NOAA/NESDIS

NESDIS-PR-1300.1

SYSTEMS ENGINEERING

PROCEDURAL REQUIREMENTS

July 2017

COMPLIANCE IS MANDATORY

Prepared by:
U.S. Department of Commerce
National Oceanic and Atmospheric Administration (NOAA)
National Environmental Satellite, Data, and Information Service (NESDIS)

THIS PAGE INTENTIONALLY BLANK

Approval Page

Document Number: **NESDIS-PR-1300.1**	
Document Title Block: **NESDIS SYSTEMS ENGINEERING PROCEDURAL REQUIREMENTS**	
Process Owner: Mark Mulholland	**Document Release Date:** July 30, 2017

Prepared by:

Mark Mulholland
Office of System Architecture and Advanced Planning

24 July 2017
Date

Approved by:

Karen St. Germain
Office of System Architecture and Advanced Planning

31 Aug 2017
Date

Document Change Record

VERSION	DATE	CCR #	SECTIONS AFFECTED	DESCRIPTION
1.0	July 31, 2017		All	Initial version

Contents

PREFACE

P.1 PURPOSE

The purpose of this PR is to establish common requirements for performing Systems Engineering (SE) across NESDIS projects of varying scope and size. SE is defined as a methodical, multi-disciplinary approach for the design, realization, technical management, operations, and retirement of a system. A system is the combination of elements that function together to produce the capability required to meet a need. The elements include all hardware, software, equipment, facilities, personnel, processes, and procedures needed for this purpose. Implementation of a disciplined SE approach will help enhance NESDIS core SE capabilities. This document:

a. establishes a common SE life cycle
b. describes the SE technical management processes required in the life cycle of a project
c. provides procedural requirements for a project's Systems Engineering Plan (SEP).

P.2 APPLICABILITY

a. This NESDIS Procedural Requirement (PR) applies to all NESDIS Offices (as defined in Appendix A). This PR applies to NESDIS employees and NESDIS support contractors that use NESDIS processes to augment and support NESDIS technical work. This PR applies to other contractors, grant recipients, or parties to agreements only to the extent specified or referenced in the appropriate contracts, grants, or agreements.

b. The requirements enumerated in this document are applicable to all projects (as defined in Appendix A). For existing projects, the Director of the Office of Systems Architecture and Advanced Planning (OSAAP) may grant requests for variance allowing continuation of current practices that do not comply with this PR.

c. NOAA collaborates with many domestic and international partners to fulfill its mission. With OSAAP's concurrence and mutual agreement, NESDIS Offices may tailor the requirements of this PR or follow the partner's SE approach.

d. In this PR, all mandatory actions (i.e. requirements) are identified by the symbol "[REQ]" to unambiguously define all requirements. They are also captured in the Requirements Matrix in Appendix C. The Requirements Matrix takes precedence if there are any discrepancies between the narrative and the Matrix with respect to identifying requirements. The terms "shall" and "must" are not used to specify mandatory actions because they can be interpreted as legally-binding terminology, which removes all agency discretion and can create a potential liability problem for NOAA/NESDIS.

P.3 AUTHORITY

NESDIS-PD-1110.1, NESDIS Systems Engineering and Program Management Policy.

P.4 APPLICABLE DOCUMENTS

1. DAO 208-16, Acquisition Project Management, Effective Date: 2015-05-26
2. DOC Scalable Acquisition Project Management Guidebook, July 2, 2012, Version 1.0
3. NAO 205-1, NOAA Records Management Program.
4. NESDIS-PD-1110.1, NESDIS Systems Engineering and Program Management Policy.
5. NASA Systems Engineering Handbook, Rev 1, NASA/SP-2016-6105 REV 2, February 2017.
6. INCOSE Systems Engineering Handbook, INCOSE-TP-2003-002-04 2015.

Chapter 1. Introduction

a. Systems engineering at NESDIS requires the application of a systematic, disciplined engineering approach throughout the life cycle of a project. The emphasis of systems engineering is on achieving – within the schedule, cost, and quality constraints – the stakeholder functional, physical, and operational performance requirements in the intended use environments, and over the system's planned lifetime.

b. This PR establishes a common life cycle model and provides common SE technical management processes for NESDIS systems engineering activities.

c. The requirements established in this PR may be tailored using the guidelines provided in Chapter 3.

d. Figures within this PR are intended to be notional, not prescriptive.

e. Hierarchy of Related Documents: This PR focuses on systems engineering procedural requirements. It flows down from NESDIS-PD-1110.1, NESDIS Systems Engineering and Program/Project Management Policy, as shown in Figure 1-1.

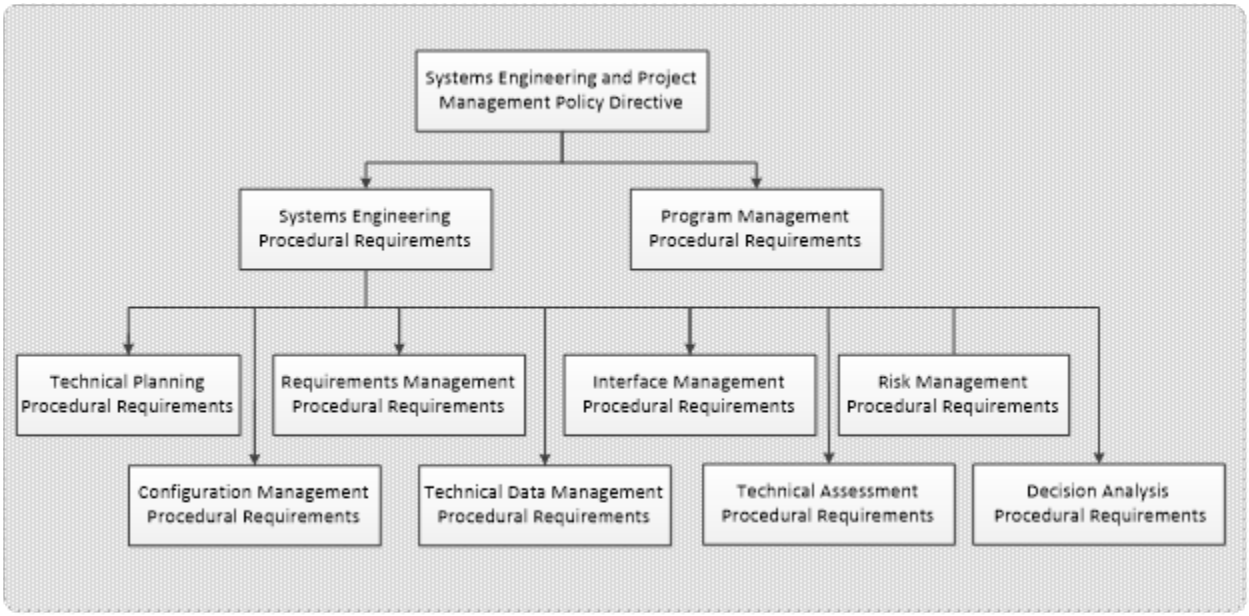

Figure 1-1: Hierarchy of Related Documents

Chapter 2. Roles and Responsibilities

2.1 General

The roles and responsibilities of senior management are defined in NESDIS-PD-1110.1, NESDIS Systems Engineering and Program/Project Management Policy.

2.2 Office of System Architecture and Advanced Planning

a. [REQ] OSAAP ensures compliance with this PR.

b. [REQ] OSAAP ensures compatibility of systems engineering policies across NESDIS.

2.3 NESDIS Office Directors

a. [REQ] NESDIS Office Directors are responsible and accountable for the planning and execution of projects assigned to their Office.
b. [REQ] NESDIS Office Directors establish policies, processes, and procedures to execute the requirements of this PR.
c. [REQ] NESDIS Office Directors assess and take corrective actions to improve the execution of the requirements of this PR.

Chapter 3. Systems Engineering Procedural Requirements

3.1 Systems Lifecycle

a. A system life cycle is the evolution of a system from concept through retirement. A system progresses through its life cycle as a result of actions, performed and managed by people in organizations, using processes for execution of these actions. System life cycles vary according to the nature, purpose, use, and prevailing circumstances of the system.

b. The system life cycle phases represent the major life cycle periods of a system and describe the major progress and achievement milestones of the system through its life cycle. The transition from one phase to the next give rise to primary decision gates, also called milestones or Key Decision Points (KDPs). The decision gates provide an opportunity for the management team to conduct a review of project's preparedness to move to the next phase. A specific set of entrance and exit criteria are established for each phase. Figure 3-1 shows a generic NESDIS System Life Cycle.

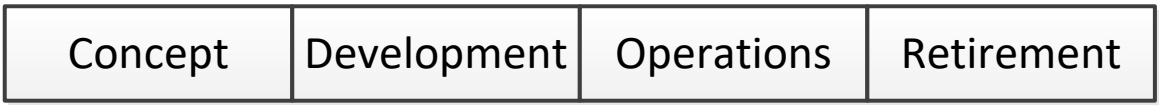

Figure 3-1: Generic NESDIS System Life Cycle
(Basis: INCOSE Systems Engineering Handbook, 4th Edition)

c. The details within this generic life cycle depend upon the project and the policies that govern the project. The DOC scalable Acquisition Project Management Guidebook specifies the guidelines to implement the Scalable Acquisition Project Management Framework (Figure 3-2). The framework prescribes a disciplined, repeatable, and comprehensive acquisition management process. The framework depicts the life cycle phases of a project from the initial concept to its operational use and final disposal, minimum standard of processes and reviews, and the project milestones where formal reviews will be performed. The term "scalable" refers to the flexibility of the Framework processes and documentation to be tailored to suit a project's profile (size, complexity, and risk). All projects using a linear (or Waterfall) development model adhere to the Framework's concepts but tailor the documentation and reporting according to the project profile.

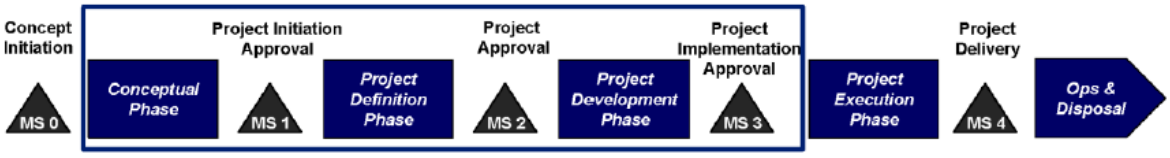

Figure 3-2: DOC Scalable Acquisition project Management Framework

d. Some NESDIS projects may benefit by using Agile methods.

e. In some instances, a combination of the two approaches may be necessary.

f. Life Cycle Requirements

(1) [REQ] All projects within NESDIS will use one of the following development methodologies: Waterfall, Agile, or a combination of the two.

(2) [REQ] All projects will establish entrance and exit criteria for each life cycle phase.
(3) [REQ] All projects conduct technical life cycle reviews and milestone reviews.
(4) [REQ] All documents, data, and results are maintained and dispositioned as Federal records in accordance with the Directive NAO 205-1, NOAA Records Management Program.

3.2 Systems Engineering Processes

a. SE processes include Technical Management Processes (discussed in this PR) and Technical Processes (discussed in lower level PRs).

b. For NESDIS, the Technical Management Processes are:

(1) **Technical Planning** - establishes a plan for applying and managing each of the common technical processes that will be used to drive the development of the system. This process also establishes a plan for identifying and defining the technical effort required to satisfy the project objectives and life-cycle phase exit criteria within the cost, schedule, and risk constraints of the project.
(2) **Requirements Management** – the elicitation, specification, documentation, verification, and validation of requirements at multiple levels of the system, which comprehensively define what the system shall do.
(3) **Interface Management** - the specification and design of information flows between connected (sub)systems, and between systems and Users.
(4) **Risk Management** - the identification of major risks to a project or system, and ongoing efforts to retire or otherwise mitigate the risks.
(5) **Configuration Management** - a comprehensive process for maintaining consistency of a product's performance, functional, and physical attributes with its requirements, design, and operational information.
(6) **Technical Data Management** - the plan to handle the engineering products and information generated during the system lifecycle, for example engineering parameter budgets, automated test scripts, software tools, simulations and prototypes. Not to be confused with the "science data" generated by a system.
(7) **Technical Assessment** - the cross-cutting process used to help monitor technical progress of a program/project through technical reviews. It also provides status information to support assessing system design, product realization, and technical management decisions.
(8) **Decision Analysis** - the formal process by which key design choices are objectively evaluated against clear and consistent criteria. Decision analysis offers techniques for modeling decision problems mathematically and finding optimal decisions numerically.

c. Each of these processes will be detailed in the lower level PRs.

3.3 Systems Engineering Plan (SEP)

a. The purpose of the SEP is to help guide all technical aspects of the project, and provide an engineering management structure to ensure system level end-to-end compliance. The SEP is used to establish the plan, processes and procedures governing the engineering and technical work. It is a tailorable document that captures a project's current and evolving systems engineering strategy, and its relationship with the overall project management effort throughout the life cycle of the system. It is first released early in the life cycle and updated as needed throughout the life cycle.
b. The primary function of the SEP is to provide the basis for implementing the technical effort and communicating what will be done and by whom, when, where, how, and why it is being done. In

addition, the SEP identifies cost drivers, and the roles and responsibility interfaces of the technical effort and how those interfaces will be managed.

c. The SEP provides the specifics of the technical effort and describes what technical processes will be used, how the processes will be applied using appropriate activities, how the project will be organized to accomplish the activities, and the resources required for accomplishing the activities. The process activities are driven by the critical events during any phase of a life cycle (including operations) that set the objectives and work product outputs of the processes and how the processes are integrated.
d. The SEP provides the communication bridge between the project management team and the technical implementation teams. It also facilitates effective communication within the technical teams. The SEP provides the framework to realize the appropriate work products that meet the entry and exit criteria of the applicable project life-cycle phases. The SEP also provides the Project Management team with necessary information for assessing technical progress.
e. SEP Requirements:
   (1) [REQ] All NESDIS projects are required to document their SE approach in a SEP and present it for approval by the project's Milestone Decision Authority (MDA).
   (2) [REQ] All SEPs should demonstrate how the project implements the SE Technical Management Processes described in Section 3.2.
   (3) [REQ] The preliminary SEP is established early in the Concept phase.
   (4) [REQ] The SEP is approved and baselined prior to entering the Development phase.
   (5) [REQ] As significant changes occur, the SEP is updated, reviewed, and reapproved.

3.4 Tailoring Guidelines

a. Tailoring is the process used to seek relief from the requirements of this PR.
b. The tailoring process should occur at the beginning of a project, but may occur at any time in the project's life cycle. It results in changes to the implementation of requirements depending on the timing of the request. Tailoring of the requirements in this PR will be submitted to OSAAP.
c. The results of tailoring the PR requirements will be documented in the Requirements Matrix in Appendix C.
d. The results of the tailoring of SE requirements will be documented in the next revision of the SEP, along with supporting rationale and documented approvals from the requirement owner.
e. The project's MDA will have responsibility to approve or disapprove any requirement that is tailored.
f. Tailoring requirements:
   (1) [REQ] Requests for variance are submitted through the configuration management process.
   (2) [REQ] The results of tailoring are documented in the Requirements Matrix and submitted to the MDA for approval.

Appendix A: Glossary

Baseline: An agreed-to set of requirements, designs, or documents that will have changes controlled through a formal approval and monitoring process.

Entrance Criteria: Guidance for minimum accomplishments each project needs to fulfill prior to a life-cycle review.

Exit Criteria: Specific accomplishments that must be satisfactorily demonstrated to meet the objectives of a life-cycle and technical review so that a technical effort can progress further in the life cycle. Exit criteria are documented in the corresponding technical review plan.

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

Milestone Decision Authority (MDA): The individual authorized by NESDIS to make important decisions for programs and projects under their authority.

NESDIS Office(s): A term used in the widest sense to include NESDIS Headquarters elements, NESDIS Operations and Acquisitions offices, the Center for Satellite Applications and Research (STAR), and the National Centers for Environmental Information (NCEI).

Process: A set of activities used to convert inputs into desired outputs to generate expected outcomes and satisfy a purpose.

Product: A part of a system that performs operational functions; part of a system that performs life-cycle services; result of the technical efforts (e.g., plan, baseline, or test result).

Product: Derived data from the raw instrument measurements in a specific output format. Products may be classified as Level 0, Level 1, and Level 2+ depending on their degree of processing.

Program: A strategic investment by a 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 defined goals, objectives, requirements, life-cycle cost, a beginning, and an end. A project yields new or revised products or services that directly address NESDIS' strategic needs. They may be performed wholly in-house; by Government, industry, or academia partnerships; or through contracts with private industry. In this document, readers should treat the term project in the widest sense, to include projects, programs, portfolios, and major initiatives.

Requirement: A statement of a function to be performed, a performance level to be achieved, or an interface to be met..

Risk: In the context of mission execution, the potential for performance shortfalls, which may be realized in the future, with respect to achieving explicitly established and stated performance requirements. The performance shortfalls may be related to any one or more of the following mission execution domains: (1) safety, (2) technical, (3) cost, and (4) schedule.

Stakeholder: A group or individual who is affected by or has an interest in a project.

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

Systems Engineering: A methodical, multi-disciplinary approach for the design, realization, technical management, operations, and retirement of a system.

Systems Engineering Plan (SEP): The SEP identifies the roles and responsibility interfaces of the technical effort and how those interfaces will be managed. The SEP is the vehicle that documents and communicates the technical approach, including the application of the common technical processes; resources to be used; and key technical tasks, activities, and events along with their metrics and exit criteria.

Tailoring: The process used to seek relief from the PR requirements consistent with program or project objectives, allowable risk, and constraints.

Technical Team: A multidisciplinary group of individuals with appropriate domain knowledge, experience, competencies, and skills assigned to a specific technical task.

Variance: A departure from approved product definition information, for a limited amount of time or for a specified effectivity, that does not require revision of approved product definition information.

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

DAO	Department Administrative Order
DOC	Department of Commerce
INCOSE	International Council on Systems Engineering
KDP	Key Decision Point
MDA	Milestone Decision Authority
NASA	National Aeronautics and Space Administration
NCEI	National Centers for Environmental Information
NESDIS	National Environmental Satellite, Data, and Information Service
NOAA	National Oceanic and Atmospheric Administration
OSAAP	Office of System Architecture and Advanced Planning
PD	Policy Directive
PR	Procedural Requirements
SE	Systems Engineering
SEP	Systems Engineering Plan
STAR	Satellite Applications and Research

Appendix C: Requirements Matrix

2.2.a	OSAAP ensures compliance with this PR.
2.2.b	OSAAP ensures compatibility of systems engineering policies across NESDIS.
2.3.a	NESDIS Office Directors are responsible and accountable for the proper planning and execution of projects assigned to their Office.
2.3.b	NESDIS Office Directors establish policies, procedures, and processes to execute the requirements of this PR.
2.3c	NESDIS Office Directors assess and take corrective actions to improve the execution of the requirements of this PR.
3.1.f.1	All projects within NESDIS will use one of the following development methodologies: Waterfall, Agile, or a combination of the two.
3.1.f.2	All projects will establish entrance and exit criteria for each life cycle phase.
3.1.f.3	All projects conduct technical life cycle reviews and milestone reviews.
3.1.f.4	All documents, data, and results are maintained and dispositioned as Federal records.
3.3.e.1	All NESDIS projects are required to document their SE approach in the SEP and present it for approval by the MDA.
3.3.e.2	All SEPs should demonstrate how the project implements the SE Technical Management Processes described in Section 3.2.
3.3.e.3	The preliminary SEP is established early in the Concept phase.
3.3.e.4	The SEP is approved and baselined prior to entering the Development phase.
3.3.e.5	As significant changes occur, the SEP is updated, reviewed, and reapproved.
3.4.f.1	Requests for variance are submitted through the configuration management process.
3.4.f.2	The results of tailoring are documented in the Requirements Matrix and submitted to the MDA for approval.

Appendix D: References

1. NASA Systems Engineering Processes and Requirements, NPR 7123.1B, April 18, 2013.
2. NASA Space Flight Program and Project Management Requirements, NPR 7120.5E, August 14, 2012.

THIS PAGE INTENTIONALLY BLANK