ARMSTRONG FLIGHT PROCEDURAL REQUIREMENTS (AFPR)

Directive: **AFPR-7123.1-001F-4**
Effective Date: **August 1, 2018**
Expiration Date: **February 1, 2024**

Compliance is mandatory.

SUBJECT: Systems Engineering Requirements Document (with Admin Changes dated December 5, 2019)

RESPONSIBLE OFFICE: Director of Research Engineering

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PREFACE

P.1 Purpose

a. The purpose of this document is to establish the Armstrong Flight Research Center (AFRC, hereinafter referred to as Center) requirements for the implementation of systems engineering (SE) practices in accordance with NPR 7123.1. SE is a logical systems approach performed by multidisciplinary teams to engineer and integrate the Center's systems to ensure products meet customers' needs. This systems approach is applied to all elements of a system and all hierarchical levels of a system over the complete project life cycle.

P.2 Applicability

a. This document and the requirements identified within it apply to projects that have been assigned a project chief engineer. Projects and tasks that include engineering design work, but do not have a project chief engineer assigned, must comply with other applicable processes such as AFOP-7900.3-023 (Airworthiness & Flight Safety Review Process), AFOP-7900.3-021 (Aircraft Structural Modification Analysis, Review, and Documentation Requirements), and AFOP-7123.1-006 (Structural Ground Test Development and Execution. This document does not apply to projects and tasks that are undertaken strictly for research and that have no material products other than knowledge and experience.

b. Through partnerships with industry, academia, other National Aeronautics and Space Administration (NASA) Centers, and other government agencies, the Center enters into projects at various stages of their life cycles, often just prior to the operations phase. When a project chief engineer is assigned, the applicability of this document and other Center requirements will be assessed. Projects that have a project chief engineer assigned, are past Phase A (see Figure 1), and that do not have a Systems Engineering Management Plan (SEMP) or equivalent as of June 1, 2018 have until December 1, 2018 to produce the document.

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

c. NPR 1280.1, NASA Integrated Management System Policy

d. NPR 7150.2, NASA Software Engineering Requirements

P.4 Applicable Documents and Forms

AFG-7120.5-001, Project Chief Engineer's Handbook

P.5 Measurement/Verification

None.

P.6 Cancellation

AFPR-7123.1-001E-002, Systems Engineering Requirements Document - REDLINE, dated August 14, 2018.

Hard copy signed by Stephen C. Jensen for	8/28/2018
Bradley C. Flick	Date
Director, Research & Engineering Directorate	

DISTRIBUTION: Approved for release via the Document Library.

CHAPTER 1: INTRODUCTION

1.1 Project Lifecycle

1.1.1 The Center SE requirements are defined to establish a standard, disciplined engineering approach to systems development throughout the life cycle of a project. In alignment with NPR 7120.5 and NPR 7123.1, the project life cycle shown in Figure 1. has been defined for projects performed by the Center.

1.1.2 The life cycle is intended to be a standard for the Center's projects, but it is common for the Center to enter into partnerships with external entities on existing projects at various stages of their life cycles. The requirements of this document are intended to ensure consistency between all projects being conducted at the Center.

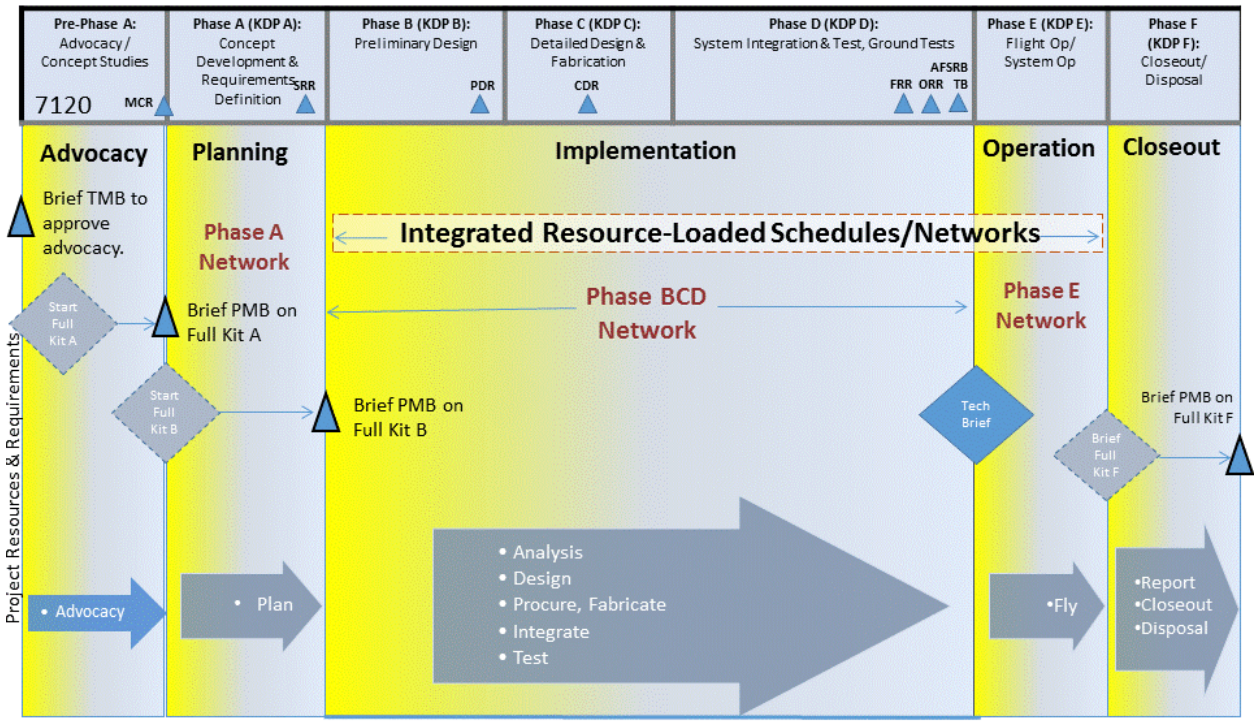

Figure 1. Armstrong Project Lifecycle

KDP – Key Decision Point
TMB – Tactical Management Board
PMB – Program Management Board
MCR – Mission Concept Review
FRR – Flight Readiness Review
AFSRB – Airworthiness and Flight Safety Review Board
TB – Tech Brief
ORR – Operational Readiness Review
SRR – Systems Requirement Review
PDR – Preliminary Design Review
CDR – Critical Design Review
SIR* – Systems Integration Review

* Not required unless specified in the Project Plan

1.2 Armstrong Flight Procedural Requirement (AFPR) Scope

This document describes the Center's implementation of the requirements in NPR 7123.1.

1.3 Complying with Agency Requirements

Center projects will meet the intent of the requirements allocated to projects by NPR 7123.1. Guidance for meeting the intent of the project-allocated requirements is contained in AFG-7120.5-001 (Project Chief Engineer's Handbook). The method of compliance for each requirement is documented in the project SEMP or equivalent.

1.4 NPR 7123.1 Requirements Allocated to the Center

The compliance matrix mandated by NPR 7123.1 requirement SE-04 is found in Appendix C. The matrix references other Center documents in which the relevant policies, procedures, and processes may be found for each NPR 7123.1 requirement allocated to the Center.

1.5 Process Improvement and Training

1.5.1 The Chief of the Systems Engineering and Integration Branch will identify improvement areas each year and document the status of improvement efforts on the branch's Sharepoint site.

1.5.2 The Chief of the Systems Engineering and Integration branch will develop a training package to Programs & Projects Directorate Branch Chiefs, Research & Engineering Directorate Branch Chiefs, the Education Office, and Center Chief Technologist to help funders and participants in engineering efforts understand their responsibilities with regard to the SE requirements.

1.6 Standards

Project chief engineers are responsible for working with the project manager and the lead operations engineer to implement design standards appropriate for each project. Among the standards that should be considered are those listed in Section P.3 as well as those design standards listed in the Standards Documents section of the On-Line Document Information Exchange (ODIE).

1.7 NPR 7123.1 Requirements Allocated to Projects

1.7.1 The project chief engineer is responsible for completing the SEMP worksheet (AFG-7120.5-001, Appendix C) or equivalent and obtaining the required signatures

before System Requirement Review (SRR) or, in the case of a project that has arrived at the Center in a later phase, at a milestone negotiated by the Director of Research & Engineering and the project chief engineer. The SEMP worksheet or equivalent, when completed, stands as the compliance and implementation agreement and the engineering review plan agreement between the project and the Director of Research & Engineering.

1.7.2 The Chief of the Systems Engineering and Integration branch will collect SEMP worksheets and equivalents in a library available on the Branch's Sharepoint site.

CHAPTER 2: RESPONSIBILITIES

Per NPR 7123.1, the Designated Governing Authority for the technical effort described in this document begins with the Center Director. From there, authority is delegated to the Director of Flight Operations or Director of Research & Engineering Directorates. Authority for issues that relate to the application of aircraft airworthiness standards for modification, operation, or maintenance of aircraft are further delegated through the Director of Flight Operations to a project's lead operations engineer. Authority for issues related to the application of technical requirements and standards, including the approval of waivers, are delegated to the project's chief engineer through the Director for Research & Engineering Directorate. See Figure 2. for a graphical representation of this process.

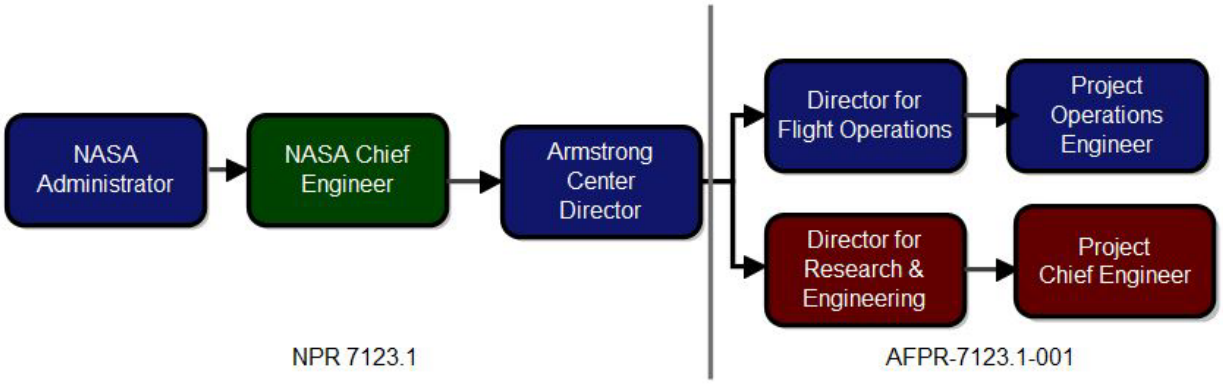

Figure 2. Flow of Technical Designated Governing Authority at Armstrong

Appendix A: Definitions

A.1 Verification. Proof by examination of objective evidence that the product complies with specifications. Verification is performed to ensure the product complies with requirements and may be determined by test, analysis, demonstration, inspection, or a combination of these.

A.2 Validation. Proof by examination of objective evidence that the product accomplishes the intended purpose. Validation is performed to ensure that the product is ready for a particular use, function, or mission, and may be determined by test, analysis, demonstration, or a combination of these.

Appendix B: Acronyms

AFSRB	Airworthiness and Flight Safety Review Board
AFG	Armstrong Flight Guide
AFOP	Armstrong Flight Operational Procedure
AFPR	Armstrong Flight Procedural Requirement
CDR	Critical Design Review
FRR	Flight Readiness Review
KDP	Key Decision Point
MCR	Mission Concept Review
NASA	National Aeronautics and Space Administration
OCE	Office of Chief Engineer
ORR	Operational Readiness Review
PDR	Preliminary Design Review
PMB	Program Management Board
SE	Systems Engineering
SEMP	Systems Engineering Management Plan
SIR	Systems Integration Review
SRR	Systems Requirement Review
TB	Tech Brief
TMB	Tactical Management Board

Appendix C: Mapping of NPR 7123.1 Common Technical Processes

C.1 The goal of this Appendix is to establish traceability of NPR 7123.1 Common Technical Process requirements with elements in this document and additional guidance information.

NPR Reqt		Comply?	Justification
SE-01	Center Directors shall perform the following activities: establish policies, procedures, and processes to execute the requirements of this SE NPR	Yes	This document describes the policies, procedures and processes to execute the requirements for the SE NPR.
SE-02	Center Directors shall perform the following activities: assess and take corrective actions to improve the execution of the requirements of this SE NPR.	Yes	See Section 1.5 of this document
SE-03	Center Directors shall perform the following activities: select appropriate standards applicable to projects under their control.		See Section 1.6 of this document.
SE-04	Center Directors shall perform the following activities: Complete the compliance matrix, as tailored, in Appendix H.1 for those requirements owned by the Office of Chief Engineer (OCE), and provide to the OCE upon request.	Yes	This matrix
SE-07	Center Directors or designees shall establish and maintain a Stakeholder Expectations Definition process to include activities, requirements, guidelines, and documentation for the definition of stakeholder expectations for the applicable product layer.	Yes	Guidelines for stakeholder expectation definition in AFG-7120.5-001 section 4.1.1 and Appendix C
SE-08	Center Directors or designees shall establish and maintain a Technical Requirements Definition process to include activities, requirements, guidelines, and documentation for the definition of technical requirements from the set of agreed upon stakeholder expectations for the applicable product layer.	Yes	Guidelines for Technical Requirements Definition in AFG-7120.5-001 section 4.2.1 and Appendix C
SE-09	Center Directors or designees shall establish and maintain a Logical Decomposition process to include activities, requirements, guidelines, and documentation for logical decomposition of the validated technical requirements of the applicable product layer.	Yes	Guidelines for Logical Decomposition in AFG-7120.5-001 section 4.2.1 and Appendix C
SE-10	Center Directors or designees shall establish and maintain a Design Solution Definition process to include activities, requirements, guidelines, and documentation for designing product solution definitions within the applicable product layer that satisfy the derived technical requirements.	Yes	Guidelines for Design Solution Definition in AFG-7120.5-001 sections 4.3, 4.4 and Appendix C

NPR Reqt		Comply?	Justification
SE-11	Center Directors or designees shall establish and maintain a Product Implementation process to include activities, requirements, guidelines, and documentation for implementation of a design solution definition by making, buying, or reusing an end product of the applicable product layer.	Yes	Guidelines for Product Implementation in AFG-7120.5-001 section 4.5 and Appendix C
SE-12	Center Directors or designees shall establish and maintain a Product Integration process to include activities, requirements, guidelines, and documentation for the integration of lower level products into an end product of the applicable product layer in accordance with its design solution definition.	Yes	Guidelines for Product Implementation in AFG-7120.5-001 section 4.5 and Appendix C
SE-13	Center Directors or designees shall establish and maintain a Product Verification process to include activities, requirements/specifications, guidelines, and documentation for verification of end products generated by the product implementation process or product integration process against their design solution definitions.	Yes	Guidelines for Product Implementation in AFG-7120.5-001 section 4.5 and Appendix C
SE-14	Center Directors or designees shall establish and maintain a Product Validation process to include activities, requirements, guidelines, and documentation for validation of end products generated by the product implementation process or product integration process against their stakeholder expectations.	Yes	Guidelines for Product Implementation in AFG-7120.5-001 section 4.5 and Appendix C
SE-15	Center Directors or designees shall establish and maintain a Product Transition process to include activities, requirements, guidelines, and documentation for transitioning end products to the next higher level product layer customer or user.	Yes	Guidelines for Product Implementation in AFG-7120.5-001 section 4.5 and Appendix C
SE-16	Center Directors or designees shall establish and maintain a Technical Planning process to include activities, requirements, guidelines, and documentation for planning the technical effort.	Yes	Guidelines for technical planning in AFG-7120.5-001 section 4.1.3 and Appendix C
SE-17	Center Directors or designees shall establish and maintain a Requirements Management process to include activities, requirements, guidelines, and documentation for management of requirements throughout the system life cycle.	Yes	Guidelines for Requirements Management in AFG-7120.5-001 Appendix C
SE-18	Center Directors or designees shall establish and maintain an Interface Management process to include activities, requirements, guidelines, and documentation for management of the interfaces defined and generated during the application of the system design processes.	Yes	Guidelines for Interface Management in AFG-7120.5-001 Sections 4.3 and 4.4

NPR Reqt		Comply?	Justification
SE-19	Center Directors or designees shall establish and maintain a Technical Risk Management process to include activities, requirements, guidelines, and documentation for management of the risk identified during the technical effort.	Yes	Risk Management Requirements and Guidelines in AFOP-7120.5-003, Section 5.2
SE-20	Center Directors or designees shall establish and maintain a Configuration Management process to include activities, requirements, guidelines, and documentation for configuration management.	Yes	Configuration Management Requirements and Guidelines in AFPD-8040.1-001
SE-21	Center Directors or designees shall establish and maintain a Technical Data Management process to include activities, requirements, guidelines, and documentation for management of the technical data generated and used in the technical effort.	Yes	Technical Data Management Guidelines in AFG-7120.5-001 Section 4.1.2
SE-22	Center Directors or designees shall establish and maintain a Technical Assessment process to include activities, requirements, guidelines, and documentation for making assessments of the progress of planned technical effort and progress toward requirements satisfaction.	Yes	Technical Assessment Guidelines in AFG-7120.5-001 Appendix C and Appendix D
SE-23	Center Directors or designees shall establish and maintain a Decision Analysis process to include activities, requirements, guidelines, and documentation for making technical decisions.	Yes	Decision Analysis Guidelines in AFG-7120.5-001 Appendix C

Appendix D: Reference Documents

a. AFOP-8715.3-003, Flight Load Laboratory Ground Test Hazard Analysis

b. AFOP-7123.1-006, Structural Ground Test & Development Execution

c. AFOP-7150.2-004, Software Assurance

d. AFOP-7900.3-021, Aircraft Structural Modification Analysis, Review, and Documentation Requirements

e. AFOP-7900.3-023, Airworthiness & Flight Safety Review Process

f. AFOP-7900.3-024, Flight Operational Readiness Review (ORR)

g. AFG-7900.4-002, Operations Engineer's Handbook

Change Log

Baseline, 11-09-07

Baseline-1, 05-04-09
- Redline version created to satisfy NCR deadline. To be updated by Aug 3, 2009.

Baseline-2, 07-23-09
Note: This document was originally approved as DPR-1420.1. The signature page in this minor revision still shows the original number. The content of the document has not changed. The minor revision applies only to the addition of the document serial number.
- Changed document number from DPR-7123.1 to DPR-7123.1-001
- Pgs. 3 & 12, removed references to cancelled document DOP-M-106, Western Aeronautical Test Range (WATR) Mission Control Center (MCC) Systems Software Acceptance Testing

Revision A
- Relined to answer NCR

Revision B, 08-06-10
- Extended expiration date by 6 months

Revision C, 03-09-11
- Formatted to comply with Agency requirements
- Removed references to cancelled documents DCP-P-005, DCP-P-006, DHB-P-002, DOP-P-003
- Changed DHB-O-001 to G-7900.4-002
- Changed DHB-X-001 to G-7900.3-001
- Incorporated Section 5.0, description of the SE engineer processes and mapping to the DPR processes
- Addresses the audit finding, NPR 7123.1A requirements not flowed to center documentation
- Updated the Dryden lifecycle to include the SMB and PMB project development review process
- Added Appendix B Acronyms
- Added Appendix C Mapping of NPR 7123.1 Common Technical Processes
- Updated Figure 2, Designated Governing Authority at Dryden, which eliminates the associate director of operations.

Admin Change, C-1, 03-09-11
- Changed reference to DCP-$-604 to DOP-R-604

Revision D,
- Deleted part of 1.2 DPR Scope
- Deleted 1.4.1
- Deleted 1.5 Risk Management
- Deleted Chapter 2 Engineering Life Cycle Requirements
- Deleted Chapter 3 LifeCycle Review Criteria
- Deleted Chapter 4 Common Technical Process
- Updated Appendix C Mapping of NPR 7123.1 Common Technical Processes
- Added Appendix D Reference Documents
- Updated references to G-7120.5-001, Project Chief Engineer’s Handbook

Admin Change, D-1, 08-30-16
- Deleted reference to cancelled DCP-P-025 in Appendix D

Revision E, 08-14-17
- DPR-7123.1-001 renumbered to AFPR-7123.1-001 in accordance with Center instruction.
- Formatted document to current PR template
- Addresses findings:
  - Section 1.4.1: Corrected reference to Appendix containing the compliance matrix. Was: Appendix X; Is: Appendix C. [NCR 17I01-RE-1032]
  - Section 1.5.1 and Section 1.5.2: Corrected the name of the branch. Was: Systems Engineering; Is: Systems Engineering and Integration. [NCR 17I01-RE-1032]
  - Section 1.5.1: Changed how progress on branch improvement areas are statused. Was: Brief the Director for research and Engineering at least quartlerly; Is: document the status of improvement efforts at least four times each calendar year on the branch's Sharepoint site. [NCR 17I01-RE-1033, NCR 17I01-RE-1036]
  - Section 1.5.2: Clarified how often design review metrics will be updated and who will use them. Was: identify and collect design review metrics in a library on the branch's Sharepoint site and use them quarterly to to identify areas to consider for process improvement. Is: The Branch Chief will update metrics at least four times each calendar year and will identify areas to consider for process improvement at least annually. [CAP 719-11]

Revision E-001, Redline, 06-11-2018
- Updated sections P.2 Applicability, P.4 Applicable Documents, P.5 Measureent/Verification, and P.6 Cancellation
- Updated Figure 1 to latest version of AFRC Project LifeCycle
- Chapter 3: AS9100 (AEROSPACE QUALITY MANAGEMENT SYSTEM STANDARD) REQUIREMENTS removed in its entirety
- Removed definitions A.1 First Article, A.2 Formulation Phase, and A.3 Key Characteristics from Appendix A
- Definitons A.4 Verification and A.5 Validation renumbered to A.1 and A.2 respectively
- Document reference hyperlinks updated in Appendix D: Reference Documents
- TOC updated to reflect changes made within body of this directive
- Addresses NCR 823-01 and metric action

Revision E-002, Redline, 06-14-2018
- Updated sections P.2 Applicability
- Added directives to Appendix D: Reference Documents

Revision F, 08-20-2018
- Accepted changes from Redline Revision E-001 and E-002
- Renumbered paragraphs
- Updated Distribution statement
- Updated document referenced in Appendix C

Revision F-1, Admin Change, 12-05-2019
- Removed cancelled document references AFOP-7900.3-022, Tech Brief (T/B) & Mini Tech Brief (Mini T/B), and AFG-7900.3-001, Airworthiness & Flight Safety review, Independent Review, Technical Brief, and Mini Tech Brief
- Fixed typo in Appendix C requirement number SE-16
- Appendix D renumbered

Revision F-2, Admin Change, 10-04-2020
- Fixed typo in page headers 2-13

Revision F-3, Admin Change, 05-17-21

- Added page break between Chapter 1 and Chapter 2.

Revision F-4, Admin Change, 07-31-23

- Extended expiration from 8/1/23 to 2/1/24.