

**BY ORDER OF THE COMMANDER
AIR FORCE RESEARCH LABORATORY
(AFRL)**

**AIR FORCE RESEARCH LABORATORY
INSTRUCTION 61-104**

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Scientific/Research and Development

**SCIENCE AND TECHNOLOGY (S&T)
SYSTEMS ENGINEERING (SE) AND
TECHNICAL MANAGEMENT**

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

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This instruction implements Air Force Policy Directive (AFPD) 61-1, *Management of Science and Technology*, and is to be used in conjunction with Air Force Instruction (AFI) 63-1201, *Life Cycle Systems Engineering*; Air Force Materiel Command Instruction (AFMCI) 61-102, *Advanced Technology Demonstration Technology Transition Planning*; AFMCI 63-1201, *Implementing Operational Safety Suitability and Effectiveness and Life Cycle Systems Engineering*; AFMCI 62-202, *AFMC Core Criteria for Critical Engineering Position*; Air Force Research Laboratory Instruction (AFRLI), 61-202, *AFRL Laboratory Management Review (LMR) Process*, and AFRLI 61-108, *Science and Technology (S&T) Program Management*. A non-directive guidebook accompanying this instruction provides additional information to aid in the application and assessment of the AFRL S&T Systems Engineering (SE) process. This instruction applies across the entire AFRL S&T portfolio encompassing all programs in Basic Research, Applied Research and Advanced Technology Development. This publication may be supplemented at any organizational level, but all direct Supplements must be routed to the Office of Primary Responsibility (OPR) of this publication for coordination prior to certification and approval. Refer recommended changes and questions about this publication to the OPR using the AF Form 847, *Recommendation for Change of Publication*; route AF Form 847 through the appropriate functional chain of command. Requests for waivers must be submitted to the OPR listed above for consideration and approval. Ensure that all records created as a result of processes prescribed in this publication are maintained IAW Air Force Manual (AFMAN) 33-363, *Management of Records*, and disposed of IAW the Air Force Records Information Management System (AFRIMS) Records Disposition Schedule (RDS).

SUMMARY OF CHANGES

This instruction has been substantially revised and must be completely reviewed. References to the Systems Engineering (SE) Council (SEC) have been removed, and introduces the SE and Program Management (PM) Council (SEPM Council), paragraph 2. It assigns overall SE responsibility in AFRL to the Director (DoE) of the AFRL Engineering and Technical Management Directorate, paragraph 2. Attachments have been moved to the AFRL SE Guidebook, a non-directive companion to this instruction.

1. Overview. This instruction defines the S&T SE process as derived from the SE processes of the Defense Acquisition Guidebook (DAG) and outlines roles and responsibilities of key AFRL personnel in the tailored application of SE principles and fundamentals at every level of research and development (R&D). It applies to all AFRL organizations and subordinate units; however, the director of AFOSR is granted waiver authority for AFOSR.

1.1. Each TD must document their tailored application of the S&T SE process in a TD-specific operating instruction (OI) or supplement to this instruction (See paragraph 2.4.6). Each TD Director is granted waiver authority for any Basic Research programs, budget category 6.1 or externally funded regardless of funding source, and any Small Business Innovation Research (SBIR) programs performed in his/her TD.

1.2. The primary objective of the AFRL S&T SE process is to ensure that the right technical content and execution rigor are applied across the entire AFRL S&T portfolio. To support this objective, the specific goals for application of SE within AFRL are:

1.2.1. Tailor application of S&T SE to the maturity of the technology under development across the portfolio.

1.2.2. Use strong and consistent technical and technical management processes to translate capability needs into S&T concepts and/or technologies for development.

1.2.3. Ensure repeatability of S&T results.

1.2.4. Consistently deliver technology deliverables that provide “best value” solutions to needed war-fighting capabilities.

1.2.5. Successfully transition technology and knowledge to our customers.

2. Roles and Responsibilities.

2.1. Commander (AFRL/CC). This instruction constitutes the Commander’s appointment of the AFRL Director of Engineering (DoE) as the AFRL Technical Engineering Authority (TEA) in accordance with (IAW) AFMCI 63-1201. The Commander will:

2.1.1. Provide policy guidance and resources for the implementation and application of the AFRL S&T SE process.

2.1.2. Promote the tailored application of systems engineering, airworthiness, Operational Safety, Suitability and Effectiveness (OSS&E) and Mission Assurance (for research targeted for cyber/information systems and space application) policy for technology development efforts involving systems, sub-systems, and components (Reference AFMCI 63-1201).

2.1.3. Commission a Systems Engineering and Program Management Council (SEPM Council) with the AFRL DoE as Chair (paragraphs 2.2 and 2.6).

2.2. AFRL Director of Engineering. The AFRL DoE will serve as the AFRL TEA and will provide corporate-level guidance, direction, assessment, content, implementation, status, and continuous improvement of the AFRL S&T SE process. The AFRL DoE provides the overall supervision, management guidance, and advocacy for resources required to plan, direct, organize, and control SE activities IAW AFMC, USAF and DoD policy, directives and requirements. The AFRL DoE will:

2.2.1. Advise AFRL Senior leadership, including the Commander, Executive Director, Chief Technologist, and TD Directors, on policies, processes, and procedures as applied to all managed and/or supported SE and engineering integration efforts.

2.2.1.1. Support AFRL/CC in the application of systems engineering, airworthiness, OSS&E, and Mission Assurance policy involving technology development efforts of systems, sub-systems, and components by the AFRL workforce. (Reference AFI 63-1201, AFI 62-601, USAF Airworthiness, and AFRLMAN 99-103.)

2.2.1.2. Provide advice and counsel to technical experts on matters involving SE.

2.2.2. As the SEPM Council Chair:

2.2.2.1. Appoint a Secretariat to the SEPM Council.

2.2.2.2. Ensure that SEPM Council participates in the development of S&T SE policy for the AFRL enterprise, documents and prepares updates to this instruction as necessary.

2.2.2.3. Monitor the AFRL enterprise compliance with this instruction and take corrective action as necessary.

2.2.3. Monitor results of SE assessments performed in concert with the existing AFRL laboratory management review and program management review processes (paragraph 4).

2.2.4. Participate in selection of TD Chief Engineers.

2.2.5. Promote the use of Modeling and Simulation (M&S) as an engineering analysis tool through participation in war games, such as the AF Future Games and AFMC ACS Wargame.. Promote participation in exercises to develop and demonstrate technology.

2.2.6. Ensure the AFRL technical workforce is trained to implement the S&T SE process. Provide education and training opportunities for the AFRL technical workforce in SE principles and fundamentals and the application of the S&T SE process.

2.2.7. Advocate the use of the S&T SE process principles and fundamentals by the entire AFRL technical workforce on all AFRL S&T programs.

2.2.8. Develop, implement, and maintain a process to act on requests for AFRL subject matter experts (SMEs) to support MAJCOM teams.

2.2.8.1. Determine appropriateness of individual AFMC and AFSPC requests for SME support and task TDs through appropriate channels.

2.2.9. Oversee a technology transition planning process which focuses on collaboration between AFRL and transition and/or acquisition agents and end users IAW AFMCI 61-102.

2.3. Technology Directorate (TD) Director. The TD director ensures the S&T SE process, principles, and fundamentals are appropriately applied to support the mission of his/her TD. Further, each director will:

2.3.1. Appoint a TD Chief Engineer as the TD technical focal point for engineering matters. For the 711 HPW the Wing Commander/Director will appoint a Wing Chief Engineer with responsibilities as the Human Effectiveness TD technical focal point for engineering matters. A Chief Engineer is optional to AFOSR.

2.3.2. Ensure TD Scientists and Engineers (S&Es) understand the S&T SE principles and fundamentals and have appropriately tailored application of those principles and fundamentals across all TD S&T programs.

2.3.3. Ensure TD performance of SE assessments in concert with the existing AFRL laboratory / program management review process IAW AFRLI 61-202 or AFRLI 61-108 (paragraph 4).

2.3.4. Provide TD SMEs to MAJCOM teams (paragraph 2.2.8). AFRL/EN will ensure that requests for TD SME support are valid.

2.4. TD Chief Engineer. The TD Chief Engineer will:

2.4.1. Serve as the TD representative on the AFRL SEPM Council.

2.4.2. Implement AFRL S&T SE policy IAW this instruction in his/her TD.

2.4.3. Support the TD Director in ensuring TD Scientists and Engineers have the knowledge, skills and abilities necessary to implement the S&T SE process per this instruction.

2.4.4. Promote the use of M&S (to include war gaming) to augment and support design, development and test where appropriate.

2.4.5. Support TD application of airworthiness, OSS&E, and Mission Assurance policy involving technology development efforts of systems, sub-systems, and components. (Reference AFI 63-1201, AFI 62-601, USAF Airworthiness, and AFRLMAN 99-103.)

2.4.6. Prepare and staff (following TD procedures) a TD-specific S&T SE instruction or AFRLI 61-104 supplement to implement and tailor the application of the S&T SE framework in accordance with this instruction and the DAG eight Technical Management Processes. Submit the TD instruction and tailoring rationale to the SEPM Council initially or when updated for review, as required by AFMCI 63-1201 (paragraph 2.6.3). Additionally, review this TD instruction/ supplement whenever AFRLI 61-104 is revised and update it as necessary.

2.4.7. Support the TD Director in ensuring that S&T Program Managers implement the AFRL S&T SE process in planning and executing their S&T programs.

2.4.8. Participate in TD reviews (e.g., Program Management Reviews (PMRs), Laboratory Management Reviews (LMRs), Program Baseline Reviews (PBRs), Staff Assistance Visits (SAVs), etc.).

2.4.9. Provide TD “best practice” examples on SE process application and effectiveness for sharing across AFRL through the AFRL SEPM Council (paragraph 2.6.4).

2.4.10. In collaboration with the TD Chief Scientist, ensure critical technologies, systems, and information are protected following the policy and direction of AFRLPAM 63-17, *Acquisition Program and Technology Protection*.

2.4.11. Ensure technology transition planning process is appropriately documented IAW AFMCI 61-102 and AFRLI 61-108.

2.5. AFRL Scientists and Engineers (S&Es) will:

2.5.1. Implement the AFRL S&T SE process in planning and executing S&T programs.

2.5.2. Serve as a SME to support MAJCOM teams when requested through the TD management chain.

2.5.3. Ensure early identification of ancillary requirements such as Electromagnetic Interference/Electromagnetic Compatibility (EMI/EMC), electromagnetic spectrum management (IAW AFRLI 33-118), human systems integration (HSI), test range availability, intelligence support, etc. See the accompanying SE Guidebook for additional information.

2.6. AFRL SEPM Council. The SEPM Council is the AFRL corporate body responsible for improving and strengthening the culture, discipline, and consistency of applying SE processes in AFRL. The SEPM Council is comprised of the AFRL DoE, TD Chief Engineers including a representative from AFOSR, and a secretariat appointed by the AFRL DoE. The SEPM Council will:

2.6.1. Develop, promote, and update policy, process, tools and training for the S&E workforce across the AFRL enterprise to include SE, airworthiness, OSS&E, and Mission Assurance.

2.6.2. Review this instruction and the SEPM Council Charter and prepare updates as necessary.

2.6.3. Review each tailored TD SE instruction for continuity and consistency with overall AFRL SE policy and recommend alterations as needed.

2.6.4. Maintain an awareness of government, commercial industry, and academic SE best practices, procedures, and tools and make them available for use across AFRL.

2.6.5. Liaise with the AFRL S&T Computational Science & Engineering (CSE) Working Group on issues of mutual concern.

2.6.6. Liaise with the AFMC Engineering Directorate on issues of mutual concern.

2.7. AFRL S&T Program Managers. Responsible for implementing the S&T SE process in their S&T programs. S&T Program Managers will:

2.7.1. In consultation with the TD Chief Engineer, continuously apply the S&T SE process, tailored to the S&T program's needs and maturity, during S&T program planning and execution. See paragraph 3 and the accompanying SE Guidebook for more information.

2.7.2. Assess the managed S&T program's SE health in accordance with this instruction (paragraph 4) for use at LMRs, PMRs, technical interchange meetings (TIMs), etc., as appropriate. Collaborate with the TD Chief Engineer or SEPM Council representative as needed to accomplish any required program SE assessment.

2.7.3. Collaborate with and/or support transition agents (organizational entities responsible for incorporating technology into a system or platform) and end users in developing and executing Technology Transition Strategies, Plans, and Agreements.

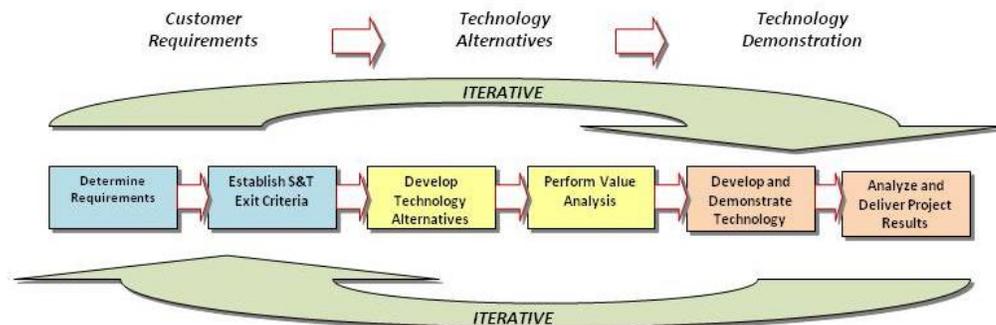
2.7.4. Follow flight release and airworthiness processes as determined by the AFRL Designated Technical Authority (DTA). When appropriate, implement OSS&E and/or Mission Assurance policy.

2.7.5. Maintain the design and/or product baseline for development assets that may remain with an operational user.

3. S&T Systems Engineering Process. The S&T SE process is the process by which AFRL Scientists and Engineers (S&Es) decompose scientific research objectives to knowledge, or capability needs to technology alternatives. S&T SE also enables innovation by providing a framework that guides the researcher to develop technology efforts capable of supporting current or potential future operational needs. The eight DAG SE technical management processes and the eight DAG SE technical processes are foundational to the S&T SE process. The eight technical management processes are performed continuously and concurrently while the eight technical processes are performed sequentially, although with considerable iteration and feedback checking, throughout the S&T program. See the accompanying AFRL SE Guidebook for details.

3.1. One framework for implementation of the principles and fundamentals of the SE process on AFRL S&T programs is depicted below. If a TD elects to use an alternative implementation framework in lieu of the one presented here, the TD framework must be specified in the TD-specific OI or supplement along with a demonstration that the TD framework is consistent with the S&T SE framework.

Figure 1. S&T Systems Engineering Process



4. Assessment of S&T SE Application.

4.1. A macro view of the health of the application of an S&T SE process can be attained through a series of questions developed from the DAG processes. TD Directors ensure the use of these questions to assess the sufficiency of the SE process on a particular S&T program during currently existing internal reviews such as laboratory management reviews and program management reviews. See the accompanying AFRL SE Guidebook for examples of assessment standards for each of the SE key questions tailored for application across all phases of technology development from Basic Research through transition to an end user. The SE key questions are:

- 4.1.1. Who is your customer?
- 4.1.2. What are the customer's requirements?
- 4.1.3. How will you demonstrate you have met the requirements?
- 4.1.4. What are the technology options?
- 4.1.5. Which is the best approach?
- 4.1.6. What are the risks to developing the selected technology?
- 4.1.7. How will you structure your program to meet requirements and mitigate risk?
- 4.1.8. What is your business-based transition plan that meets customer approval?

4.2. At the discretion of the TD director, a more rigorous systems engineering assessment, such as Air Force Systems Engineering Assessment Model (AF SEAM), may be used in place of the 8 SE Key Questions in paragraphs 4.1.1 through 4.1.8 to assess the application of the S&T SE process.

5. Accompanying AFRL SE Guidebook. The guidebook, which is both non-directive and non-prescriptive, guides the user in the application and assessment of the AFRL S&T SE process for technology development. It is available at the following site: <https://org2.eis.afmc.af.mil/sites/afrlhq/EN/Docs/Forms/AllItems.aspx?RootFolder=%2fsites%2fafrlhq%2fEN%2fDocs%2fSystems%20Engineering%20Guidebook&folderCTID=0x012000E823E338602B1F4B9CC34A30BD3BAE6B&view=%7b5835E570%2d2BAA%2d4B59%2dBDC2%2dC2BAE831C567%7d> . The guidebook:

- 5.1. Elaborates on the principles and fundamentals of the S&T SE process and provides examples of activities that typically occur at each step of the S&T SE Process.
- 5.2. Aids in the evaluation and assessment of individual S&T program progress in applying the S&T SE process for Basic Research, Applied Research, and Advanced Technology Development.

THOMAS J. MASIELLO
Major General, USAF
Commander

Attachment 1**GLOSSARY OF REFERENCES, FORMS, AND SUPPORTING INFORMATION*****References***

Defense Acquisition Guidebook

AFI 62-601, *USAF Airworthiness*, 11 June 2010

AFI 63-1201, *Life Cycle Systems Engineering*, 23 July 2007

AFMAN 33-363, *Management of Records*, 1 March 2008

AFMCI 61-102, *Adv Technology Demonstration Technology Transition Planning*, 30 May 2006

AFMCI 62-202, *AFMC Core Criteria for Critical Engineering Position*, 21 July 2005

AFMCI 63-1201, *Implementing Operational Safety Suitability and Effectiveness and Life Cycle Systems Engineering*, 14 October 2009

AFRLI 33-118, *AFRL Electronic Spectrum Management*, 12 May 2011

AFRLI 61-108, *Program Baseline Development*, 28 March 2003

AFRLI 61-202, *AFRL Laboratory Management Review (LMR) Process*, 20 October 2005

AFRLMAN 99-103, *AFRL Test Program*, 21 May 2007

AFRLPAM 63-17, *Acquisition Program and Technology Protection*, 24 July 2007

Adopted Forms

AF Form 847 *Recommendation for Change of Publication*

Abbreviations and Acronyms

AF SEAM—Air Force Systems Engineering Assessment Model

CBA—Capability Based Assessment

CBP—Capability Based Planning

CET—Concept Engineering Team

CSE—Computational Science & Engineering

DAG—Defense Acquisition Guidebook

DoE—Director of Engineering

DP—Development Planning

DTA—Designated Technical Authority

EMC—Electromagnetic Compatibility

EMI—Electromagnetic Interference

HSI—Human Systems Integration

IAW—In Accordance With

JCIDS—Joint Capabilities Integration and Development System

LMR—Laboratory Management Review

M&S—Modeling and Simulation

MRL—Manufacturing Readiness Level

OPR—Office of Primary Responsibility

OPSEC—Operations Security

OSS&E—Operational Safety, Suitability and Effectiveness

PBR—Program Baseline Review

PMR—Program Management Review

R&D—Research and Development

S&Es— - Scientists and Engineers

S&T—Science and Technology

SAV—Staff Assistance Visit

SBIR—Small Business Innovation Research

SE—Systems Engineering

SEPM—Systems Engineering and Program Management

SME—Subject Matter Expert

TD—Technology Directorate

TEA—Technical Engineering Authority

TIM—Technical Interchange Meeting

TRA—Technology Readiness Assessment

TRL—Technology Readiness Level