planning documentation that defines the objectives and scope of the review; entry criteria and items to be reviewed; the review schedule coordinated with the overall program schedule; the general approach for accomplishing the review; and review participants. The objectives of the review are defined in terms of success criteria or outcomes. Once the objectives and scope are established, the data to support these objectives can be identified. While the schedule in the technical planning documentation provides guidance for setting the review date, the specific date for the review is set once the entry criteria are determined to be in place. The approach can range from an informal review for small programs to incremental reviews for large complex programs replete with a standalone plan for the review. An example of a defined approach for a Critical Design Review (CDR) is conducting design assessments on individual lower level design elements designated as Configuration Items (CI) on an incremental basis leading to a system level CDR that integrates the results of the individual lower level reviews.

The generic steps for conducting a review are:

- Define review objectives and scope
- Establish success criteria, prerequisites (entry criteria), and approach to be used
- Set the date for the review and activities leading up to the review
- Create an agenda for the review
- Identify and notify participants and stakeholders of their roles and responsibilities
- Identify the item(s) to be reviewed and the extent of review of each
- Compile and distribute review data package
- Obtain participants' responses to data package
- Assess readiness to proceed
- Collect comments to the data package (review item discrepancies)
- Update data package
- Incorporate accepted changes
- Provide summary of concerns
- Update Risk Mitigation Plans
- Conduct review
- Document the review

- Publish review minutes
- Compile action item list
- Compile issues list
- Track action items and issues
- Document closed action items and issues

4.2.6.2.1.3 Exit Criteria (Outputs)

Outputs are the outcome of a successful technical review. They are a set of records that may be used to support a critical decision point or to verify that another key phase in the development has been reached. They contain approved documents or approved changes to documents under review and may result in adding documents to the baseline. Typical review outputs include:

- Approved design documents
- SLMN and gap analyses
- Requirements document(s) and specifications, including IRD/ICD
- Architectures
- Technical manuals
- Updated plans
- Risk Mitigation Plans
- Verification plans
- SEMP (TPPs)
- Approved reports
- Test reports
- TPM reports
- Risk Management Reports
- Review minutes
- Action item and issue documentation

4.2.6.2.1.4 Tools

The tools used to conduct technical reviews record the changes to and status of the technical baseline as the development proceeds. They include the requirements database, the technical performance measurement database, the risk database, and the project database used to document and monitor action items and issues.

4.2.6.2.1.5 Process Metrics

Metrics are preestablished criteria that measure the success of a technical review. In turn, a successful technical review allows the project to proceed to the next phase. An individual technical review, due to its particular characteristics, may have additional specific metrics. They usually include:

- **Customer (stakeholder) acclimation**, which is defined as the extent of satisfaction that the review met the stated objectives. This can be measured through contract award fees, customer feedback surveys, or formal concurrence with the final review data package.
- **The number of new requirements** (system or subsystem) that surfaces at later reviews compared to the original number of requirements
- **The number of Requests For Action (RFA)** that are resolved by formal action
- **Errata** measured as the number of pages changed as a percentage of the total page count of the presentations

4.2.6.2.2 Audits

Audits are used to verify the system that has been developed is consistent with the requirements baseline. Audits are conducted in two phases. The Functional Configuration Audit (FCA) uses testing to verify that the system functions and performs according to the specifications. The testing is at the configuration item level. The Physical Configuration Audit (PCA) verifies completion of any corrective actions identified through the FCA as well as verifies that all baseline documentation is complete and accurately represents the as-built system.

In each case, an audit plan should be prepared to accomplish the following:

- Detail the audit processes to be used
- Identify the participants and their responsibilities
- Identify the item(s) to be audited
- Document the audit schedule
- Identify the documentation and supporting reference material to be audited
- Identify any supporting activities
- Furnish examples of PCA-related documentation, as appropriate

4.2.6.2.3 FAA System Engineering Milestones

The FAA has established a set of reviews and audits to support its system lifecycle model (see Figure 4.2-2 above). The generic use and structure of technical reviews and audits (see subsection 4.2.6.2 above) must be tailored to some extent for each review. The tailoring details are found in Appendix C along with some best practice techniques and approaches for the following:

- **Technology Readiness Assessment (TRA).** This is a multidisciplined technical review that assesses the maturity of Critical Technology Elements (CTE) being considered to address user needs and that analyzes operational capabilities and environmental constraints within the Enterprise architectural framework. If a specific technology or its application is either new or novel, then that technology is considered a CTE. The TRA is not a risk assessment but is a systematic metrics-based tool to identify and enable early attention to technology maturation events. The TRA will score each identified CTE using nine Levels of Maturity (LOM) as shown in Figure 4.2-6. Technology maturity, as defined in DOD 5000.2, is "a measure of the degree to which proposed critical technologies meet program objectives and is a principal element of program risk. A technology readiness assessment examines program concepts, technology requirements, and demonstrated technology capabilities in order to determine technological maturity." (See Appendix C for details.)

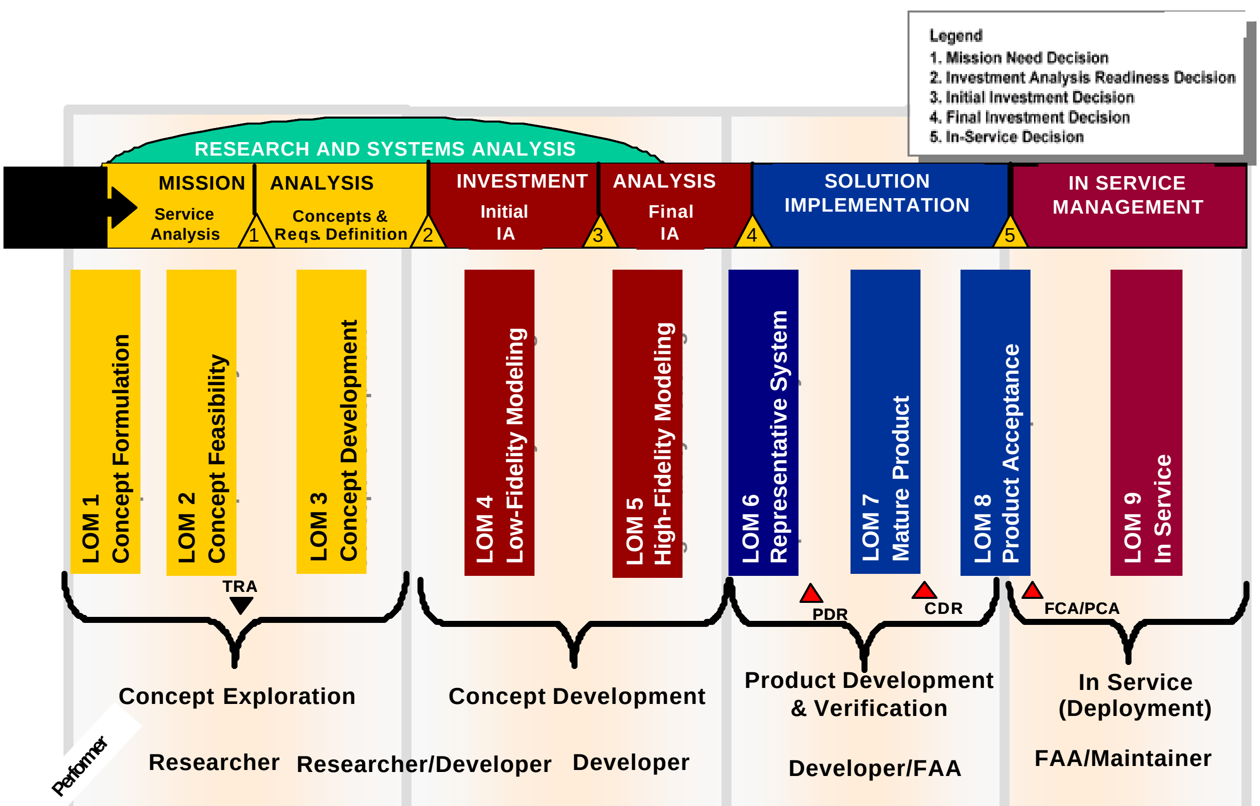

Figure 4.2-6. Technology Levels of Maturity and the System Lifecycle

- **SE Investment Analysis Review (SIAR).** The SIAR determines if the mission need capabilities shortfall can be fulfilled by candidate solutions (concepts and preliminary requirements). The candidate solutions, technical constraints, and risk definition must be sufficiently complete to support a Mission Need Decision. This checkpoint verifies that the identified needs, shortfalls, and technical constraints have been validated; that initial feasibility assessments have been accomplished; and that proposed solutions are consistent with the NAS Enterprise Architecture or required changes have been identified. The technical portion of the SIAR involves reviewing the pPR for readiness to proceed to investment analysis. The SIAR also establishes an initial set of TPPs.

- **Functional Baseline Review (FBR).** This is a formal review to ensure that requirements have been completely and properly identified and that there is a mutual understanding between the implementing organization and stakeholders. It captures functional requirements that go with the Mission Analysis and Investment Analysis phases.

- **System Requirements Review (SRR).** At the program level, this is a formal internal FAA review to ensure that the system requirements have been completely and properly identified. The SRR is generally conducted just before AMS Investment Decision (AMS Milestone 4). It validates program cost, schedule, and performance in supporting milestone approvals. The SRR establishes the Allocated baseline as the governing technical description, which is required before proceeding to the next AMS Acquisition phase.

  At the contract level, the SRR is a formal, system-level review to ensure that system requirements have been completely and properly identified and that a mutual understanding exists between the government and contractor.

- **Preliminary Design Review (PDR).** This formal review confirms the preliminary design logically follows the contract level SRR findings and meets the requirements. It normally results in approval to begin detailed design and is often seen by many external organizations as the last viable point for effective technology insertion before the start of detail design.

- **Critical Design Review (CDR).** This formal review evaluates the completeness of the design, its interfaces, and suitability to start initial manufacturing.

- **Verification Readiness Review (VRR).** This is a formal review of the contractors' readiness to begin verification (including testing) on both hardware and software configuration items.

- **Functional Configuration Audit (FCA).** This formal review verifies that the system and all subsystems can perform all required design functions in accordance with their functional and allocated configuration baselines.

- **Physical Configuration Audit (PCA).** This formal audit establishes the product baseline as reflected in an early production configuration item.

- **In Service Performance Review (ISPR).** This is a formal technical review to characterize In-Service technical and operational health of the deployed system by providing an assessment of risk, readiness, technical status, and trends in a measurable form that will substantiate In Service support and budget priorities.

Each SE control gate or milestone fits within the AMS framework and supports various investment decisions as shown in Table 4.2-4. The table addresses the entry and exit criteria for both the SE milestones and AMS investment decision points to provide the reader visibility into the extent of overlap between the two needs.

Table 4.2-4. SE Milestones as a Function of AMS Lifecycle Phases (based on Nov 2005 AMS)

AMS Lifecycle Phase	SE Milestone Entry Criteria	SE Milestone	Purpose	Timing	SE Milestone Output (SE Products only)	Investment Decision Gate (AMS)
Mission Analysis						
(Corporate)	• Enterprise Architecture • Conops • Concerns and Issues • Technology • Market Research • Need • Corporate Strategy and Goals • Legacy System	**Technology Readiness Assessment Technology Readiness Assessment (TRA)** — a multi-disciplined technical review that assesses the maturity of Critical Technology Elements being considered to address user needs, analyzes operational capabilities and environmental constraints within the Enterprise architectural framework.	Determine extent that new and/or novel technologies may be mature enough to be considered for implementation into the NAS.		• Validated NAS Functional portion of EA • Technology opportunities • Updated Risk Assessment • Gap Analysis	
(Service level)	• Conops • Mission Need Analysis • Standards • Guidance and Tools for Service level MA				• Functional Architecture	**1 - Mission Need Decision *(new)***
(Concept and Requirements Definition)	• Preliminary Conuse • FAA Policy • Standards • Preliminary OSED • Constraints • Integrated Program Schedule	**SE Investment Analysis Review (SIAR)** — The intent of the SIAR is to determine if the mission need			• Service Level Mission Need (SLMN) • Preliminary Exhibit 300 Attachment 1 (pPR — previously the iRD) • Final	**2 - Investment Analysis Readiness Decision *(previous JRC1)***

AMS Lifecycle Phase	SE Milestone Entry Criteria	SE Milestone	Purpose	Timing	SE Milestone Output (SE Products only)	Investment Decision Gate (AMS)
	• Initial Description of Alternatives	capabilities shortfall can be fulfilled by candidate solutions (concepts and preliminary requirements). The candidate solutions, technical constraints, and risk definition is complete enough to support a Mission Need Decision.			Description of Alternatives • Lifecycle Cost Estimate • OSED • CONUSE	
Investment Analysis						
(Initial)	• Preliminary Exhibit 300 Attachment 1 (pRD — previously the iRD) • Constraints • FAA Policy • Standards • IMS • Investment risks	**Functional Baseline Review (FBR)** — A formal review to ensure that requirements have been completely and properly identified and that there is a mutual understanding between the implementing organization and stakeholders. It captures functional requirements that go with the Mission Analysis and Investment Analysis phases.	It validates program cost, schedule, and performance to support Milestone approvals. It establishes the Functional baseline as the governing technical description which is required before proceeding to the next AMS phase or Decision gate.	It is generally conducted just prior to the Initial Investment Decision (AMS Investment Milestone 3).	• Final Requirements Set - Exhibit 300 Attachment 1 (previously the fRD) • Program WBS • Program SOW • Final SEMP	**3 - Initial Investment Decision *(previous JRC-2A)***
(Final)	• fPR • Architecture Impacts • Risks • IMS	*(Program level)* **System Requirements Review (SRR)** — A	Assesses the technical readiness to begin Solution	Precedes and supports AMS Milestone	• System Specification • Risks for recommended alternative	**4 - Final Investment Decision *(previous***

AMS Lifecycle Phase	SE Milestone Entry Criteria	SE Milestone	Purpose	Timing	SE Milestone Output (SE Products only)	Investment Decision Gate (AMS)
	• LCE cost estimate of each alternative • Draft Interface documents	formal internal FAA review ensure that the system requirements have been completely and properly identified. It is generally conducted just prior to AMS Investment Milestone 4. It validates program cost, schedule, and performance for the purpose of supporting milestone approvals. It establishes the Allocated baseline as the governing technical description which is required before proceeding to the next AMS phase.	Implementation.	4. A second SRR is conducted after AMS Milestone 4 and contract award to assess contractor's readiness to begin development.	• LCE cost estimate for recommended alternative • Draft ISR Checklist • Interface documents • (Contractor) SOW	***JRC-2B)***
Solution Implementation						
	• System specification • SOW • Contract WBS	*(Contract level)* **System Requirements Review (SRR) —**- A formal, system-level review conducted to ensure that system requirements have been completely and properly identified and that a mutual understanding	Assesses the Contractor's readiness to begin development.	After contract award and prior to functional allocation activities begin	• Agreement on system specification	

AMS Lifecycle Phase	SE Milestone Entry Criteria	SE Milestone	Purpose	Timing	SE Milestone Output (SE Products only)	Investment Decision Gate (AMS)
		between the government and contractor exists.				
(Preliminary design)	• Completed allocated baseline as documented in design specifications for each hardware and software configuration item.	**Preliminary Design Review (PDR)** — A formal review that confirms the preliminary design logically follows the SFR findings and meets requirements. It normally results in approval to begin detailed design.	Assesses the preliminary design against the Allocated baseline and readiness to begin detailed design.	At completion of functional allocation activities and prior to beginning detailed design	• (Approval to begin detail design) • Risks • RFA	
(Detail design)	• Completed design package for each hardware and software configuration item.	**Critical Design Review (CDR)** — A formal review conducted to evaluate the completeness of the design, its interfaces, and suitability to start initial manufacturing.	Assesses the preliminary system product design package against the Allocated baseline.	At completion of CI detail design activities and prior to fabrication of hardware and coding of final software modules (the "90%" design point)	• (Approval to begin fabrication) • Risks • RFA	
(Verification)	• System definition is under formal configuration control • All verification plans approved • Draft verification procedures	**Verification Readiness Review (VRR)** — A formal review of contractors' readiness to begin verification (including testing) on both hardware and	Assesses the readiness to begin product technical evaluation.	At completion of system fabrication and prior to initiation of formal verification activities	• (Approval to begin formal verification) • Risks • Detailed verification procedures	

AMS Lifecycle Phase	SE Milestone Entry Criteria	SE Milestone	Purpose	Timing	SE Milestone Output (SE Products only)	Investment Decision Gate (AMS)
	available • Verification assets/resources identified and available.	software configuration items.				
	• Verification program complete • Reports approved • Verification article configuration compliance to design package established	**Functional Configuration Audit (FCA)** — A formal review to verify that the system and all subsystems can perform all of their required design functions in accordance with their functional and allocated configuration baselines.	Assesses the as-built system's functional compliance with the product baseline & supports completion of PCA.	At completion of qualification and integration testing and prior to delivery of first production article.	• Configuration reconciliation list • Gap of required versus verified performance	
	• Technical data package complete • Quality control results available • Manufacturing and quality control plans complete • FCA complete • Configuration differences between FCA and PCA units reconciled	**Physical Configuration Audit (PCA)** —A formal audit that establishes the product baseline as reflected in an early production configuration item.	Assesses the as-delivered system's compliance with the product baseline. Supports the AMS Milestone 5 (In Service Decision). Establishes CM control transfer from Implementor to Owner.	After delivery of initial production unit and prior to CAI	• Baselined hardware/software configuration • Operator and user manuals	**5 - In-Service Decision *(same)***
In-Service Management						
		In Service Performance Review (ISPR) — A				

AMS Lifecycle Phase	SE Milestone Entry Criteria	SE Milestone	Purpose	Timing	SE Milestone Output (SE Products only)	Investment Decision Gate (AMS)
		formal technical review to characterize In Service technical and operational health of the deployed system by providing an assessment of risk, readiness, technical status, and trends in a measurable form that will substantiate In-Service support and budget priorities.				

4.2.7 Integrated Technical Planning Metrics

The primary integrated planning metric is publication and approval of the SEMP, supporting technical plans, and the ISAP at each AMS milestone.

4.2.8 Integrated Technical Planning Tools

Integrated Technical Planning requires plan templates, word processing, display, and scheduling tools. Specific projects may tailor the template(s) to provide information pertaining to specific deliverables, tasks, and tools.

4.2.9 References

1. Kevin Forsberg, Hal Mooz, and Howard Cotterman. *Visualizing Project Management: Models and Frameworks for Mastering Complex Systems*. 3rd edition (hardcover). New York, NY: John Wiley & Sons, September 1, 2005.

2. *Practice Standard for Work Breakdown Structures*. Project Management Institute, Inc., Four Campus Boulevard, Newtown Square, PA, 10973, 2001.

3. Pritchard, Carl. *How to Build a Work Breakdown Structure.* The Cornerstone of Project Management. ESI International, 4301 Fairfax Drive, Arlington, VA 22203, 1998.