Human Systems Integration (HSI) in Acquisition

Integrating Human Concerns into Life Cycle Systems Engineering

Management Guide

HSI Domain and Acquisition Phase Guides also Available

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Source Disclaimer: Definitions for acronyms, terms, and tools used in this product came from a variety of Department of Defense sources including Department of Defense Instruction (DODI) 5000.02 and the Defense Acquisition Portal. Definitions for human systems integration and its related domains were taken from the International Council on Systems Engineering (INCOSE) Systems Engineering Handbook v3.1 Appendix M, August 2007. Tool descriptions were taken from the Directory of Design Support Methods and in some cases from tool web sites. Photography was provided by the Air Force.

This product was produced for the Air Force Human Systems Integration Office (AFHSIO) by Booz Allen Hamilton under the auspices of the Survivability/Vulnerability Information Analysis Center (SURVIAC). Requests for copies and any other questions should be sent to: AFHSIO, 5201 Leesburg Pike, Skyline 3, Suite 1501, Falls Church, VA 22041-3202 or Email: hsi.workflow@pentagon.af.mil

August 2009

HSI in Acquisition

Integrating Human Concerns into Life Cycle Systems Engineering

Air Force Human Systems Integration Office

Disclaimer: This product contains references to existing and emerging tools currently available and/or in use in Government, academia, and industry. The tools listed are illustrative of what can be used to perform the identified activities and are not exhaustive due to the volume of tools available. The Air Force Human Systems Integration Office, the Air Force, and the Department of Defense do not endorse any specific contractor or commercial product.

Executive Summary

Human Systems Integration (HSI) encompasses the interdisciplinary technical and management processes for integrating human considerations within and across all system elements; an essential enabler to systems engineering practice. HSI processes facilitate trade-offs among human-centric domains without replacing individual domain activities, responsibilities, or reporting channels. The human-centered domains with recognized application to HSI include: Manpower, Personnel, Training, Human Factors Engineering, Survivability, Environment, Safety, Occupational Health, and Habitability.

The goal of HSI is to maximize total system performance, understanding that the human element is an integral part of systems, while minimizing total ownership costs. To be effective, HSI must be conducted as a fundamental part of the overall systems engineering activities within the Air Force Integrated Defense Acquisition, Technology, and Logistics Life Cycle Management System. HSI activities will focus on overall system performance and also on the design and integration of many subsystems, thus making HSI a critical part of the design process.

This guide assumes a basic understanding of DoD Systems Engineering (SE), HSI principles and practices, and acquisition acronyms and terminology. It was developed to depict when HSI activities should be performed to influence system design throughout the SE process. Its purpose is to facilitate domain and systems engineering integration on HSI issues.

Relevant tasks, tools, and references for HSI and each of the HSI process domains are identified and aligned with existing SE processes and reviews for each acquisition phase. Many of the tasks identified are notional best practices and not all tasks would be performed with every acquisition program.

Three versions of this guide have been produced. This version is organized by acquisition phase. Another version organized by domain is also available as well as a separate, shorter management version which focuses solely on HSI activities. Copies of the other versions can be obtained by contacting AFHSIO.

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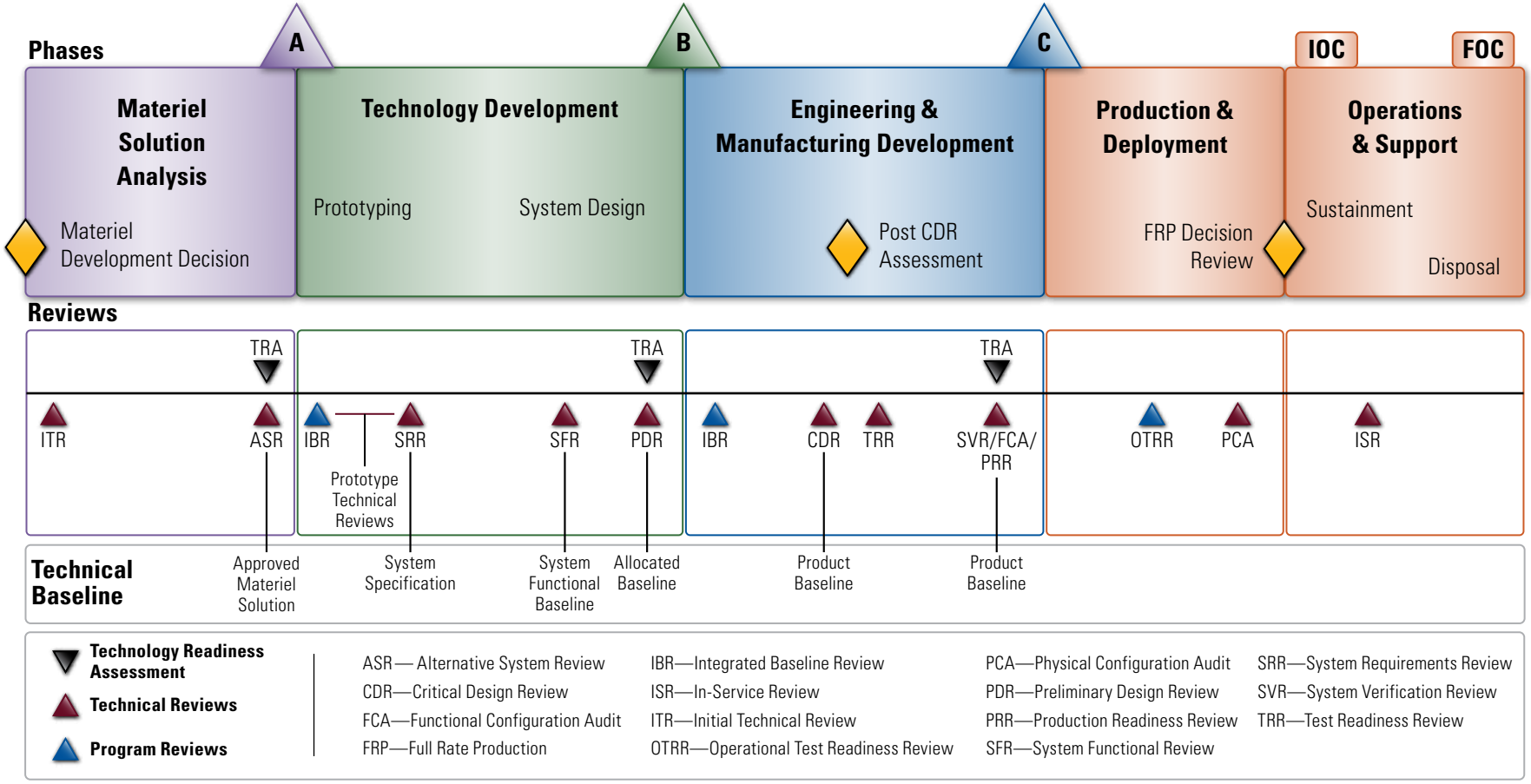
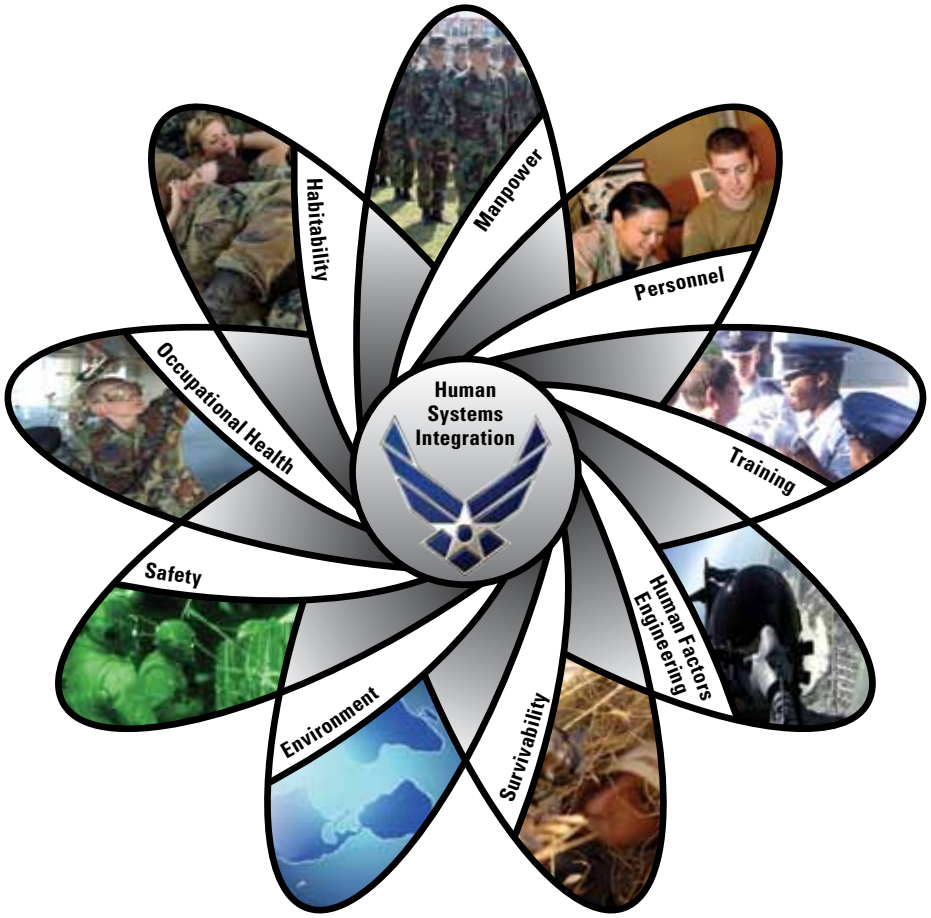
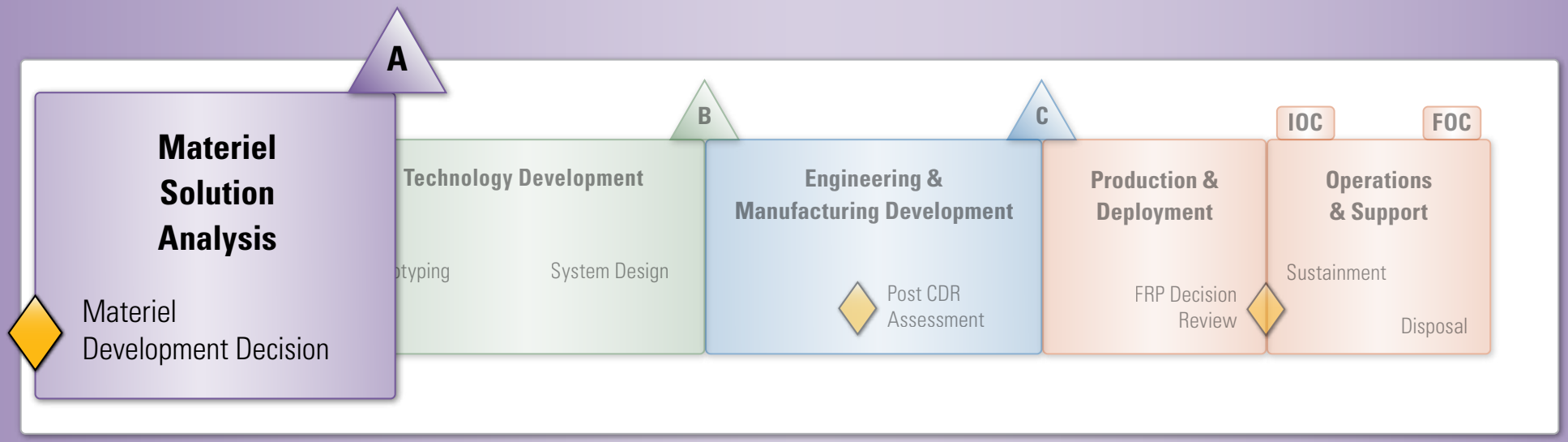
Acquisition Life Cycle and Systems Engineering Technical Review Timing



Human Systems Integration

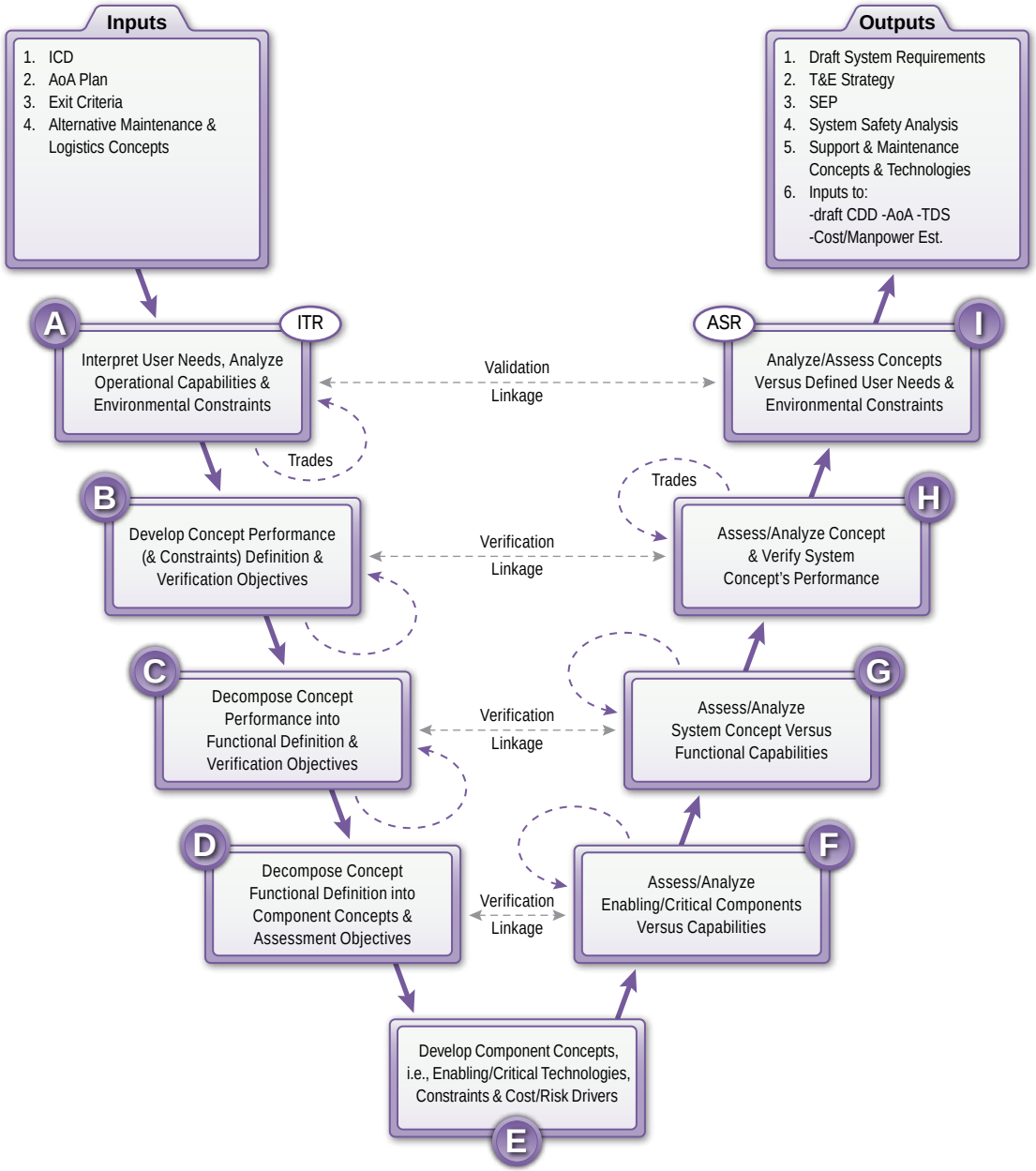


Human Systems Integration (HSI)—Encompasses the interdisciplinary technical and management processes for integrating human considerations within and across all system elements; an essential enabler to systems engineering practice. The HSI processes facilitate trade-offs among the human-centric domains without replacing individual domain activities, responsibilities, or reporting channels. The human-centered domains with recognized application to HSI include: Manpower, Personnel, Training, Human Factors Engineering, Survivability, Environment, Safety, Occupational Health, and Habitability.



Materiel Solution Analysis—The purpose of this phase is to assess potential materiel solutions. The Materiel Solution Analysis Phase begins with the Materiel Development Decision review which is the formal entry point into the acquisition process. The lead DoD Component(s) prepare an AoA study plan to assess preliminary materiel solutions, identify key technologies, and estimate life-cycle costs. The Materiel Solution Analysis Phase ends when the AoA has been completed, materiel solution options for the capability need identified in the approved ICD have been recommended by the lead DoD Component conducting the AoA, and the phase-specific entrance criteria for the initial review milestone have been satisfied. (DODI 5000.02)

Materiel Solution Analysis Phase

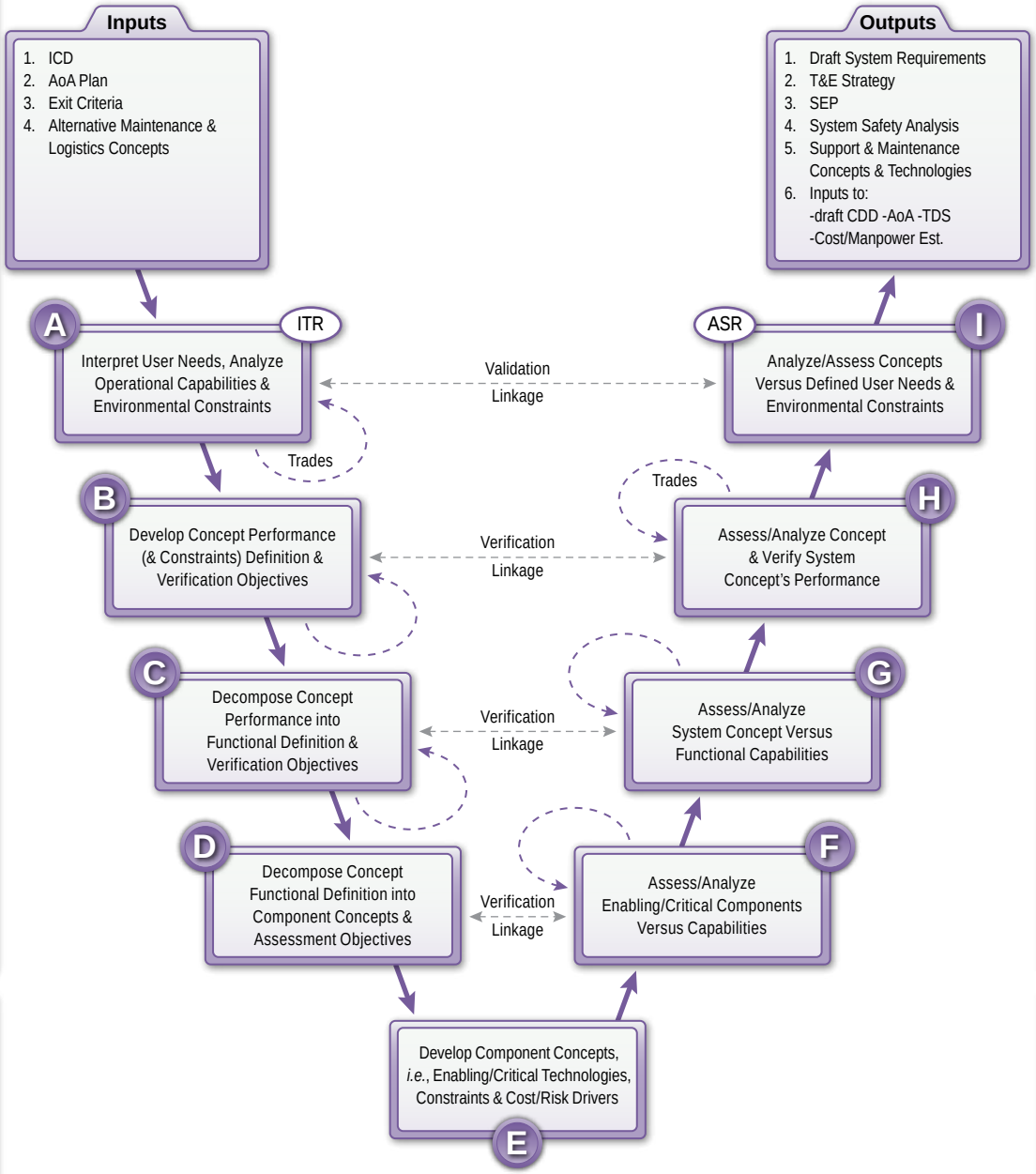


Materiel Solution Analysis Phase

Human Systems Integration

Activities for Each Input:

1.0 Review available Concept of Operations (CONOPS) and other available data
1.1 Select and review Baseline Comparison System(s) (BCS) documentation
1.2 Assess potential HSI domain effects
1.3 Ensure human constraints are included
1.4 Ensure domain points of contact (POCs) are identifed
2.0 Set HSI conditions and constraints for consideration in Analysis of Alternatives (AoA)
2.1 Collect domain inputs for each alternative
2.2 Define trade space and risk associated with each of the domains
3.0 Identify, compile, and track domain exit criteria
4.0 Set HSI conditions and constraints for consideration in concepts
4.1 Collect domain inputs for each concept
4.2 Define trade space and risk associated with each domain and provide inputs for each concept



The numbers in the Activities boxes correspond to the numbers In the Inputs and Outputs boxes.

Activities for Each Output:

1.0 Collect domain requirements inputs
1.1 Ensure draft system requirements include human constraints
2.0 Determine which HSI domains can be tested
2.1 Provide domain inputs as applicable
3.0 Write draft HSI Plan
4.0 Ensure each domain reviews the Environment, Safety and Occupational Health (ESOH) hazard and risk analysis for each system [*e.g.*, the Preliminary Hazard List (PHL)]
4.1 Collect domain impacts and costs
4.2 Provide domain trade-off impacts
5.0 Summarize domain trade-off inputs
5.1 Provide consolidated domain inputs
6.0 Provide HSI and domain inputs as applicable

References:

- DODI 5000.02 & DODD 5000.01
- Defense Acquisition Guidebook (DAG)
- CJCSI 3170.01
- AFPD 63-1/AFPD 20-1
- AFI 63-101 & AFI 63-1101
- AFI 63-1201
- Domain-specifc policies

Tools:

- CATIA
- HSI Requirements Guide
- IMPRINT

Materiel Solution Analysis: Human Systems Integration

A

- Assess and identify applicable HSI limitations pertaining to environmental issues such as system threats, usage environment, support environment, doctrine, and operational concepts
- Assess and identify applicable HSI limitations pertaining to resources such as the industrial base, notional available development, operation and support budgets, and required date for system fielding
- Assess and identify applicable HSI limitations on the technology base to be used for concept maturation
- Review applicable HSI limitations in statutory and regulatory documents such as the Federal Acquisition Regulation, the DoD 5000-series, CJCSM/I guidance, *etc.*
- Ensure all HSI drivers of the concept definition are completely captured and managed as an integral human-centered system

B

- Analyze and assess trade space and HSI risks for each alternative concept
- Define and relate human performance to capability needs and draft CONOPS
- Define test requirements needed to evaluate the ability of the matured system concept(s) to meet requirements of verification planning
- Assess and document derived HSI requirements at the system performance level

C

- Translate concept-level HSI criteria (*e.g.,* applicable HSI impacts, human performance limitations, domain-specific risks, tactical system, support system, training system, *etc.*) into functional requirements
- Analyze and assess trade space and HSI risks against desired functional performance in accordance with draft CONOPS
- Enable verification planning for test and evaluation of matured concept functionality as defined in system function allocation

D

- Analyze allocation of concept functions into component concepts and assessment objectives OR apply identified HSI constraints to analyze and define concept component design requirements
- Test and evaluate HSI component-level requirements through verification planning

E

- Ensure that HSI is adequately addressed in analyses, modeling and simulation, demonstrations, *etc.*
- Review historical information (*e.g.,* successes, mishaps, lessons learned, poor human performance, *etc.*)

F

- Assess HSI impacts when rating component concept alternatives
- Review results of hardware and software modeling, simulations, demonstrations, and prototypes to verify the satisfaction of component-level HSI requirements

G

- Ensure that HSI attributes are integrated to support overall capability
- Assess HSI functional-level impacts of rating concept alternatives
- Review results of hardware and software modeling, simulations, demonstrations, and prototypes to verify that functional-level HSI requirements have been satisfied

H

- Assess each system concept against identified HSI criteria and requirements
- Document critical HSI risks, mitigations, and potential trade-offs for each concept alternative
- Rate concept alternatives at this level to identify critical HSI risks and mitigation control measures

I

- Ensure that HSI considerations are included in the identification of advantages/ disadvantages for each approach
- Ensure that enabling technologies address HSI considerations

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ITR

- Review Cost Analysis Requirements Description (CARD)-like documents to confirm that HSI has been included in the system overview, risk and system operation concept
- Verify that HSI inputs are included throughout the program's cost estimate
- Verify that HSI domain requirements are included and presented in sufficient detail to support a valid program cost estimate
- Provide HSI inputs to reflect the chosen materiel solution approach
- Provide HSI assumptions, risks, and cost drivers

ASR

- Review AoA and evaluate multiple alternatives for the system
- Verify that system requirements are consistent with user needs and applicable HSI domain standards
- Provide HSI inputs and risks for alternative materiel solutions that have been identified

Trades

- Participate in AoA to ensure that HSI considerations have been addressed in the assessment of advantages and disadvantages
- Participate in trade studies to identify potential HSI hazards and risks, to ensure that HSI criteria are included in this phase

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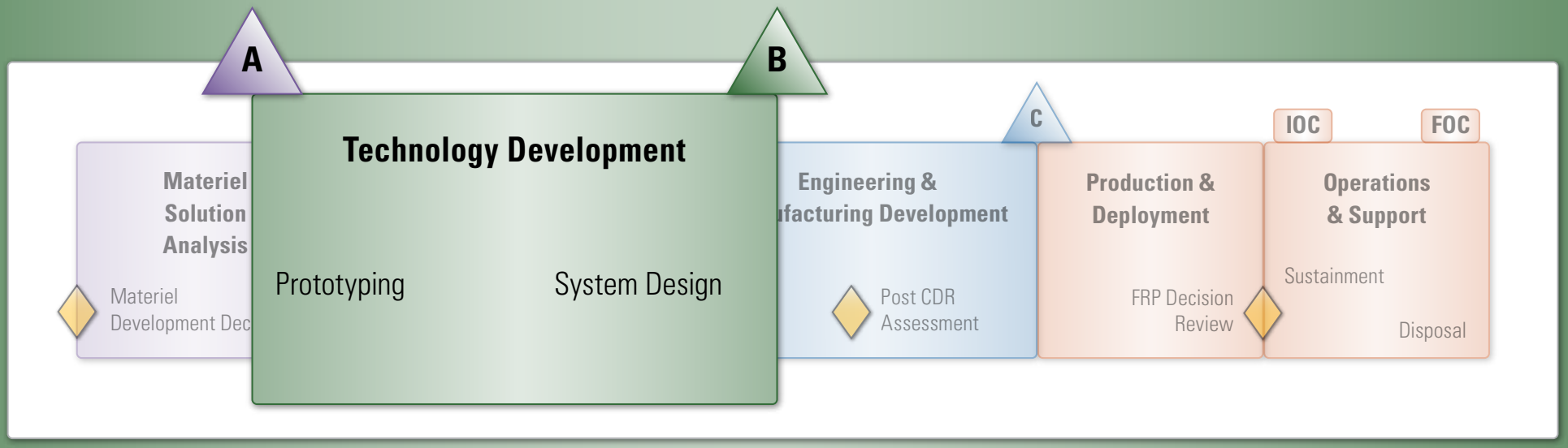
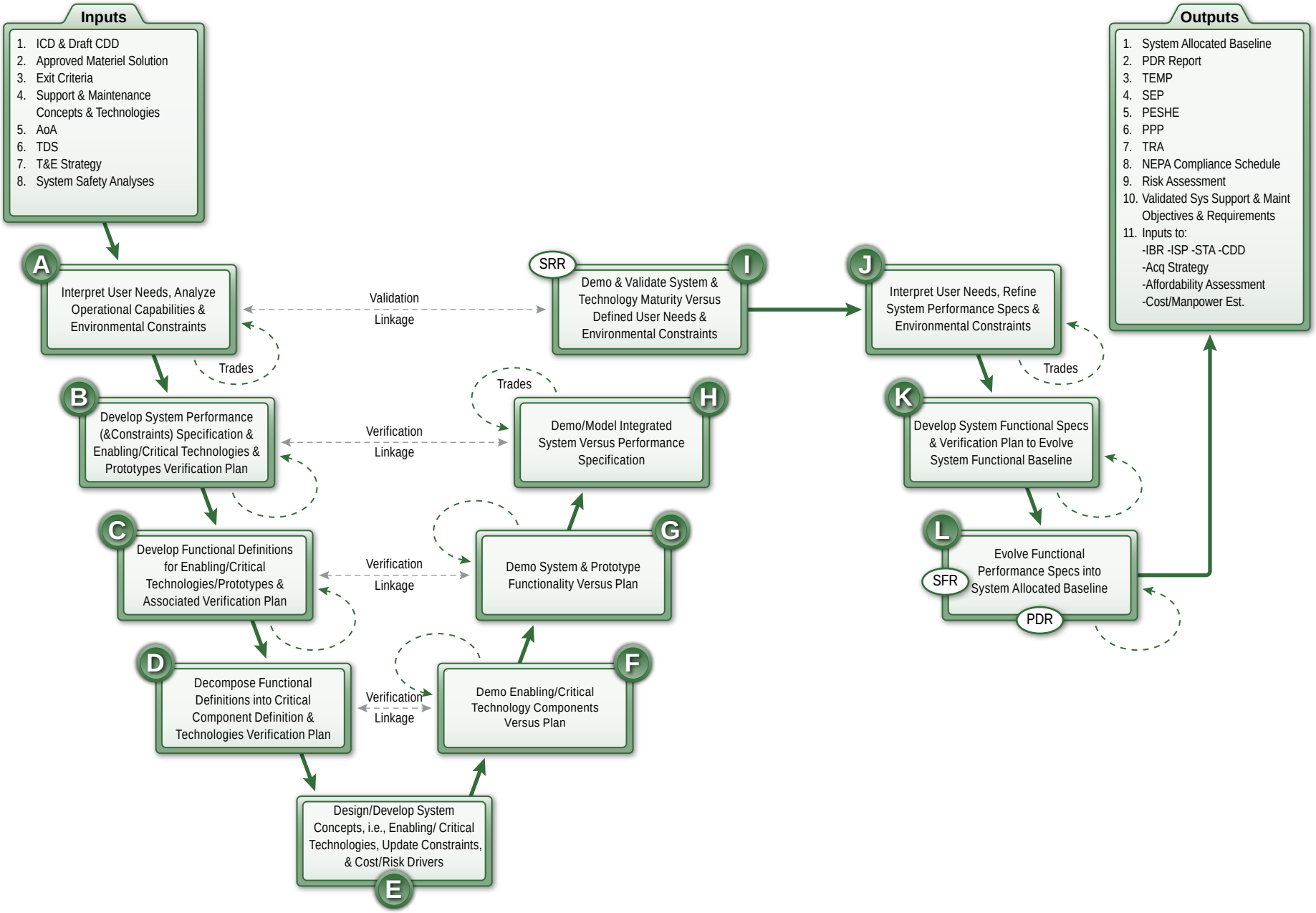


Technology Development—The purpose of this phase is to reduce technology risk, determine and mature the appropriate set of technologies to be integrated into a full system, and to demonstrate critical technology elements on prototypes. Technology Development is a continuous technology discovery and development process reflecting close collaboration between the S&T community, the user, and the system developer. It is an iterative process designed to assess the viability of technologies while simultaneously refining user requirements. (DODI 5000.02)

Technology Development Phase

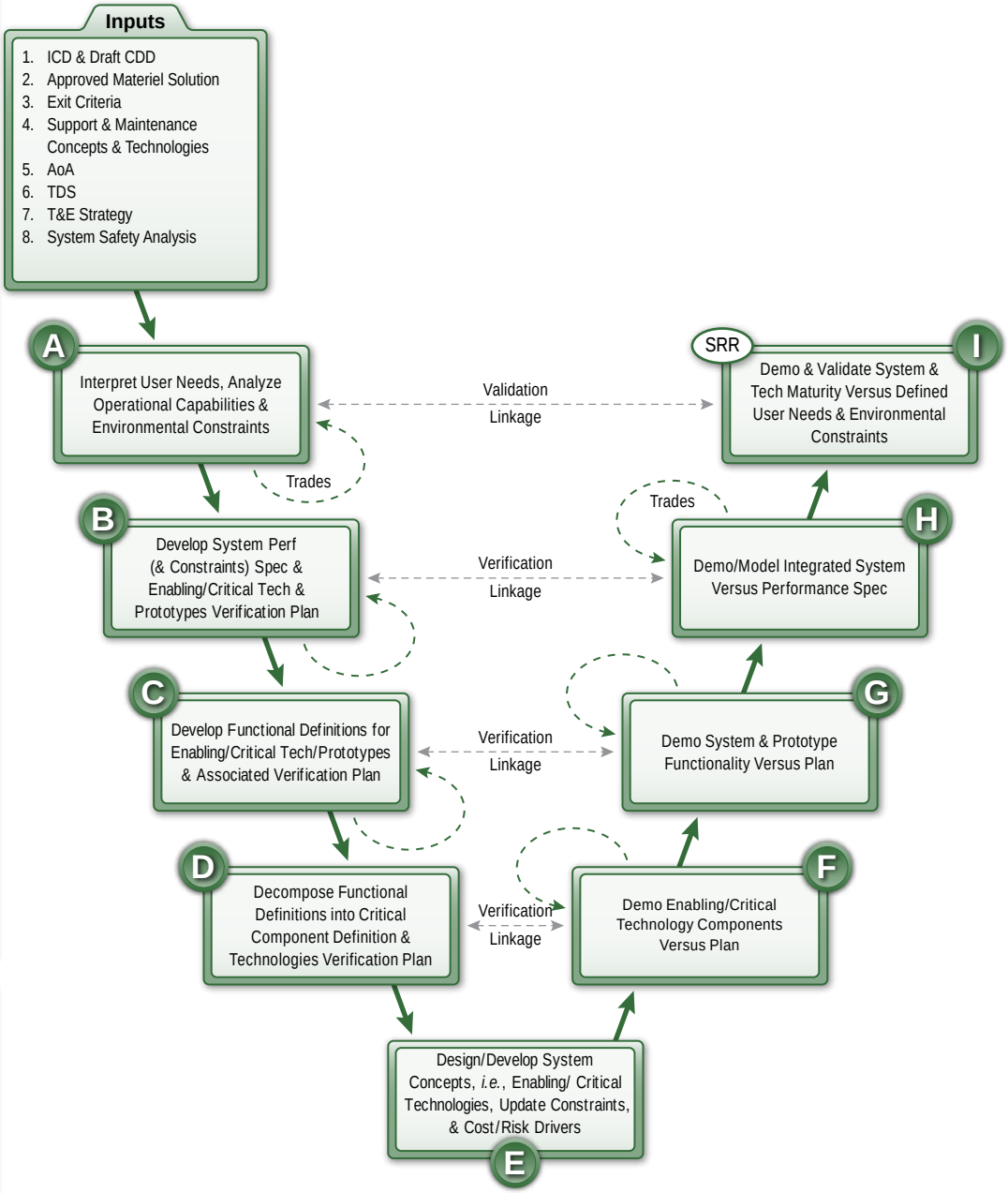


Technology Development Phase (Inputs)

Human Systems Integration

Activities for Each Input:

1.0 Update HSI domain effects
1.1 Review and update human constraints
2.0 Identify trade-off opportunities among domains
2.1 Evaluate requirements against concepts
2.2 Assess domain risks and impacts
3.0 Identify the key risks
3.1 Develop ESOH hazard and risk analysis (*e.g.*, PHL)
4.0 Assess HSI domain inputs for maintenance and support strategies
5.0 Identify associated risks for each alternative
5.1 Provide domain inputs for each alternative
5.2 Identify alternatives' strengths and weaknesses based on HSI domain trade-offs
6.0 Review domain inputs for proposed capabilities
6.1 Identify candidate HSI technologies for maturation based on Total Risk Assessment (TRA)
7.0 Prioritize HSI domain requirements for the chosen materiel solution
7.1 Distinguish risk controls and mitigation technologies
7.2 Verify process for HSI domain requirements verifcation
8.0 Develop safety analysis for each concept
8.1 Coordinate within domains to identify hazards



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References:

- DODI 5000.02 & DODD 5000.01
- DAG
- CJCSI 3170.01
- AFPD 63-1/AFPD 20-1
- AFI 63-101 & AFI 63-1101
- AFI 63-1201
- Domain-specifc policies

Tools:

- IMPRINT
- CATIA
- IPME

Technology Development Phase (Inputs): Human Systems Integration

A
- Identify critical HSI technology needs
- Assess HSI domain-specifc technology maturity to minimize impact on HSI domains

B
- Ensure HSI criteria are traceable back to defned system capabilities and constraints
- Identify HSI requirements in any system or subsystem performance specifcation, solicitation, contract, and evaluation criteria
- Defne HSI test requirements for identifed technologies

C
- Defne HSI criteria for weapon system, support, equipment, and training systems
- Assess HSI impacts from technology trade-offs or refnements
- Defne HSI test requirements for identifed technologies

D
- Update system HSI criteria
- Assess HSI impacts on hardware and software elements (physical interfaces, functional interfaces, standards, and existing technologies)
- Understand HSI impacts for system-of-systems technology
- Defne HSI testing and validation requirements for critical system components

E
- Address HSI risk areas within modeling and simulation demonstrations and analyses
- Identify and evaluate HSI constraints and risks associated with the overall system
- Revise HSI cost and risk drivers based on technology testing and validation

F
- Integrate evaluations of critical technologies across all functional areas
- Validate technology components against system component HSI requirements
- Participate in and evaluate demonstrations for HSI impacts with new technology components

G
- Evaluate critical technologies from an HSI perspective
- Review demonstration results for HSI-related constraints, risks, and opportunities
- Assess HSI impacts associated with trade-offs or component refnements

H
- Evaluate critical technologies from an HSI perspective
- Ensure HSI is properly refected in modeling and simulation engineering development models
- Review demonstration results for HSI-related constraints, risks, and opportunities
- Assess HSI impacts associated with accepted technology risks and system capabilities

I
- Ensure applicable HSI elements are embedded in the System Performance Specifcation and associated system development plans

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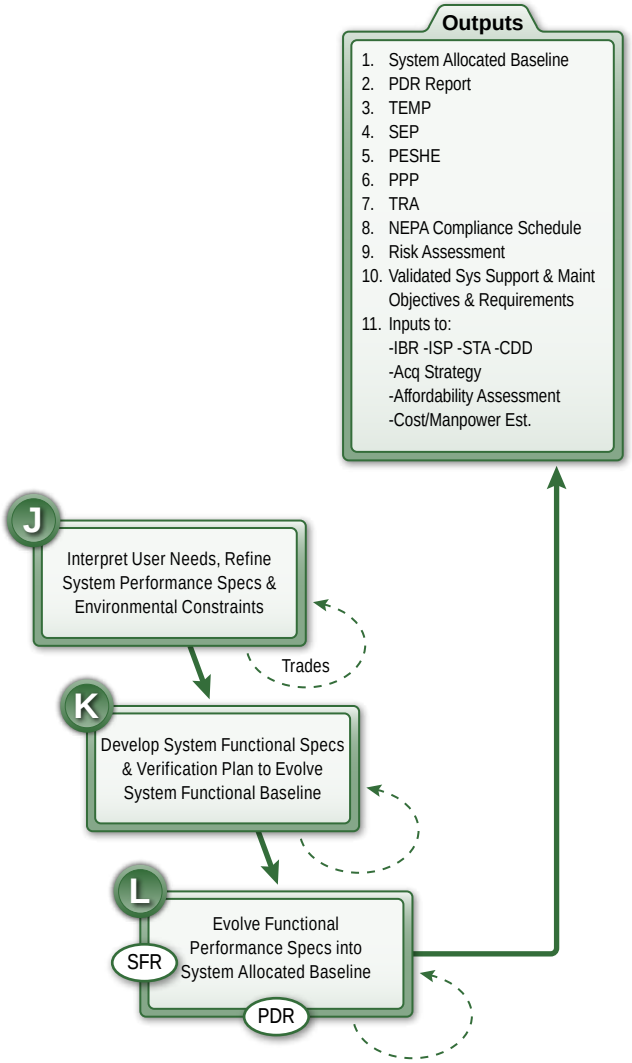
SRR
- Validate HSI criteria against user requirements
- Ensure HSI requirements have been included in the Systems Performance Specifcation
- Ensure all HSI performance requirements that affect system requirements derived from the Capability Development Document (CDD) are testable and defned in the system functional baseline
- Ensure that HSI risks are included in the comprehensive risk assessment

Trades
- Participate in AoA to ensure that HSI considerations have been addressed in the assessment of advantages and disadvantages
- Ensure trade space and risks analyzed include HSI considerations and are assessed against available technologies

The letters on this page correspond with the letters on the previous page and are associated with the respective SE step boxes.

Technology Development Phase (Outputs)

Human Systems Integration



Activities for Each Output:

1.0 Incorporate domain considerations into baseline parameters
1.1 Identify domain performance requirements
1.2 Assign requirements to system components
2.0 Address all HSI concerns
2.1 Document HSI issues, concerns, risks, and action items
3.0 Provide HSI inputs for testing
3.1 Ensure HSI risk areas will be tested
3.2 Identify preliminary HSI test techniques
4.0 Include HSI planning
4.1 Include HSI inputs throughout
5.0 Include HSI integration strategy, risks, responsibilities, and hazard tracking process
6.0 Provide HSI inputs as needed
7.0 Update risk mitigation technology readiness levels
8.0 Review and update checklist items
9.0 Reassess HSI risks
9.1 Update HSI risks and inputs to other technology areas
10.0 Provide HSI inputs to support and maintenance requirements
11.0 Participate in compilation of the inputs with HSI
11.1 Provide HSI requirements and domain inputs as applicable
11.2 Update the Manpower Estimate Report (MER)

References:

- DODI 5000.02 & DODD 5000.01
- DAG
- CJCSI 3170.01
- AFPD 63-1/AFPD 20-1
- AFI 63-101 & AFI 63-1101
- AFI 63-1201
- Domain-specifc policies

Tools:

- IMPRINT
- CATIA
- IPME

The numbers in the Activities boxes correspond to the numbers In the Inputs and Outputs boxes.

Technology Development Phase (Outputs): Human Systems Integration

J

- Develop HSI profle and system boundaries across the life cycle
- Embed HSI in requirements and acquisition documentation *i.e.,* Initial Capabilities Document (ICD), CDD, Acquisition Program Baseline (APB), Systems Engineering Plan (SEP), Human Systems Integration Plan (HSIP), Test and Evaluation Master Plan (TEMP), Life Cycle Management Plan (LCMP), *etc.*
- Identify, develop, and document HSI-critical requirements and verify they are included in the requirements tracking system
- Include ESOH assessment (reference updated DAG, Chapter 4–Systems Engineering)

K

- Conduct HSI analysis and develop HSI risk metrics
- Research all subsystem Human-Machine Interface (HMI) and HSI requirements
- Review all trade studies for HSI impacts
- Expand HSI analysis to include functional specifcations
- Verify HSI-critical functional specifcations are included in requirements tracking system and in the System Verifcation Plan
- Verify National Environmental Policy Act Executive Order (NEPA/EO) 12114 requirements are being met at proposed testing and training locations
- Provide HSI updates for demilitarization/disposal planning
- Identify HSI requirements in system or subsystem solicitations or contracts

L

- Review updated ESOH hazard and risk analysis for HSI impacts [*e.g.,* Preliminary Hazard Analysis (PHA), System Hazard Analysis (SHA), Subsystem Hazard Analysis (SSHA), and Operations and Support Hazard Analysis (O&SHA)
- Review HSI-derived requirements for component, subsystem, and system to include test requirements
- Provide updated input for demilitarization/disposal planning
- Expand and update HSI limitations, risks, and attributes as detailed design specifcations evolve
- Verify HSI-critical design specifcations are included in requirements tracking system, detailed design specifcations, and in Confguration Item (CI) Verifcation Plan
- Address HSI in the Preliminary Design Review (PDR)

SFR

- Address HSI requirements in the system functional baseline and in conjunction with the lower-level performance requirements
- Ensure requirements, metrics, and development efforts associated with HSI are included in the program documentation and LCMP
- Ensure system requirements and the functional baseline are suffciently detailed to enable a reasonable cost estimate

PDR

- Ensure domain-specifc performance requirements are included in the preliminary design
- Review subsystem requirements to address HSI issues
- Ensure HSI design factors have been reviewed and included where needed in the overall system design
- Ensure HSI risks are identifed and manageable
- Ensure 100% of all safety-critical drawings are complete
- Ensure requirements, metrics, and development efforts associated with HSI are included in the program documentation and LCMP
- Evaluate the preliminary design for possible risks, design shortfalls, and undocumented requirements

Trades

- Conduct trade studies on threshold and objective levels of HSI requirements as the design matures
- Refne HSI-related key performance parameter thresholds and objectives with approval of requirements authority
- Participate in HSI-critical trade studies
- Review results of all trade studies
- Coordinate with other HSI domains to assess trade-offs within HSI and determine technology readiness

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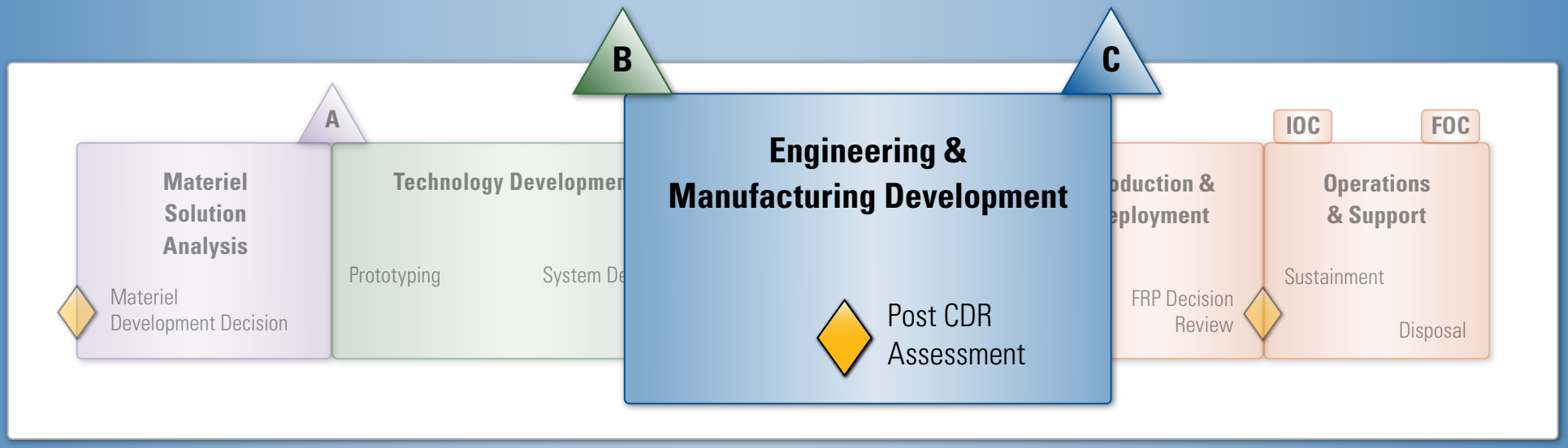
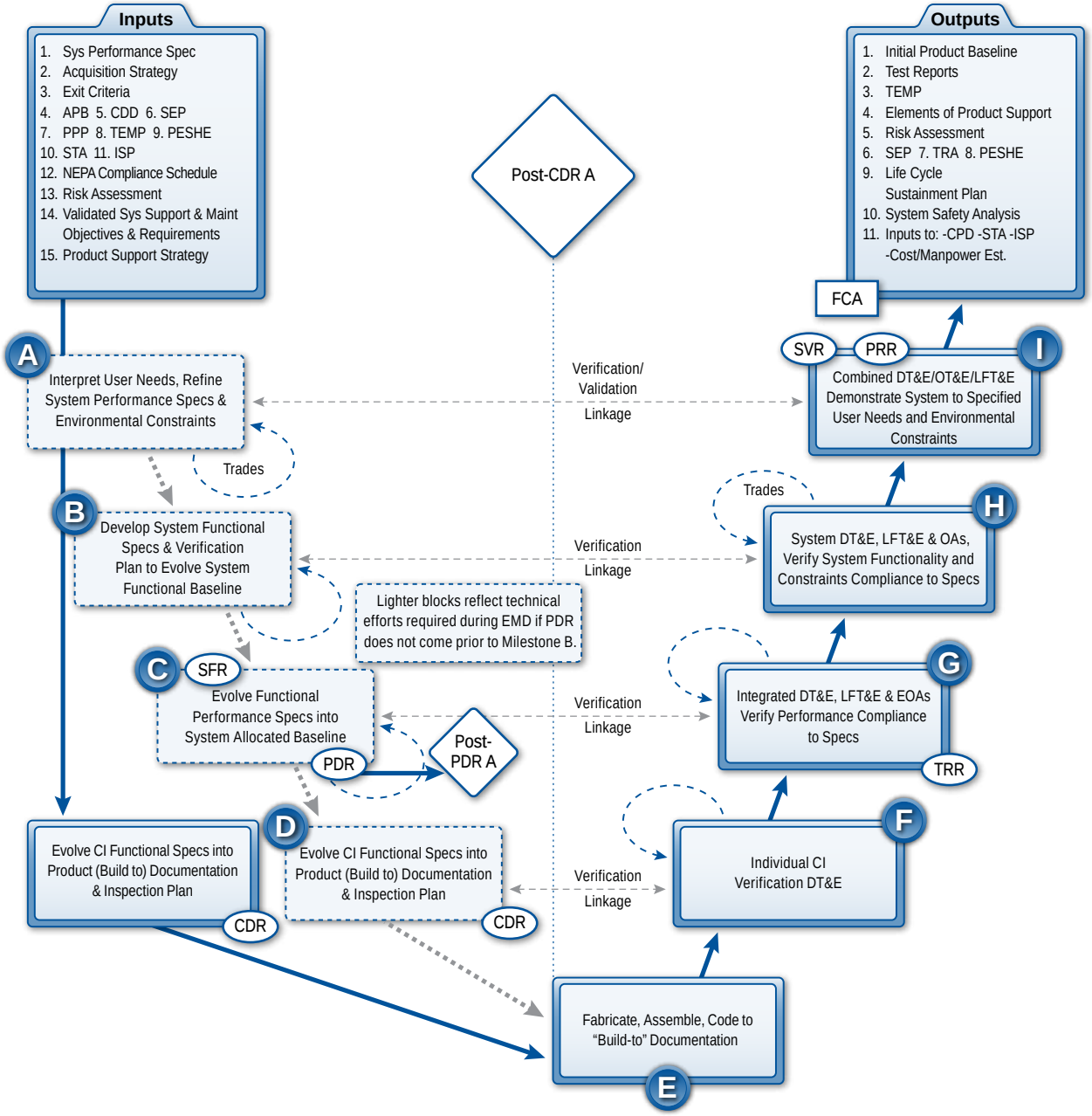


Engineering and Manufacturing Development—The purpose of the EMD Phase is to develop a system or an increment of capability; complete full system integration (technology risk reduction occurs during Technology Development); develop an affordable and executable manufacturing process; ensure operational supportability with particular attention to minimizing the logistics footprint; implement human systems integration (HSI); design for producibility; ensure affordability; protect CPI by implementing appropriate techniques such as anti-tamper; and demonstrate system integration, interoperability, safety, and utility. (DODI 5000.02)

Engineering & Manufacturing Development

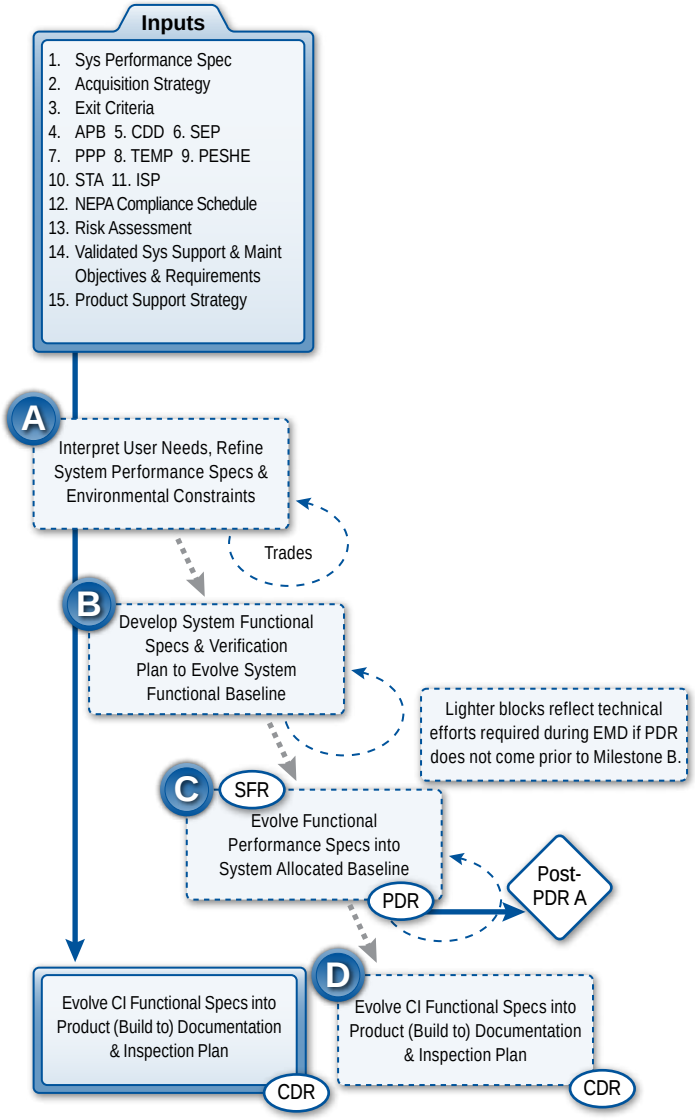


Engineering and Manufacturing Development (Inputs)

Human Systems Integration

Activities for Each Input:

1.0 Update HSI performance criteria
1.1 Ensure domain-specifc inputs are included
2.0 Provide HSI inputs as required
3.0 Update critical domain-specifc risks and mitigation approaches
4.0 Verify HSI criteria are included
5.0 Update HSI inputs
6.0 Validate and fnalize HSIP
6.1 Include HSI domain inputs
7.0 Provide HSI inputs as required
8.0 Assess HSI risk areas
8.1 Review modeling and simulation efforts and results
8.2 Develop and document Live Fire Test and Evaluation (LFT&E) strategy
9.0 Coordinate with ESOH Subject Matter Experts (SMEs) to verify HSI consideration
9.1 Review the Programmatic Environment, Safety, and Occupational Health Evaluation (PESHE) and ensure it includes HSI integration strategy, risks, responsibilities, and hazard tracking process
10.0 Verify HSI content if required
11.0 Verify HSI content if required
12.0 Review NEPA schedule checklist items for HSI inputs as applicable
13.0 Update HSI risks based on new/recent tests and analysis
14.0 Provide consolidated HSI inputs to the support and maintenance requirements and associated plans
15.0 Provide HSI inputs as required



References:

- DODI 5000.02 & DODD 5000.01
- DAG
- CJCSI 3170.01
- AFPD 63-1/AFPD 20-1
- AFI 63-101 & AFI 63-1101
- AFI 63-1201
- Domain-specifc policies

Tools:

- IMPRINT
- CATIA
- ATB Model
- IPME

The numbers in the Activities boxes correspond to the numbers In the Inputs and Outputs boxes.

Engineering and Manufacturing Development (Inputs): Human Systems Integration

A

- Develop HSI profle and system boundaries across the life cycle
- Embed HSI in requirements and acquisition documentation *i.e.,* ICD, CDD, APB, SEP, HSIP, TEMP, LCMP
- Identify and/or develop HSI-critical requirements and verify they are included in the requirements tracking system
- Include ESOH assessment (reference updated DAG, Chapter 4–Systems Engineering)

B

- Initiate development of HSI analysis and risk metrics
- Review and understand all subsystem HMI and HSI requirements
- Review all trade studies for HSI impacts
- Expand HSI analysis to include functional specifcations
- Verify HSI-critical functional specifcations are included in the requirements tracking system and in the System Verifcation Plan
- Verify NEPA/EO 12114 requirements are being met at proposed testing and training locations
- Provide updated input for demilitarization/disposal planning

C

- Review updated system safety and ESOH hazard and risk analysis for HSI impacts (*e.g.,* PHA, SHA, SSHA, and O&SHA)
- Review HSI-derived requirements for component, subsystem, and system to include test requirements
- Provide updated input for demilitarization/disposal planning
- Expand and update HSI limitations, risks, and attributes as detailed design specifcations evolve
- Verify HSI-critical design specifcations are included in requirements tracking system, detailed design specifcations, and in the CI Verifcation Plan
- Ensure HSI is addressed as part of the overall PDR

D

- Review ESOH hazard and risk analysis for HSI impacts (*e.g.,* SSHA, SHA, and O&SHA)
- Update HSI-derived requirements for component, subsystem, and system to include test and inspection requirements
- Identify HSI-critical processes for product baseline build-to documentation and software code-to documentation
- Include system HSI-critical processes and components in inspection plan
- Participate in component design selections
- Review Level of Repair Analysis and Maintenance Task Analysis for HSI impacts
- Verify system HSI-critical design specifcations are included in the requirements tracking system and detailed design specifcations as necessary

SFR

- Ensure HSI requirements are addressed in the system functional baseline in conjunction with the lower-level performance requirements
- Incorporate HSI in system and software assessments
- Ensure requirements, metrics, and development efforts associated with HSI are included in the program documentation and LCMP
- Ensure system requirements and the functional baseline are suffciently detailed to enable a reasonable cost estimate

PDR

- Ensure domain performance requirements are included in the preliminary design
- Review subsystem requirements to address HSI issues from all functional areas
- Ensure HSI design factors have been reviewed and included where needed in the overall system design
- Ensure HSI risks are identifed and manageable
- Ensure 100% of all safety-critical drawings are complete.
- Ensure requirements, metrics, and development efforts associated with HSI are included in the program documentation and LCMP
- Evaluate the preliminary design for possible risks, design shortfalls and undocumented requirements

CDR

- Update HSI inputs in the risk assessment
- Review CDD requirements to ensure HSI concerns are considered
- Ensure HSI risks are identifed and manageable
- Ensure requirements, metrics, and development efforts associated with HSI are included in the program documentation and LCMP
- Ensure hardware design and software product specifcations have adequately addressed all HSI risks

Trades

- Participate in HSI-critical trade studies and review results of all trade studies
- Ensure as the design is fnalized, HSI considerations that affect the component level of the system are part of the decision making and trade studies that occur at this level of design
- Coordinate with other HSI domains to assess trade-offs within HSI and determine technology readiness
- Coordinate with systems engineers to provide inputs to trade-offs that affect system and subsystem HSI requirements

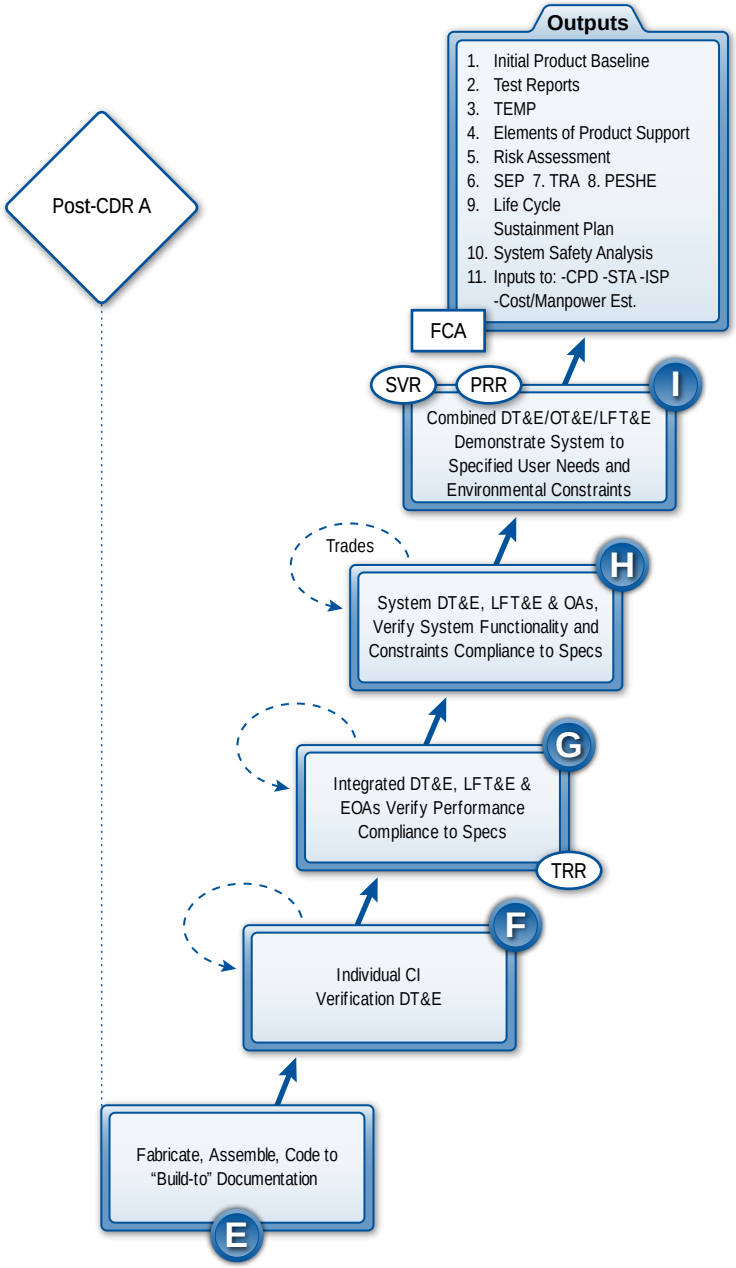
Post-PDR A

- Ensure open HSI issues and risks are documented in the PDR assessment report
- Review documentation for domain-specifc requirements, analysis, decisions, and taskings

The letters on this page correspond with the letters on the previous page and are associated with the respective SE step boxes.

Engineering and Manufacturing Development (Outputs)

Human Systems Integration



The numbers in the Activities boxes correspond to the numbers In the Inputs and Outputs boxes.

Activities for Each Output:

1.0 Update domain considerations into baseline parameters and reassess domain performance requirements
1.2 Integrate subsystem and component requirements
2.0 Identify HSI concerns in modeling and simulation outputs, mock-up tests, and frst article testing
3.0 Review and update for HSI issues
4.0 Identify HSI aspects of maintenance and logistics
5.0 Document residual risks and HSI risk acceptance decisions
5.1 Review domain-specifc incidents and mishaps that are HSI-related
6.0 Update HSIP with HSI-related concerns from technical reviews
6.1 Update strategy to refect HSI risks and control measures
7.0 Update HSI technology readiness levels from risk considerations
8.0 Identify ESOH risks and strategy for integration into SEP and HSIP
8.1 Review identifed gaps with ESOH POCs
9.0 Update HSI inputs to maintenance and logistics planning
10.0 Review System Safety Analysis for accuracy and completeness
10.1 Review safety analysis data for HSI opportunities
11.0 Provide HSI inputs as required
11.1 Update the MER with HSI-relevant content

References:

- DODI 5000.02 & DODD 5000.01
- DAG
- CJCSI 3170.01
- AFPD 63-1/AFPD 20-1
- AFI 63-101 & AFI 63-1101
- AFI 63-1201
- Domain-specifc policies

Tools:

- IMPRINT
- CATIA
- ATB Model
- IPME

Engineering and Manufacturing Development (Outputs): Human Systems Integration

E

- Evaluate process and design changes as necessary
- Review and recommend HSI updates to the TEMP
- Ensure CI verifcation Developmental Test and Evaluation (DT&E) procedures include HSI requirements and verifcation testing
- Initiate HSI risk acceptance reviews and documentation as appropriate

F

- Update status information on HSI risks and impacts
- Verify integrated DT&E, LFT&E, and Early Operational Assessment (EOA) procedures include appropriate HSI tests and evaluations
- Recommend HSI risk mitigation control measures based on DT&E test results as appropriate
- Initiate HSI risk acceptance reviews and documentation as appropriate
- Ensure NEPA/EO 12114 compliance is completed prior to testing

G

- Ensure tests are conducted that address HSI and all test results are reviewed for hazard control effectiveness
- Update HSI impacts and risks based upon confguration changes
- Provide updated HSI input for demilitarization/disposal planning
- Verify system DT&E, LFT&E and EOA procedures include HSI-appropriate tests
- Recommend HSI risk mitigation measures based on test results
- Provide HSI risk review and acceptance for upcoming test activities, as appropriate
- Verify that HSI test results support specifcation requirements

H

- Ensure NEPA/EO 12114 compliance is completed prior to testing
- Ensure test results mitigated HSI-relevant challenges
- Update HSI status and analyses based upon confguration changes
- Verify the combined DT&E, LFT&E and EOA procedures include appropriate HSI tests derived from system HSI analyses and reviews
- Recommend HSI risk mitigation measures as necessary
- Provide HSI risk review and acceptance for upcoming test activities as appropriate
- Ensure HSI issues identifed during testing are resolved

I

- Ensure NEPA/EO 12114 compliance is completed prior to testing
- Ensure test results mitigated HSI-relevant challenges
- Review operational supportability and interoperability certifcations for HSI suffciency
- Identify and characterize any residual HSI risks
- Update HSI status and analyses based upon confguration changes
- Recommend HSI risk mitigation measures, as necessary

TRR

- Ensure tests are planned to address identifed HSI requirements
- Ensure test procedures and planning are complete and compliant for HSI
- Verify that identifed HSI risk levels are acceptable to the program leadership
- Ensure operations and support HSI risks are fully documented and made available to testers

SVR

- Ensure system functionality is assessed and determine if it meets HSI requirements documented in the functional baseline
- Ensure adequate HSI metrics are in place
- Ensure HSI risks are identifed and manageable
- Review manufacturing processes to ensure the manufacturer has addressed HSI issues, focusing on environment, safety, packaging, and transportation
- Reassess production readiness in the event of signifcant manufacturing process changes (*i.e.,* new locations or subcontractors)

PRR

- Ensure HSI risks are identifed and manageable
- Ensure changes made during Engineering and Manufacturing Development do not degrade HSI in either the materials or manufacturing processes

FCA

- Confrm the HSI performance requirements achieve their functions during testing
- Ensure HSI concerns are addressed when reviewing the CI's test/analysis data, including software unit test results, to validate the intended function or performance stated in its specifcation is met
- Audit HSI functional requirements against development test results to ensure satisfaction of all requirements

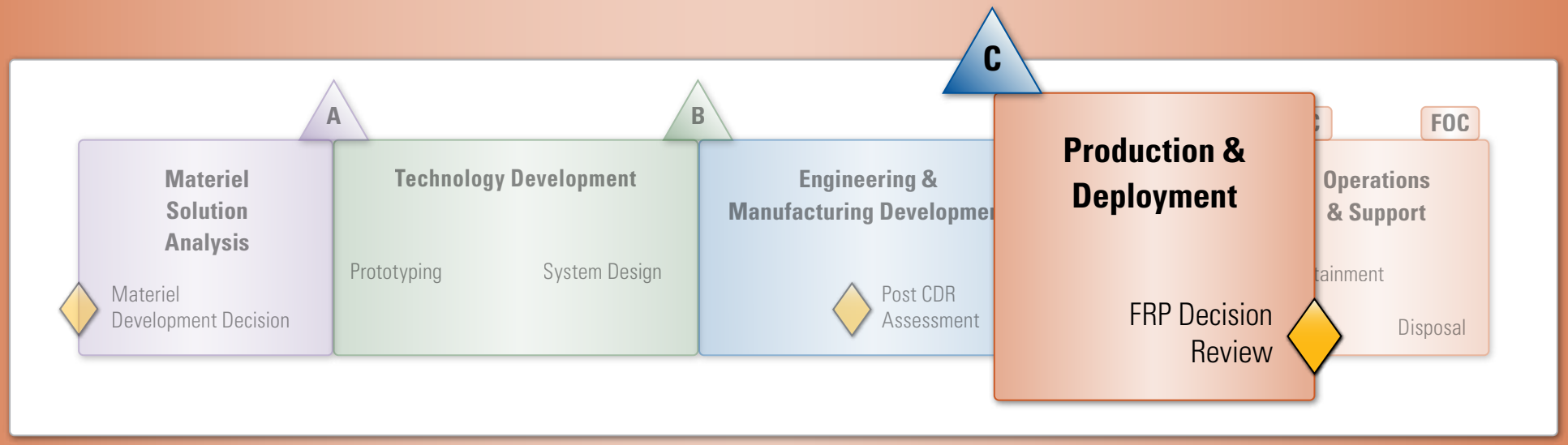
Trades

- Ensure as the design is fnalized, HSI considerations that affect the component level of the system are part of the decision making and trade studies that occur at this level of design
- Participate in HSI-critical trade studies to ensure HSI concerns are addressed
- Review results of all trade studies

Post-CDR A

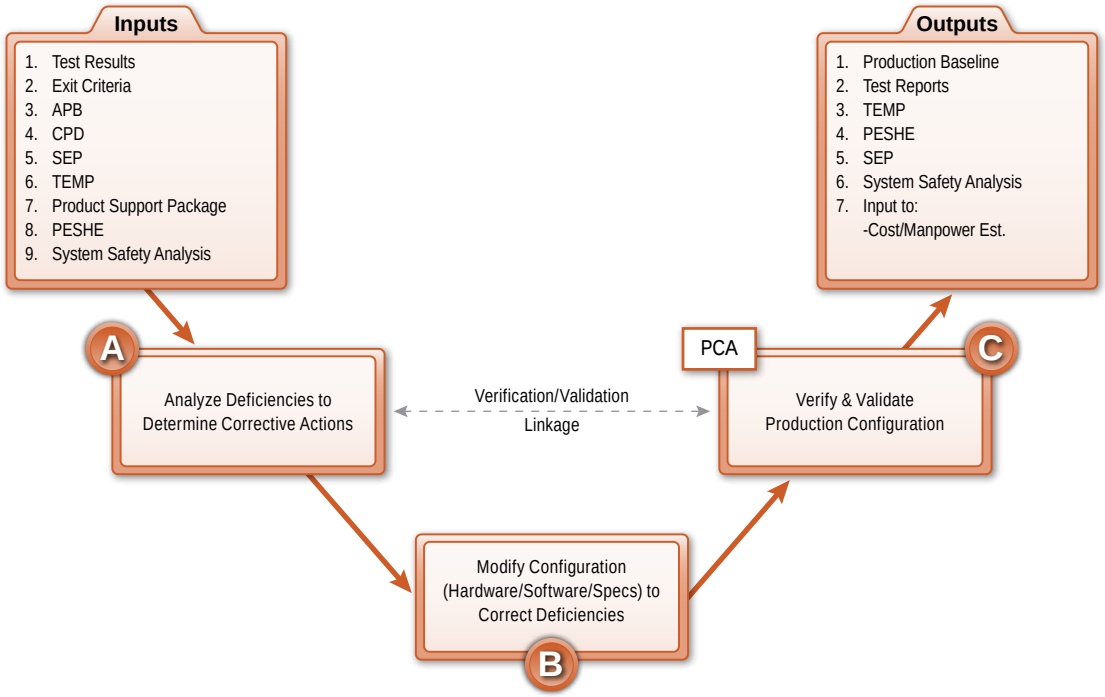
- Assess HSI risks against exit criteria for this acquisition phase
- Identify those HSI risks that could result in a breach to the program baseline or substantially impact cost, schedule, or performance

The letters on this page correspond with the letters on the previous page and are associated with the respective SE step boxes.



Production and Deployment—The purpose of the Production and Deployment Phase is to achieve an operational capability that satisfies mission needs. Operational test and evaluation shall determine the effectiveness and suitability of the system. (DODI 5000.02)

Production & Deployment Phase

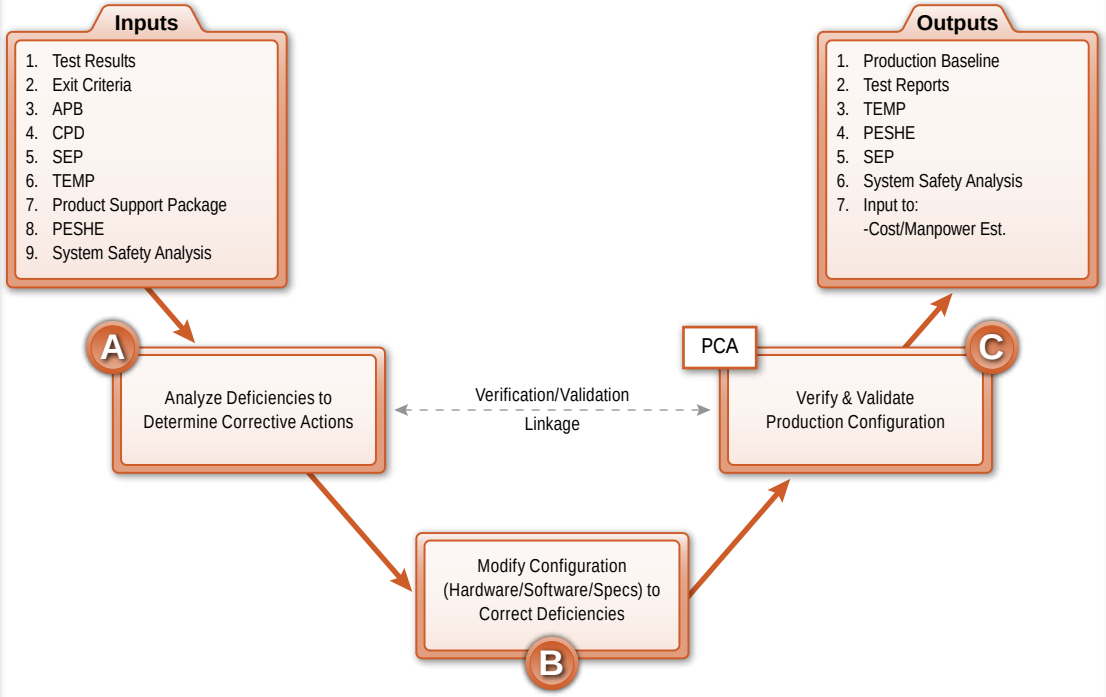


Production & Deployment Phase

Human Systems Integration

Activities for Each Input:

1.0 Review integrated system results and identify HSI concerns
1.1 Document results of HSI-specifc testing and identify planned corrective actions as appropriate
1.2 Leverage test results for HSI modifcations
2.0 Document risk control measures of identifed HSI constraints
3.0 Provide comprehensive HSI program inputs as required
4.0 Update HSI requirements and performance attributes to the system
5.0 Update strategy for incorporating HSI risk management into SE
5.1 Update HSIP with HSI-related concerns from operational test results
6.0 Monitor test planning to ensure HSI risk areas are being addressed
6.1 Revise to refect modifcations in HSI testing approach
7.0 Provide HSI updates to product support plans
8.0 Ensure inclusion of HSI risks and strategy for integration into SEP
9.0 Continue to monitor and track ongoing analysis results for HSI opportunities
9.1 Update with HSI inputs as required



Activities for Each Output:

1.0 Provide HSI updates based on Low Rate Initial Production (LRIP) and test results as required
2.0 Review test results for any HSI concerns and ensure appropriate corrective actions will be taken to address shortfalls.
2.1 Ensure trade-off decisions address HSI
3.0 Incorporate HSI-relevant data and further testing requirements
4.0 Coordinate with ESOH SME's for any required updates
4.1 Verify compliance with NEPA provisions
5.0 Update HSI risks and strategy for integration
5.1 Revise to refect changes in HSI data or strategies
6.0 Review and include HSI inputs as required
7.0 Revise MER to refect domain-specifc changes and impacts

References:

- DODI 5000.02 & DODD 5000.01
- DAG
- CJCSI 3170.01
- AFPD 63-1/AFPD 20-1
- AFI 63-101 & AFI 63-1101
- AFI 63-1201
- Domain-specifc policies

The numbers in the Activities boxes correspond to the numbers In the Inputs and Outputs boxes.

Tools:

- IMPRINT

Production and Deployment: Human Systems Integration

A

- Review defciency reports (DR) for HSI implications
- Participate in development of HSI mitigation measures
- Participate in Confguration Control Board (CCB) to include reviewing Engineering Change Proposals (ECPs) for HSI implications
- Analyze effectiveness of recommended NEPA/EO 12114 mitigation measures, and potential impacts on the natural environment
- Participate in planning of build, modifcation, verifcation, and test activities for the proposed design solution
- Assess the proposed design solution for correction of HSI defciencies

B

- Verify HSI system requirements and constraints at testing and training locations
- Identify HSI-critical design and verifcation requirements
- Provide HSI risk review and acceptance for upcoming test activities as appropriate
- Balance HSI recommendations with system cost, schedule, and performance risks

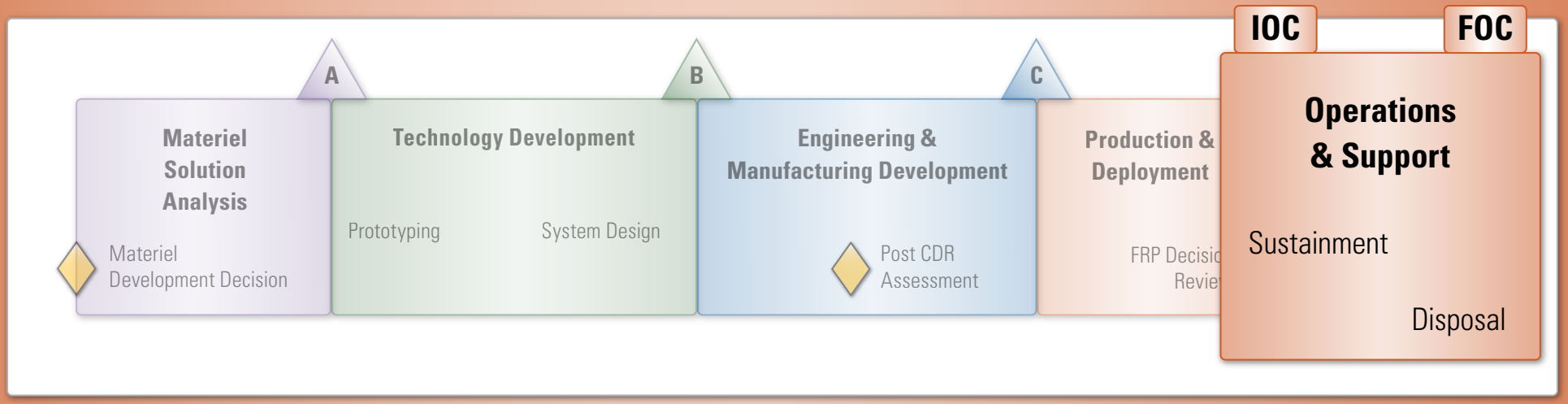
C

- Verify and validate HSI-critical design confguration
- Monitor testing and test results to validate HSI-relevant modifcations are effective
- Incorporate approved HSI changes that resolve HSI issues in the fnal production confguration baseline

PCA

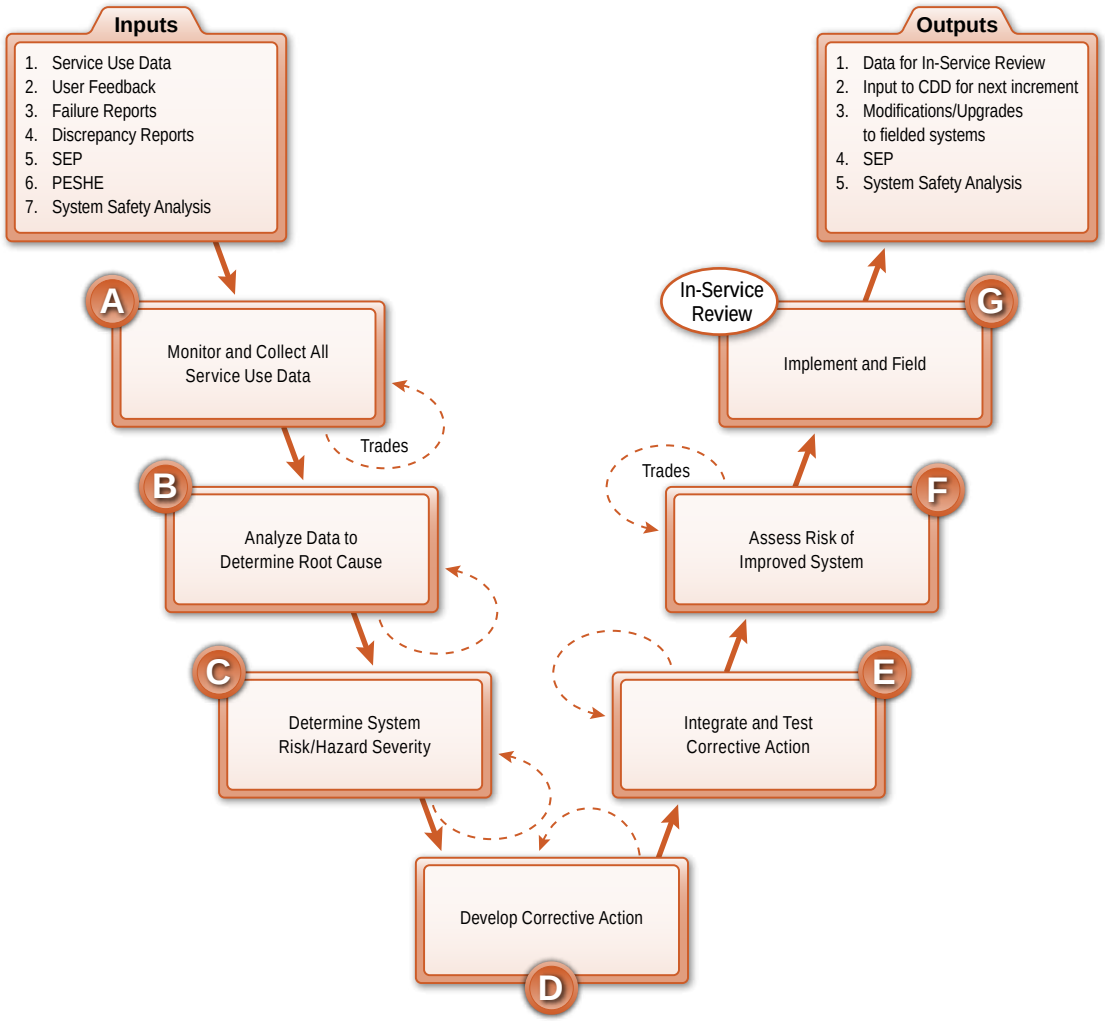
- Ensure human concerns are accounted for with testing, measuring, and controlling within the system
- Ensure HSI concerns are adequately planned, tracked, and controlled when confrming the manufacturing processes, quality control system, measurement, test equipment, and training
- Ensure the procured data package matches the as-built confguration
- Identify hazardous materials and processes in the technical data package

The letters on this page correspond with the letters on the previous page and are associated with the respective SE step boxes.



Operations and Support—The purpose of the Operations and Support Phase is to execute a support program that meets materiel readiness and operational support performance requirements, and sustains the system in the most cost-effective manner over its total life cycle. Operations and Support has two major efforts, Life-Cycle Sustainment and Disposal. (DODI 5000.02)

Operations & Support Phase

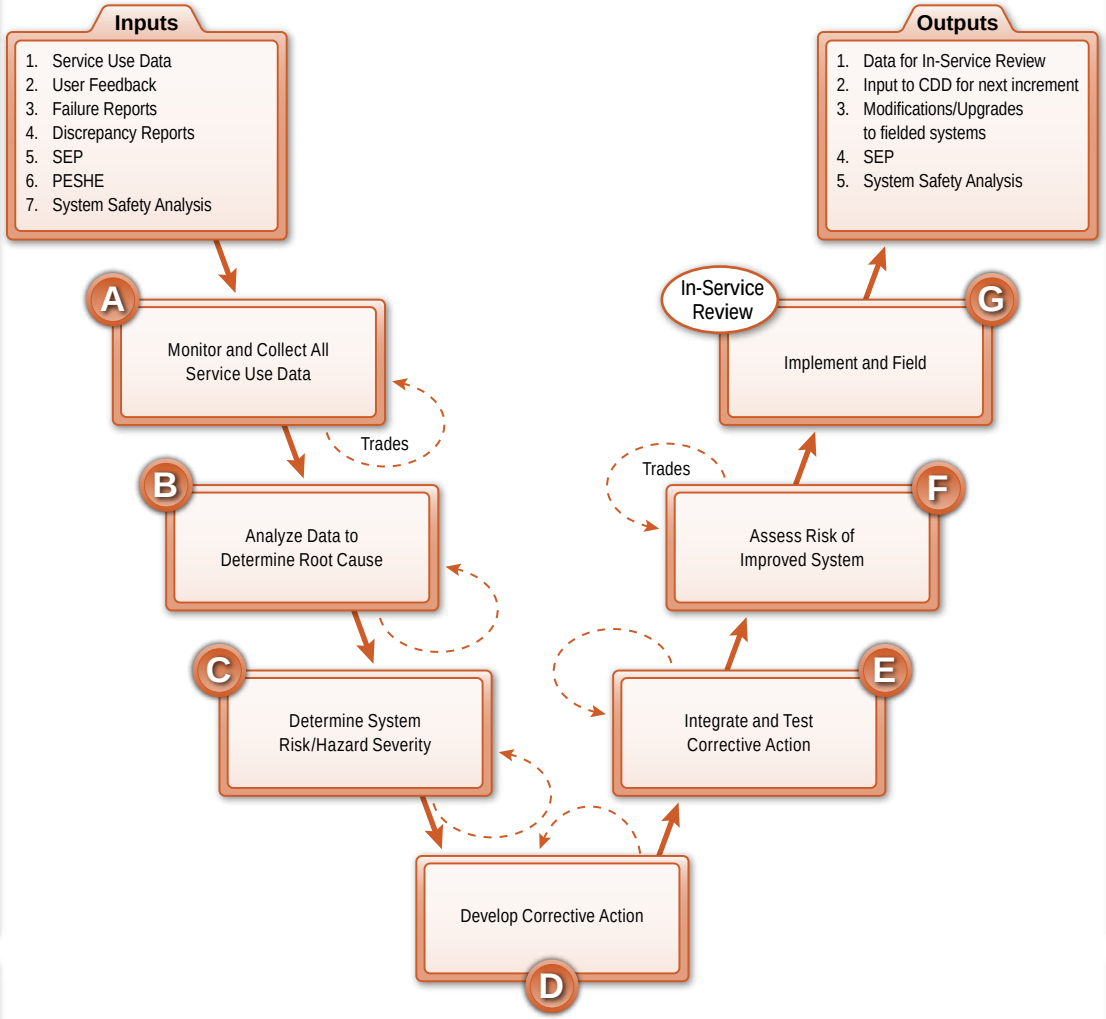


Operations & Support Phase

Human Systems Integration

Activities for Each Input:

1.0 Review HSI-related incident and mishap data reports
1.1 Identify HSI-related maintenance issues
1.2 Provide HSI inputs and constraints to system modifcations
2.0 Solicit user inputs to identify HSI issues
2.1 Participate in system HSI working groups to highlight HSI opportunities
3.0 Review HSI-related incident and mishap data reports
3.1 Ensure domain SMEs review relevant reports
4.0 Review and analyze for HSI issues
4.1 Provide HSI inputs to trade-off analysis
5.0 Update strategy for merging HSI risk management into SE
5.1 Update HSIP
6.0 Ensure inclusion of HSI risks and strategy for incorporation into PESHE
7.0 Revise HSI data and analysis results



The numbers in the Activities boxes correspond to the numbers In the Inputs and Outputs boxes.

Activities for Each Output:

1.0 Update HSI risk assessment
1.1 Review HSI hazards and DRs from operations and maintenance
2.0 Document achievable HSI requirements for each incremental stage
2.1 Include HSI inputs as needed
3.0 Incorporate HSI analyses, impacts, and defciency data
4.0 Review and update
4.1 Add any modifcations and technology developments that are HSI-related
5.0 Revise to refect domain-specifc changes as required

References:

- DODI 5000.02 & DODD 5000.01
- DAG
- CJCSI 3170.01
- AFPD 63-1/AFPD 20-1
- AFI 63-101 & AFI 63-1101
- AFI 63-1201
- Domain-specifc policies

Tools:

- IMPRINT

Operations and Support: Human Systems Integration

A

- Provide system HSI criteria to engineering and logistics staff
- Review data for HSI-influenced hazards (*e.g.,* trend analysis)
- Identify opportunities for technology insertion to reduce HSI risks
- Analyze rates for Class A, B, and C mishaps for the system and subsystems for HSI causal factors
- Review technical data change requests that may impact HSI

B

- Apply appropriate System Safety Analysis techniques to determine if HSI root causal factors exist
- Evaluate data for HSI implications
- Revise system's hazard analysis and risk tracking systems. Modify system status reports to reflect HSI impacts

C

- Prioritize HSI-related hazards for risk mitigation
- Revise system's hazard analysis and risk tracking systems. Modify system status reports to reflect HSI impacts

D

- Apply system safety order of precedence to HSI corrective actions
- Revise system's hazard analysis and risk tracking systems. Modify system status reports to reflect HSI impacts
- Identify requirements for verification of HSI mitigation control measures

E

- Evaluate test results for risk mitigation effectiveness
- Ensure control measures do not introduce latent problems into other domains, systems, human performance, or processes
- Revise system's hazard analysis and risk tracking systems. Modify system status reports to reflect HSI impacts

F

- Conduct in-depth system analyses to ensure corrective measures and design modifications do not spawn additional deficiencies or degrade human performance
- Recommend deficiency closure to appropriate risk acceptance authorities (updated residual risk)
- Revise system's hazard analysis and risk tracking systems. Modify system status reports to reflect HSI impacts

G

- Continue to monitor and track system health, human performance indicators, mishaps, deficiencies, closure actions, mitigation measure effectiveness, and residual risk to validate enhancement efforts

In-Service Review

- Ensure that HSI considerations are included during the risk, operational readiness, technical status, and trends assessments in a measurable form
- Substantiate assessments with in-service support budget priorities
- Include System Safety Working Group to support the System Hazard Risk Assessment
- Review and update problem-reporting metrics

Trades

- As corrective actions are incorporated into the system, HSI considerations that affect the system should be part of the decision making and trade studies that occur
- Utilize HSI analysis to influence maintenance and modification trade-off decisions
- Participate in HSI-critical trade studies and review results of all trade studies

The letters on this page correspond with the letters on the previous page and are associated with the respective SE step boxes.

Acronyms

Acronyms

A

AFHSIO	Air Force Human Systems Integration Office
AFI	Air Force Instruction
AFPD	Air Force Policy Document
AoA	Analysis of Alternatives
APB	Acquisition Program Baseline
ASR	Acquisition Strategy Review
ATB	Articulated Total Body

B

BCS	Baseline Comparison System

C

CARD	Cost Analysis Requirements Description
CATIA	Computer Aided Three-Dimensional Interactive Application
CCB	Configuration Control Board
CDD	Capability Development Document
CDR	Critical Design Review
CDR-A	Critical Design Review Assessment
CI	Configuration Item
CJCSI	Chairman of the Joint Chiefs of Staff Instruction
CJCSM	Chairman of the Joint Chiefs of Staff Manual
CONOPS	Concept of Operations

D

DAG	Defense Acquisition Guidebook
DoD	Department of Defense
DODD	Department of Defense Directive
DODI	Department of Defense Instruction
DR	Deficiency Report
DT&E	Developmental Test and Evaluation

E

ECP	Engineering Change Proposal
EMD	Engineering and Manufacturing Development
EO	Executive Order
EOA	Early Operational Assessment
ESOH	Environment, Safety, and Occupational Health

F

FCA	Functional Configuration Audit
FOC	Full Operational Capability
FRP	Full Rate Production

H

HMD	Head-Mounted Display
HMI	Human-Machine Interface
HSI	Human Systems Integration
HSIP	Human Systems Integration Plan

I

IBR	Integrated Baseline Review
ICD	Initial Capabilities Document
IMPRINT	Improved Performance Research Integration Tool
IPME	Integrated Performance Modeling Environment
INCOSE	International Council on Systems Engineering
IOC	Initial Operational Capability
ISR	In-Service Review
ITR	Initial Technical Review

L

LCMP	Life Cycle Management Plan
LFT&E	Live Fire Test and Evaluation
LRIP	Low Rate Initial Production

Acronyms

M

MER	Manpower Estimate Report
MSA	Materiel Solution Analysis

N

NEPA	National Environmental Policy Act
NEPA/EO	National Environmental Policy Act/Executive Order

O

O&S	Operations and Support
O&SHA	Operations and Support Hazard Analysis
OEM	Original Equipment Manufacturer
OTRR	Operational Test Readiness Review

P

P&D	Production and Deployment
PCA	Physical Configuration Audit
PDR	Preliminary Design Review
PDR-A	Preliminary Design Review Assessment
PESHE	Programmatic Environment, Safety, and Occupational Health Evaluation
PHA	Preliminary Hazard Analysis
PHL	Preliminary Hazard List
POC	Point of Contact
PRR	Production Readiness Review

S

SE	Systems Engineering
SEP	Systems Engineering Plan
SFR	System Functional Review
SHA	System Hazard Analysis
SME	Subject Matter Expert
SRR	System Requirements Review
SSHA	Subsystem Hazard Analysis
SURVIAC	Survivability/Vulnerability Information Analysis Center
SVR	System Verification Review

T

TD	Technology Development
TEMP	Test and Evaluation Master Plan
TRA	Total Risk Assessment
TRR	Test Readiness Review

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Glossary

Glossary

Term	Definition
Acquisition Program Baseline	Prescribes the key cost, schedule, and performance constraints in the phase succeeding the milestone for which they were developed. (CJCSI 3170.01G)
Analysis of Alternatives	The evaluation of the performance, operational effectiveness, operational suitability, and estimated costs of alternative systems to meet a mission capability. The analysis assesses the advantages and disadvantages of alternatives being considered to satisfy capabilities, including the sensitivity of each alternative to possible changes in key assumptions or variables. (CJCSI 3170.01G)
Baseline Comparison System	A current operational system, or a composite of current operational subsystems, which most closely represents the design, operational, and support characteristics of the new system under development. (DAG)
Capability Development Document	A document that captures the information necessary to develop a proposed program(s). The CDD outlines an affordable increment of militarily useful, logistically supportable, and technically mature capability, supporting a Milestone B decision review. (CJCSI 3170.01G)
Configuration Item	An aggregation of hardware, firmware, computer software, or any of their discrete portions, which satisfies an end use function and is designated by the government for separate configuration management. (DAG)
Engineering Change Proposal	A proposal to the responsible authority recommending that a change to an original item of equipment be considered, and the design or engineering change be incorporated into the article to modify, add or delete, or supersede original parts. (DAG)
Exit Criteria	Program specific accomplishments that must be satisfactorily demonstrated before a program can progress further in the current acquisition phase or transition to the next acquisition phase. (DAG)
First Article Testing	Production testing that is planned, conducted, and monitored by the materiel developer. It includes preproduction and initial production testing conducted to ensure that the contractor can furnish a product that meets the established technical criteria. (DAG)
Life Cycle Management Plan	Concise document that identifies relevant issues and recommends overall acquisition, program management, and life cycle support strategies. (DAG)

Tools

Tools

Name	Description	Applicability	
		Domain	Phase
ATB Model (Articulated Total Body Model)	The ATB model is a simulation program developed for the prediction of human body dynamics during aircraft ejection, aircraft crashes, automobile accidents, and other hazardous events. It is used in the Air Force to determine the safety of restraint systems, seats, escape systems, controls and displays, and other equipment in the aircraft cockpit during development. http://www.dtic.mil/dticasd/ddsm/tools.html	• Human Systems Integration	• EMD-Inputs/Outputs
		• Safety	• MSA; TD-Inputs
CATIA (Computer Aided Three-Dimensional Interactive Application)	CATIA (V6) is a collective, integrated multi-disciplinary model for product development. CATIA's RFLP approach includes aggregating Requirements, Functional, Logical, and Physical product definitions. Meta-CAD modeling delivers a collaborative, liberated design environment. In addition to 3D system design, CATIA also integrates a 3D human modeling component to simulate human-system interaction in a virtual environment. http://www.3ds.com/products/catia/catia-discovery	• Human Systems Integration	• MSA; TD-Inputs/Outputs; EMD-Inputs/Outputs
		• Human Factors Engineering	• TD-Inputs/Outputs; EMD-Inputs/Outputs
		• Habitability	• MSA; TD-Inputs/Outputs; EMD-Inputs/Outputs; O&S
HSI Requirements Guide	The HSI Requirements Guide provides templated HSI requirements. This guide's purpose is three-fold: First, to assist requirements writers in documenting solid, unambiguous human requirements in AF and DoD level acquisition documents. Second, to assist HSI domain requirements writers in understanding where they fit into Integrated Defense Acquisition, Technology, and Logistics Life Cycle Management System. Finally, to serve as learning tool/quick reference source for HSI domain representatives who are called upon to assist with writing requirements documents.	• All Domains	• MSA
IMPRINT (Improved Performance Research Integration Tool)	An HSI tool developed by the U.S. Army Research Laboratory, Human Research & Engineering Directorate. It is a dynamic, stochastic discrete event network modeling tool designed to assess the interaction of soldier and system performance throughout the system life cycle—from concept and design through field testing and system upgrades. http://www.arl.army.mil/ARL-Directorates/HRED/imb/imprint/Imprint7.htm	• Human Systems Integration	• All Phases
		• Human Factors Engineering	• MSA; TD-Inputs/Outputs
		• Habitability	• MSA; TD-Inputs/Outputs; EMD-Inputs/Outputs; O&S

Tools

Name	Description	Applicability	
		Domain	Phase
IPME (Integrated Performance Modeling Environment)	IPME is an integrated environment of models intended to help the human factors practitioner analyze human-system performance. IPME provides: a more realistic representation of humans in complex environments, interoperability with other model components and external simulations, enhanced usability through a user-friendly graphical user interface. IPME uses a process-oriented modeling approach and builds upon a SME's accounting of how operator activities are organized or may be organized to meet operational objectives. http://www.maad.com/index.pl/ipme	• Human Systems Integration	• TD-Inputs/Outputs; EMD-Inputs/Outputs
		• Human Factors Engineering	• MSA; TD-Inputs/Outputs; O&S

Air Force Human Systems Integration Office