Subject: Systems Engineering Process Requirements

Responsible Office: Code D / Office of the Chief Engineer

CHANGE LOG

Status [Baseline /Revision /Cancelled]	Document Revision	Date of Change	Description
Baseline	0	7/9/2009	Systems Engineering Process Requirements Implementation
Revision	1	8/20/2009	Minor changes (addition) to the delineation of responsibilities of Project Line Management
Revision	2	11/1/2010	Update document to reflect that ATAAC no longer exist and duties assumed by Chief Engineer Office (ACE)
Revision	3	4/2/2012	Significant update to reflect Agency philosophy of giving more latitude to projects regarding how best to implement systems engineering requirements.
Revision	4	3/13/2018	Updated to the new APR template. Updates to the Applicable Documents, Measurement/Verification, Roles and Responsibilities, and References sections.
Revision	5	11/9/2021	Revalidated with administrative changes: updated the term "Dissenting Opinion" to "Formal Dissent;" deleted Center Director responsibility that duplicates APR 1120.2; other minor administrative changes were made to improve the readability of the document.

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PREFACE

P.1 PURPOSE

a.   The purpose of this document is to ensure the requirements of NPR 7123.1, NASA Systems Engineering Processes and Requirements, are implemented in a manner most appropriate for the Ames Research Center and are to be used in conjunction with ARC Systems Engineering (SE) Best Practices. This document establishes the SE roles and responsibilities of each stakeholder involved in the SE process area. The SE Best Practices contained in CPD 7123.2 describe the SE processes and methods that are to be implemented by each project or activity.

P.2 APPLICABILITY

a.   This directive is applicable to ARC and associated facilities (e.g., contractor's facilities) for airborne and space flight systems (both flight and ground segments) including spacecraft, instruments, payloads, technology matured to readiness levels for end-use in systems, mission critical software systems, and new and/or changes to human rated and high energy ground facilities.

b.   This directive applies to contractors, grant recipients, or parties to agreements only to the extent specified or referenced in the appropriate contracts, grants, or agreements.

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

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

P.3 AUTHORITY

a.   NPR 7120.5, NASA Space Flight Program and Project Management Requirements

b.   NPR 7123.1, NASA Systems Engineering Processes and Requirements

P.4 APPLICABLE DOCUMENTS AND FORMS

a.   APR 1000.1, Formal Dissent Process

b.   APR 1120.2, Ames Engineering Technical Authority

c.   APR 7120.5, Project Management for Space Flight Systems

d.   APR 7120.51, Program/Project Reviews for Space Flight

e.   APR 8735.2, Deviation/Waiver Process

f.   CPD 7123.2, ARC Systems Engineering Best Practices

P.5 MEASUREMENT/VERIFICATION

a.   Verification of conformance to requirements in this directive are measured through Center and Responsible Organizational management reviews, self-assessments, and subsequent analysis and reports of conformance to requirements, as well as periodic internal audits.

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P.6 CANCELLATION

a.   APR 7123.1, Systems Engineering Process Requiremenets, dated April 2, 2012.

Eugene Tu
Director

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Internal and external distribution.

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CHAPTER 1   ROLES AND RESPONSIBILITIES

1.1 Ames Chief Engineer

1.1.1   The Ames Chief Engineer is the Designated Governing Authority (DGA) for all technical efforts associated with this APR and NPR 7123.1. The Ames Chief Engineer shall:

a.   Provide the final approval signature for System Engineering Management Plans (SEMPs) and waivers of technical requirements.

b.   Provide independent evaluation of technical content and engineering approaches, including ARC Systems Engineering Best Practices, being used on a project/activity/task to ensure compliance with this APR and NPR 7123.1.

c.   Conduct various Center assessments and Program/Project reviews, per APR 7120.51, to ensure that this APR is being followed and identify any appropriate modifications or process improvements.

d.   Approve all TA funded Project Systems Engineer (PSE) appointments made by Line Management to ensure all PSEs are capable of implementing their required TA responsibilities (per APR 1120.2).

1.2 Line Management

1.2.1   Line Management has the responsibility to ensure that an appropriately trained, experienced, equipped, and supported workforce is available to support the Center's systems engineering requirements. Line Management shall:

a.   Ensure ARC SE Best Practices are implemented in order to address each of the 17 Common Technical Practices (CTPs) required by NPR 7123.1 and in accordance with appropriate ARC SE Best Practices.

b.   Conduct periodic assessments of the SE Best Practices to implement process improvements.

c.   Communicate the required SE resources for the scope of work to the Program/Project Management.

d.   Review and concur by signing the SEMP.

e.   Provide a forum for conflict resolution when technical requirements may conflict with administrative or project management (cost and schedule) constraints.

f.   Appoint PSEs that have been ACE approved and who are capable of fulfilling both their line organization and TA responsibilities; and provide other systems engineering staff as required.

1.3 Program/Project Management

1.3.1   Program/Project Management is responsible for implementing the program/project in accordance with all applicable requirements including this APR and is accountable for program/project success. The Project Manager shall:

a.   Work with Line Management to ensure the appropriate resources are available to develop and implement the Project SEMP.

b.   Obtain approval of the ARC Chief Engineer of the Project SEMP prepared in accordance with NPR 7123.1 and APR 7123.1.

c.   Ensure the project complies with the technical processes and requirements of the NPR 7123.1 and APR 7123.1 as documented in the Project specific SEMP.

1.4 Project Systems Engineer

1.4.1   The PSE is responsible for the identification and implementation of the system engineering activites across all organizations within the project. The PSE shall:

a.   Be the Engineering Technical Authority for the program/project (as delegated by the Ames Chief Engineer per APR 1120.2) and serve as the primary point of contact for the engineering technical authority process within the project.

b.   Select the technical approach, processes and methods, that the project will use to implement the 17 CTPs required by NPR 7123.1 in accordance with the appropriate ARC SE Best Practices.

c.   Develop the SEMP per the requirements of NPR 7123.1, APR 7123.1, NPR 7120.5, and APR 7120.5 and ensure it documents how each of the 17 CTPs will be implemented and provide rationale for any deviations from the chosen ARC SE Best Practices. A draft SEMP is due at the Systems Requirements Review (SRR) and the baseline is due at the Preliminary Design Review (PDR). Subsequent to the PDR, projects document the need for additional non-compliance items at major independent milestone reviews. The SEMP is a living document. The initial SEMP is used to establish the technical content of the engineering work early in the Formulation phase and updated as needed throughout the project life-cycle phase.

d.   Ensure that members of their technical team are aware of and comply with the requirements of this APR and the project's SEMP.

e.   Facilitate the resolution of technical issues within the project and where appropriate invoke the formal dissent process as described in APR 1000.1.

f.   Support the Chief Safety Officer (CSO) to ensure product safety and quality assurance during the entire product life cycle.

g.   Resolve issues related to systems engineering policy/approach/method with the Ames Chief Engineer and the appropriate technical Directorate.

h.   Report to and as required to the Ames Chief Engineer and the appropriate technical Directorate per APR 1120.2.

1.5 Technical Team

The members of the project's technical team, including the Lead Discipline Engineers (LDE), shall adhere to the scope, guidelines, requirements, activities, and ARC SE processes established in the project specific SEMP and Project Plan.

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CHAPTER 2   SEMP DEVELOPMENT AND IMPLEMENTATION PROCESS

The SEMP reflects how all the SE related activities are to be specifically implemented by each project and is the most significant tool used in the SE process area.   Figure 1 depicts the process used to develop and implement the SEMP.
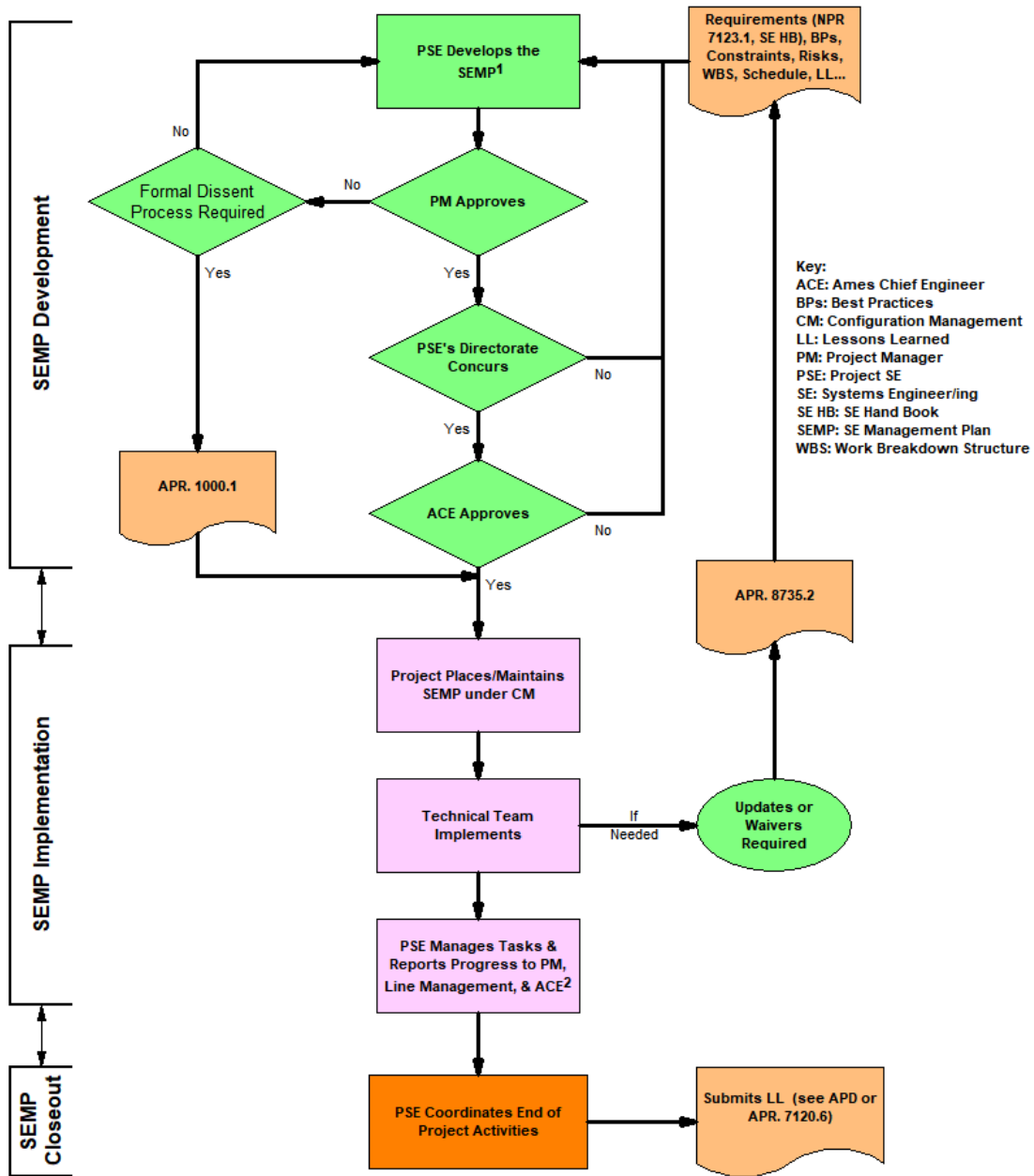
1. Describe how the 17 common technical process will be implemented and provide rationale for any deviations from the chosen set of Directorate approved BPs.

2. The reporting requirements, outside that of a major review (APR. 7120.51), are negotiated with Program/project and line management, and the ACE (APR. 1150.2).

3. Note: Line Management and the ACE are part of the Formal Dissent process.

Figure 1. SEMP Development and Implementation Process

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CHAPTER 3   WAIVERS

All waivers of this APR shall be processed in accordance with APR 8735.2, Deviation/Waiver Process.

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APPENDIX A. DEFINITIONS

Designated Governing Authority	The Center Director or the person that has been designated by the Center Director to ensure the appropriate level of technical management oversight. For large program/projects, this will usually be the identified Engineering Technial Authority. For small activities/projects, the DGA may be delegated to a line manager or other appropriate technical expert.
Process	A set of activities used to convert inputs into desired outputs to generate expected outcomes and satisfy a purpose.
Program	A strategic investment by a NASA Mission Directorate (or mission support office) that has defined goals, objectives, architecture, funding level, and a management structure that supports one or more projects.
Project	A specific investment having a beginning, goals, objectives, requirements, life-cycle cost, a beginning, and an end. A project yields new or revised products or services that directly address NASA's strategic needs. They may be performed wholly in-house; by Government, industry, or academia partnerships; or through contracts with private industry.
Requirement	The agreed upon need, desire, want, capability, or demand for personnel, equipment, facilities, or other resources or services by specified quantities for specific periods of time or at a specific time expressed as a "shall" statement. Acceptable form for a requirements statement is individually clear, correct, feasible to obtain, unambiguous in meaning, and can be validated at the level of the system structure at which stated. In pairs of requirement statements or as a set, collectively, they are not redundant, are adequately related with respect to terms used, and are not in conflict with one another.
Stakeholder	A group or individual who is affected by or has an interest or stake in a program or project. There are two main classes of stakeholders, "customers" and "other interested parties".
System	The combination of elements that function together to produce a capability to meet a need. The elements include all hardware, software, equipment, facilities, personnel, processes, and procedures needed for this purpose.
Tailoring	The process used to seek relief from SE NPR requirements consistent with program or project objectives, allowable risk, and constraints.
Waiver	A documented authorization releasing a program or project from meeting a requirement after the requirement is put under configuration control at the level the requirement will be implemented.

APPENDIX B. ACRONYMS

ACE	Ames Chief Engineer
APR	Ames Procedural Requirements
ARC	Ames Research Center
CM	Configuration Management
CSO	Chief Safety Officer
CTP	Common Technical Practices
DGA	Designated Governing Authority
LDE	Lead Discipline Engineer
LL	Lessons Learned
NESC	NASA Engineering and Safety Center
NPR	NASA Procedural Requirements
PDR	Preliminary Design Review
PSE	Project Systems Engineer
SE	Systems Engineering
SE HB	Systems Engineering Handbook
SEMP	Systems Engineering Management Plan
SRR	Systems Requirements Review
TA	Technical Authority
WBS	Work Breakdown Structure

APPENDIX C. REFERENCES

C.1   NPR 7150.2, NASA Software Engineering Requirements

C.2   APD 7120.6, Ames Research Center Knowledge Management Policy

C.3   APR 7150.2, Ames Software Engineering Requirements

C.4   NASA SP-2016-6105, NASA Systems Engineering Handbook

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