SMC Tailoring SMC-T-006
28 August 2017

Supersedes:
SMC-T-006 (2015)

Air Force Space Command

SPACE AND MISSILE SYSTEMS CENTER TAILORING

SPECIALTY AND SYSTEMS ENGINEERING SUPPLEMENT TO IEEE-15288.1

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED

FOREWORD

1. This tailoring document defines the Government's requirements and expectations for contractor performance in defense system acquisitions and technology developments.

2. This revised SMC tailoring comprises the text of The Aerospace Corporation report number TOR-2015-01949-Rev A, entitled *Tailoring of IEEE 15288.1: Specialty and Systems Engineering Supplement*, dated July 28, 2017. The major changes in this release are documented in the Change Log contained in this document.

3. Beneficial comments (recommendations, changes, additions, deletions, etc.) and any pertinent data that may be of use in improving this document should be forwarded to the following addressee using the Standardization Document Improvement Proposal appearing at the end of this document or by letter:

Division Chief, SMC/ENE
SPACE AND MISSILE SYSTEMS CENTER
Air Force Space Command
483 N. Aviation Blvd.
El Segundo, CA 90245

4. This tailoring document has been approved for use on all Space and Missile Systems Center/Air Force Program Executive Office - Space development, acquisition, and sustainment contracts.

Mr. David Davis, GG-15, DAF
SMC Chief Systems Engineer

Mr. Nick Awwad, GG-15, DAF
SMC/ENE

Mr. Thomas Fitzgerald, SES, DAF
SMC Director of Engineering

Document Change Record

Document Number	Change	Rationale
TOR-2015-01949 also published as SMC-T-006 (2015)	Transferred specialty engineering requirements from SMC-S-001 (2013) not included in IEEE 15288.1	Effective specialty engineering planning is critical to high-reliability space systems for optimizing total system performance and total ownership costs, while ensuring that the system is designed, operated, and maintained to effectively provide the user with the ability to complete their mission.
TOR-2015-01949-REV A (this document) also published as SMC-T-006 (2017)	(1) Changed title from "Specialty Engineering Supplement…" to "Specialty and Systems Engineering Supplement…" (2) Added Document Change Record (3) Updated Section 2, Context (4) Added Section 3.2.17, Balanced Assessment – Cost, Schedule, Risk, and Technical Performance (5) Added Section 3.2.18, Mission Critical Fault Analysis (MCFA) (6) Added Section 3.2.19, Operationally Relevant Testing (7) Added Section 3.2.20, Space System Verification	(1) Expands scope to accommodate space-specific generic systems engineering tailoring (2) Provides document history (3) Documented current status of documents and added reference to adoption notices. (4) Addendum requirements clarifying the balancing of system effectiveness and cost assessments (5) Transferred definition, output requirements and output attributes formerly in SMC-S-001 to establish requirements to conduct MCFA to supplement mission-FMECA requirements for space systems and aligned SMC systems engineering process names with 15288. (6) Transferred definition, output requirements, output attributes formerly in SMC-S-001 to supplement end-to-end system testing requirements for space systems. Updated terminology from Test Like You Fly (TLYF) and Like You Fly (LYF) to Operationally Relevant Testing in accordance with AFI 63-119. Transferred and updated applicable documents. (7) Supplements general verification requirements with a space-specific recommended practice.

	(8) Added Section 3.2.21, Systems Engineering Data Item Descriptions (DIDs) (9) Editorial cleanup with no change of intent or requirements	(8) Provides DOD-required output attributes for contractors systems engineering planning (9) Various tense updates (present to past) and addition of synonyms in Logistics to reflect changes from 2015 to present.

Contents

Tailoring of IEEE 15288.1:
Specialty and Systems Engineering Supplement.

1. Intent of this Tailoring Document

This tailoring document is a domain-area supplement to the industry-consensus systems engineering standard, adding specialty engineering requirements that have been historically deemed valuable to mission assurance/success of high-reliability space systems.

The specialty engineering tailoring in this document supplements IEEE 15288.1-2014 Annex E, which extends the guidance of ISO/IEC/IEEE 15288:2105 Annex E.4, *Process view for specialty engineering*. This document identifies the specialty engineering disciplines[1,2] which are critical to high-reliability space systems for optimizing total system performance and total ownership costs, while ensuring that the system is designed, operated, and maintained to effectively provide the user with the ability to complete their mission.

The systems engineering tailoring provides additional detail in areas where IEEE 15288.1 provides high level requirements or notes, but where more detailed requirements are believed necessary to maintain the level or rigor required by national security space acquisitions.

2. Context

IEEE-15288.1: 2014, *Standard for Application of Systems Engineering on Defense Programs*

IEEE 15288.1 is an addendum to ISO/IEC/IEE-15288 for application of systems engineering on defense programs that was developed by a joint services working group under the auspices of the Defense Standardization Council. This document invokes the DOD-adopted systems engineering process in ISO/IEC/IEEE-15288: 2015, *Systems and Software Engineering — System life cycle processes*[3] and expands the process outcomes and outputs. The Joint DOD Systems Engineering working group was led by industry and the SMC Chief Systems Engineer on behalf of DOD. This systems engineering standard was developed in conjunction with IEEE 15288.2, Technical Reviews and Audits on Defense Programs, and coordinated with SAE International's EIA-649-1, Configuration Management for Defense Programs. IEEE 15288.1 was formalized as a standard by the IEEE's Computer Society. The balloting involved a broad range of government and industry members and was nearly unanimous. IEEE 15288.1 has been adopted by DOD for use on contracts[4] and was included in the SMC Compliance Standards list on November 13, 2015.

SMC-S-001 (2013), *Systems Engineering Products and Requirements*

SMC-S-001 was the systems engineering standard that was used by SMC between 2008 and 2015. It was used as the basis for development of IEEE 15288.1 since, at that time, it was the only systems engineering standard found to be suitable for use on DOD contracts. This standard was the only systems engineering standard that integrates systems and specialty engineering as it relates to high-reliability space systems in

---

[1] SMC Standard # SMC-S-001 (2013), *Systems Engineering*, Section 4.3; a republication of The Aerospace Corporation report # TR-2013-00001, *Systems Engineering Requirements and Products*.
[2] USAF Space and Missile Systems Center. *SMC Systems Engineering. Specialty Engineering Disciplines*. Volume 2, 1st edition. 3 October 2011.
[3] Notice – ISO/IEC/IEEE 15288 Adoption, Tier 1. http://quicksearch.dla.mil/qsDocDetails.aspx?ident_number=213120
[4] Notice – IEEE 15288.1 Adoption, Tier 1. http://quicksearch.dla.mil/qsDocDetails.aspx?ident_number=280941

a contractually compliant manner. The specialty engineering requirements in this document derive, verbatim, from SMC-S-001. SMC-S-001 has been superseded in the SMC Compliance Standards list by IEEE 15288.1, and this supplement.

3. Tailoring of IEEE 15288.1

3.1. General IEEE 15288.1 Tailoring Instructions

The requirements in this document shall be used in conjunction with IEEE 15288.1 on contract.

The requirements of this document shall prevail in the event of conflict between this document and IEEE 15288.1.

Annex E.4 from ISO/IEC/IEEE-15288:2015 shall be normative (requirements) rather than informative (guidance).

Sections 3.2.1 through 3.2.16 of this document replaces IEEE 15288.1-2014 Annex E in its entirety and shall be:

1. Normative (requirements rather than informative guidance),
2. Tailored appropriately for specific acquisition/contract considerations, and
3. Implemented as part of the performance of IEEE 15288.1 Task 6.4.1.3, Business or Mission Analysis Process

NOTE: Acquirers should utilize their organizational or domain area compliance standards list (or other related sources) and invoke the appropriate standards for the performance of detailed specialty engineering activities.

Mission Critical Fault Analysis, (MCFA), section 3.2.17 of this document shall be an extension of IEEE 15288.1 clauses 6.4.6.4c, Failure Mode, Effects, and Criticality analysis (FMECA) and 6.4.9, Verification outputs. Operationally Relevant Testing[5] (formerly known as Test Like You Fly - TLYF), Section 3.2.18 of this document shall be an elaboration of IEEE 15288.1 clause 6.4.8.4, Integration outputs and 6.4.11.4, Validation process outputs.

Verification of Space Systems, Section 3.2.19 of this document, shall be an elaboration of IEEE 15288.1 clause 6.4.9, Verification.

3.2. Specific IEEE 15288.1 Tailoring Language

3.2.1 Specialty Engineering Analysis and Control

The contractor **shall**, for each specialty area listed below:

a. Ensure that the following specialty functions and disciplines are incorporated into the systems engineering process.

b. Establish a documented valid/approved process (including but not limited to applicable corporate process, military standards, military handbooks, NSS/industry standard processes)

[5] Air Force Manual number AFMAN 63-119, *Certification of System Readiness for Dedicated Operational Testing*. 19 February 2016

that is comprehensive and responsive to the system/end-user requirements for each specialty engineering area being integrated into the systems engineering effort.

c. Include specialty engineering requirements in the requirements analysis, functional analysis/allocation, synthesis, and systems analysis and control.

d. Include their impact in system life cycle cost estimates as well as in total system performance/reliability assessments.

e. Document specific specialty engineering products/outputs in the SEMP.

3.2.2 Parts, Materials, and Processes (PMP)

NOTE: Address as part of Project Planning Outputs – 6.3.1.4

a. Detailed environmental parameters are defined/derived that impact parts performance.

b. Parts/materials engineering/design requirements are allocated, baselined, and traced to system-level performance requirements, including risk assessments.

c. Functional parameters are baselined and captured in detailed technical/procurement specifications.

d. Technology development plans are executed and technology readiness levels demonstrate products/technology suitable for system application and support program development schedules.

e. Qualified sources of supply and industrial base assessment are addressed.

f. Space systems radiation-hardening design solutions are established.

3.2.3 Structures

NOTE: Address as part of Project Planning Outputs – 6.3.1.4

a. Detailed performance and technical requirements for each structural system, subsystem, and component are defined, allocated, and traced to system requirements.

b. Structural design specifications comply with requirements and NSS industry practice.

c. Verification methods for each structural requirement are defined.

d. Structural requirements correlation with military and other government documents, including standards, specifications, handbooks, guidelines, and Commander's policies, are presented.

e. Technical risk mitigation approaches are defined.

f. Trade studies and detailed analyses support structural design solutions.

g. Analysis tools and techniques are consistent with NSS industry practice.

h. Design qualification methods adequately define approach to demonstrate structural adequacy.

i. Quality assurance methodology ensures delivery of high-quality product.

3.2.4 Manufacturing

NOTE: Address as part of Project Planning Outputs – 6.3.1.4

a. Producibility engineering principles and practices are integrated into the design process.

b. Manufacturing methods and processes required to build the design are qualified and demonstrated to meet system performance requirements and reliability.

c. Manufacturing analyses include producibility analyses and manufacturing and production inputs to system effectiveness, tradeoff studies, and life cycle cost analyses.

d. Alternative designs and capabilities of manufacturing are evaluated.

e. Long-lead-time items, material source limitations, availability of materials and manufacturing resources, and production cost are identified, assessed, and documented.

f. Manufacturing-critical characteristics of people, product, and process solutions and their risks are identified.

g. Tooling and test equipment strategies and requirements are defined.

h. Manufacturing and producibility requirements and constraints are defined.

i. Items are producible and stable manufacturing processes are in place to reduce risk, manufacturing cost, lead time, and cycle time, and to minimize use of strategic and critical materials.

j. As part of system design, manufacturing methods, processes, and process controls have been defined, evaluated, and selected, based on total system cost, schedule, performance, and risk.

k. Product design has stabilized, the manufacturing processes and process controls have been proven, and production facilities, equipment, capability, and capacity are in place (or are about to be established) to support the approved schedule.

3.2.5 Quality Assurance

NOTE: Comprehensively addressed as part of:

- Quality Management Process – 6.2.5 and
  Quality Assurance process – 6.3.8

3.2.6 Test

NOTE: Comprehensively addressed as part of:

- Project Assessment and Control – 6.3.2.3 (process) and 6.3.2.4 (outputs);
- Decision Management Process Outputs – 6.3.3.4;
- Risk Management Process – 6.3.4;

- Configuration management – 6.3.5.4 c.2 (process) and 6.3.7.4 c.1 (outputs);
- Measurement – 6.3.7.1 (process) and 6.3.7.4 c.1 (outputs);
- System Requirements Definition process – 6.4.3.4;
- Architecture Definition Process – 6.4.4.1;
- Design Definition Process – 6.4.5.1;
- Integration Process Outputs – 6.4.8.4
- Verification Process Output – 6.4.9.4;
- Transition Process Output – 6.4.10.4;
- Operation Process Output – 6.4.12.4; and
- Data Requirements – 5.3

3.2.7 Survivability

NOTE: Address as part of Project Planning Outputs – 6.3.1.4

a. System-level survivability requirements are defined, allocated, baselined, and traced to the system-level requirements.

b. System survivability attributes and mission objectives evolved into a set of system-level survivability requirements.

c. An approach for verification of system-level survivability/operability requirements is identified.

d. Test facilities capable of simulating threat environments are identified.

e. Threat assessments and analysis are conducted, defining categories of the expected threats (i.e., nuclear, biological, terrorism, etc.) and their likelihood of occurrence.

f. Threats and mitigation strategies are defined.

g. Nuclear and other threats are translated into system environments and modeled.

h. System/threat interaction analysis is performed.

i. Hardness levels and definition of hardness margins and design criteria are identified.

3.2.8 Environmental, Safety, and Occupational Health (ESOH)

NOTE: address as part of Systems Analysis Outputs – 6.4.6.4

a. System-level ESOH requirements are defined, allocated, baselined, and traced to the system-level requirements:

(1) Hazards are identified.

(1) Hazardous materials are analyzed, including handling and disposal.

(2) Mitigation decisions are evaluated.

(3) Residual risk acceptance is evaluated.

(4) Current mitigation efforts are assessed.

(5) National Environmental Policy Act (NEPA) and Programmatic Environmental, Safety, and Health Evaluation (PESHE) requirements are incorporated.

b. ESOH risks and corrective actions and alternatives are developed to eliminate or reduce environmental, health, and identified hazards and unsafe conditions; and the threat of regulatory violations is identified.

c. Criteria are established for monitoring and reporting of pollution elimination/reduction efforts.

d. A containment program is developed, including procedures for safe use and disposal.

e. Handling and disposal of hazardous material are included in life cycle cost estimates.

3.2.9 Contamination

NOTE: Address as part of Project Planning Outputs – 6.3.1.4

a. Requirements for contamination control are identified for sensitive components or subsystems, including:

(1) Need for normal, medium, or challenging/stressing contamination control to meet requirements.

(2) Any needs for new or upgraded facilities.

(3) Shipping and prelaunch operations.

b. Cleanliness challenges are identified and solutions proposed, including:

(1) Uncleanable materials.

(2) Solvent incompatibility.

(3) Mission-unique requirements to launch vehicle.

(4) High outgassing materials.

c. Heritage analysis comprehensively and completely demonstrates that prelaunch cleanliness requirements can be met and that overall end-of-life (EOL) requirements can be met.

3.2.10 Mass Properties

NOTE: Address as part of Project Planning Outputs – 6.3.1.4

a. Mass properties requirements are reviewed and generated; changes are proposed where applicable.

b. Baselined design is reflected in the mass properties analyses and reports.

c. Subsystem and subcontractor's definition of critical mass properties parameters are reviewed and tracked to ensure that specification requirements are met.

d. Configuration layout for optimizing mass properties (weight, balance, and inertia) is analyzed.

e. Balance weight locations are defined. Provisions for balance weight installation are ensured.

f. Test plan and test procedure are generated; method of verifying requirements is defined; required mechanical ground support equipment (MGSE) is identified.

3.2.11 Logistics/Integrated Logistics Support

NOTE: Address as part of Project Planning Outputs – 6.3.1.4

a. Logistics requirements are defined, allocated, baselined, and traced to system requirements. Logistics management information (LMI), life cycle cost (LCC) analysis with a discussion of risks, and any risk reduction or control are included for the following logistics areas/ILS elements:

(1) Design interface – system reliability, maintainability, availability, survivability, including hardness and unique characteristics.

(2) Support concepts/maintenance plan – initial and steady-state support; implementation and transition schedule at organizational and depot level; warranties and SORAP/Depot Source of Repair (DSOR).

(3) Manpower and personnel – operations, maintenance (hardware and software), and training support personnel.

(4) Supply support – support concept for initial and steady state, sparing/provisioning requirements to support concept of operation.

(5) Support equipment and simulators – common and specialized/peculiar organizational and depot support equipment, and system-level simulators and trainers.

(6) Training systems and training support – initial and follow-on training, equipment, documentation and facilities; student requirements.

(7) Technical data – engineering drawings and technical orders; data rights, technical manual contract/delivery requirements.

(8) Computer resource support – software and database maintenance, facilities, equipment, COTS, and documentation.

(9) Facilities – Space projections, new or reuse requirements, site survey, deployment, and transportable facilities.

(10) Packaging, handling, storage and transportation (PHS&T) – LMI packaging analysis, government and commercial packaging requirements, and packing requirements meet

all concept of operations, including deployment storage, oversized and special packaging instruction, and air, ground, or sea shipping requirements.

3.2.12 Human Systems Integration (HSI)

NOTE 1: Address as part of Project Planning Outputs – 6.3.1.4

NOTE 2: This section presents requirements for the systems engineering planning activities associated with human systems integration. The requirements for the subordinate domains are contained within specific domain-level standards.

3.2.12.1 Scope and Nature of Work

a. Human systems integration (HSI) shall be applied as part of the overall systems engineering effort to efficiently and effectively integrate humans into the design of the system. The goals of the human systems integration effort shall be to:

(1) Plan and execute efficient development of systems that effectively integrates human operators, maintainers, support personnel, and/or users.

(2) Plan for impacts of military system operation, use, or disposal on potentially affected general populations.

(3) Ensure system performance by ensuring human integration and specified levels of performance.

(4) Apply to all aspects of military systems, equipment, and facilities acquisition, including analysis, design, development, acquisition, test and evaluation, sustainment, and product improvement.

(5) Implement by making effective demands upon, and tradeoffs between, personnel resources, skills, and training to allow for knowledgeable management of total system ownership costs.

3.2.12.2 HSI Planning

a. HSI shall be part of the overall systems engineering effort within the total project and shall coordinate with all appropriate systems engineering specialties or disciplines.[6]

b. HSI planning shall establish the collaboration between HSI domain disciplines with emphasis on each domain area's participation in system (hardware and software) design and testing.

c. HSI shall be documented and managed accordingly.

d. Risk management — HSI-related risks and issues that involve technical, cost, or schedule risks shall be identified and managed as early as possible as part of a program's overall risk management approach.

---

[6] Support material for HSI planning can be found in The Aerospace Corporation report TOR-2012(8960)-1 REV A – HSI Planning Requirements.

e. Reviews — HSI-related activities shall be reported in all appropriate programmatic or technical reviews.

f. HSI shall address the following discipline areas[7]:

(1) Manpower – number and mix (military, contractor, and civilian) of personnel required, authorized, and available to train, operate, maintain, and support the system.

(2) Personnel – human aptitudes, skills, experience levels, and abilities required to operate, maintain, and support the system when fielded and throughout its life cycle.

(3) Training – instruction and resources required to provide the necessary knowledge, skills, and abilities to properly integrate, operate, maintain, and support the system.

(4) Human factors engineering – integration of human capabilities (cognitive, physical, sensory, and team dynamics) into system design, development, modification, and evaluation to optimize human-machine interactive performance for operation and maintenance of the system.

(5) Environment – issues related to water, air, and land and the interrelationships between these and all living things.

(6) Safety – issues including design of operational systems to minimize the possibilities for accidents or mishaps that threaten personnel or the survival of the system.

(7) Occupational health – minimizing risk of injury, acute and/or chronic illness, disability, and/or reduced job performance to personnel who operate, maintain, or support the system.

(8) Survivability – minimizing risk of fratricide, detection, and probability of being attacked; and inclusion of factors that enable the crew to withstand man-made or natural hostile environments without aborting mission or suffering acute/chronic illness or death.

(9) Habitability – living or working conditions necessary to sustain the morale, safety, health, and comfort of the user/maintainer population, contributing directly to personnel effectiveness and mission accomplishment.

g. The HSI activities shall be integrated into the overall systems engineering program and management. The HSI requirements specified herein shall be coordinated with, but shall not duplicate, efforts performed to fulfill other contractual program tasks. The HSI-related portion of any analysis, design, or test and evaluation program shall be conducted under the direct cognizance of a qualified HSI-domain practitioner(s) assigned such responsibility by the contractor. “Qualified” should consider basis of education, experience, and/or certification in systems engineering, human systems integration, or any of the individual HSI domains.

[7] Individual DOD services/components may organize these same domain areas into different domain area combinations.

h. The contractor shall determine the scope and nature of HSI domain area applicability such that:

(1) Program/contract requirements are allocated to the appropriate HSI domain (discipline) areas.

(2) Responsible entities (e.g., HSI Working Group and/or Integrated or Cross Product Teams – IPTs) are identified for each applicable HSI domain within the systems engineering IPT structure.

(3) Key or lead HSI personnel in all applicable domains are identified and described in terms of qualifications.

(4) Interfaces between related HSI domains are defined and developed to ensure comprehensive and effective execution of human-related requirements.

(5) Interfaces are established between the prime contractor and all subcontract or vendor HSI activities.

(6) Domain interdependencies and tradeoffs are identified to ensure humans are considered as part of system design on par with the hardware and software.

i. HSI planning shall be described in a configuration-managed document that is used to execute the HSI effort.

j. HSI planning shall:

(1) Include the human-related tasks to be performed, milestones, level of effort, methods, and design concepts to be used, and the test and applicable evaluation methodologies.

(2) Describe data flow between HSI domains and/or IPTs (see Appendix B Giver-Receiver relationships).

(3) Be documented as a human systems integration plan and/or within the Systems Engineering Management Plan (SEMP).

(4) Be validated/updated prior to major programmatic and technical reviews.

(5) Be updated at program rebaseline and/or engineering change proposal (ECP).

k. The following activities shall be considered:

(1) Integration of relevant human-related data and analyses into all design and development activities with human-related requirements, design features, or implications, especially considering the relationships between these efforts and opportunities to effect efficiencies in system development, operation, and maintenance.

(2) HSI implications for integrated development of logistics and operational support materials, including procedures, manuals, and technical documentation.

(3) User involvement and community review of human-related activities and products, including prototype assessments, peer reviews, and formal reviews.

(4) Verification and/or validation of human requirements and human-related design options/solutions.

l. The contractor shall identify and manage human-related risks, issues, and opportunities in a way that:

(1) Ensures HSI-related risks are managed within the program's risk management process.

(2) Identifies potential cost, schedule, technical, and performance risks that result from human systems integration.

(3) Quantifies such risks and their impacts on cost, schedule, and performance.

(4) Evaluates and defines the sensitivity of HSI-related risks.

(5) Identifies alternative solutions to HSI-related issues and defines the associated risks of each alternative.

(6) Documents the identified risks, their potential impact, and the mitigation action(s) taken.

(7) Manages the actions required to avoid, minimize, control, or accept each HSI-related risk.

m. Human systems integration domain activities shall be addressed in all applicable programmatic and technical reviews, including but not limited to:

(1) Programmatic reviews, which include but are not limited to program management review, integrated baseline review, and integrated system review.

(2) System reviews, which include, but are not limited to:

i. Concept and requirements definition.

ii. Analysis of alternatives.

iii. System requirements review.

iv. System function review.

v. Preliminary design review.

vi. Critical design review.

vii. Test readiness reviews.

viii. System safety reviews.

ix. Engineering change proposal reviews.

x. Post-implementation reviews.

(3) Subsystem and other lower-level reviews including, where applicable, software specification, test readiness, and functional reviews (e.g., support, training, systems

engineering, test, and manufacturing).

3.2.13 System Security and Information Assurance

NOTE: Address as part of Project Planning Outputs – 6.3.1.4

a. A system security program is implemented that includes Information Systems Security Engineering (ISSE).

b. Protection needs are documented, including identification of mission assets and assessment of threats to those assets.

c. System security requirements are defined and complete. Includes system-specific threats and compliance with applicable DOD, national, and international system security policies. Includes system security design constraints.

d. System security architecture and management plan is documented.

e. Security design, including constraints and tradeoffs, is detailed; cryptography plans are coordinated with the National Security Agency.

f. Certification and accreditation process activities are coordinated.

g. Protection mechanisms have been verified to satisfy security requirements and residual security risks have been approved by the appropriate authorities.

3.2.14 Reliability

NOTE: Address as part of Project Planning Outputs – 6.3.1.4

a. Space system-specific reliability requirements are defined, allocated, baselined, and traceable to system requirements.

   (1) Parameters and limits are defined at this level and provided within the system specification.

   (2) Reliability requirements are reviewed against functional requirements and customary design practices.

b. Applicable specific design tasks and analyses are conducted, including:

   (1) Failure Reporting Analysis, Corrective Action System (FRACAS).

   (2) Source selection and vendor control procedures.

   (3) Failure Modes Effects and Criticality Analysis (FMECA).

   (4) Derating and margins of safety.

   (5) Fault coverage.

   (6) Single-point failure.

(7) Redundancy/single string.

c. The reliability program plan are developed for final top-level space system.

d. Items in development that have impact on support resources are identified, including time, people, money, parts, tools, storage, and transportation assets.

3.2.15 Electromagnetic Interference and Compatibility (EMI/EMC)

NOTE: Address as part of Project Planning Outputs – 6.3.1.4

a. EMI/EMC requirements are defined, allocated, baselined, and traced to system requirements, including:

(1) Use of RF shielded enclosures for vehicle, subsystems, or components, and other significant design features affecting EMC.

(2) Structure RF shielding effectiveness in excess of 40 dB.

(3) Return of power on spacecraft structure.

(4) Unshielded or untwisted or unpaired wires.

(5) Radiated emissions requirements less than 20 dBuV/m.

(6) Gimbals that form part of a shielded enclosure—high risk.

(7) Radiated susceptibility requirements in excess of 100 V/m—high risk.

(8) Systems having passive intermodulation products of order 7 or less in platform receiver pass bands.

(9) Any EMC wire shields or grounds that are required to flex or rotate or rub/roll more than 20 times.

(10) Magnetic dipole requirements more stringent than 3.5E-3 A-m^2/kg.

(11) All first-flight/first-use EMC parts.

(12) All cryo-cooled sensor EMC designs.

(13) All EMC requirements with negative margin.

(14) Any RF receiver required to work in a dense EMI environment.

(15) Any RF receiver with a burnout level of less than 30 dBm (1 mW).

b. A summary of all significant areas are addressed in the EMC Control Plan, including but not limited to program requirements tailoring and the use of heritage equipment and other NDI.

c. EMC requirements verification planning to the unit level is conducted.

d. EMI/EMC risk areas are identified and risk mitigation closure plans developed.

3.2.16 System Safety

NOTE: Address as part of Project Planning Outputs – 6.3.1.4

a. System safety requirements are defined, allocated, baselined, and traced to system requirements, including:

(1) System safety design requirements are specified and safety design criteria determined.

(2) Hazards associated with the system are identified and risks involved identified; hazard analysis is complete.

(3) Risks are minimized in the design, materials, testing, and production of end item.

(4) Retrofit actions are minimized by inclusion of safety features during definition and development of system.

b. Hazardous substances, components, and operations are isolated from other activities, areas, personnel, and incompatible materials.

c. Catastrophic risks are eliminated.

d. Critical hazards are minimized.

3.2.17 Balanced Assessment – Cost, Schedule, Risk, and Technical Performance

NOTE: Address as part of Project Assessment and Control process outputs – 6.3.2.4 and Measurement process outputs – 6.3.7

a. Each assessment of system effectiveness shall surface deficiencies for key performance parameters (KPPs) and ensure that the traceability between the MOEs, MOPs, KPPs, and TPMs is maintained.

b. Each assessment of cost shall:

(1) Include established design-to-cost targets, a current estimate of these costs, and known uncertainties in these costs.

(2) Address cost and schedule risk.

(3) Be conducted and updated as designated in the contract to support decisions, assessments of system cost effectiveness, and tradeoff studies to:

(a) Identify the sunk costs to the extent required for the specific cost assessment.

(b) Provide an estimate of the remaining development, production, operations and support (O&S), and life cycle costs for the proposed system concept to include new or modified government facilities.

(c) Demonstrate that the system concept and development plans for completing development—including any plans for new parts, materials, or processes, new or modified facilities, or other new or modified resources—are affordable and meet the program schedule requirements at acceptable risk.

(d) Identify the economic consequences of solution alternatives.

3.2.18 Mission Critical Fault Analysis

Definitions –

Critical fault risk (CFR) – A risk associated with a potential fault or flaw that would lead to mission failure.

Mission Critical Fault Analysis (MCFA) – A mission oriented top-down analysis that focuses on determining the events and sequences of events that can lead to mission failure in any phase of the mission up to and including nominal operations.

Operationally Relevant Test (formerly Test Like You Fly (TLYF)) – Any pre-operational test based on operational timelines, configurations, and other applicable mission characteristics.

a As part of System Requirements Definition Activities and Tasks, clause 6.4.3.3, the contractor shall conduct a Mission Critical Fault Analysis (MCFA) that includes:

(1) List of mission critical failures that can cause loss of mission or inability to execute mission.
(2) For each mission critical failure, the fault analysis with potential flaw contributors.

b. As part of System Analysis Activities and Tasks, clause 6.4.6.3, the contractor shall conduct critical fault risk (CFR) assessments.

c. Each assessment of critical fault risk (CFR) includes identification and documentation of:

(1) All first-time events and mission critical activities not allocated to operationally relevant tests as part of program test plans.

(2) Operationally relevant test exceptions that are correlated to the MCFA.

d. As part of System Analysis Activities and Tasks, clause 6.4.6.3, and System Realization Verification Activities and Tasks, clause 6.4.9.3, the contractor shall conduct mission critical fault analysis (MCFA) to identify the mission critical failures for each mission phase and the associated fault conditions with the following attributes:

(1) Mission failures are identified by a team representing all mission elements and technical disciplines. Each potential mission failure will be populated with all single fault paths to that failure.

(2) Single fault paths include those that involve mismatches between two items or elements (e.g., race conditions, counting strategy, or engineering units).

(3) Each mission failure analysis will be documented (e.g., in an analytical tool such as master logic diagram, fault tree, event tree, or Ishikawa diagram).

(4) MCFA will be updated as necessary to reflect changes in operations, hardware design, or software design.

3.2.19 Operationally Relevant Testing

NOTE: Operationally Relevant Testing was formerly known as Test Like You Fly – TLYF.

a. As part of Stakeholder Needs and Requirements Definition, clause 6.4.2, the contractor shall participate with the customer, if contractually directed, in developing, refining, and updating operational test and operationally relevant test planning.

b. As part of System Requirements Definition, clause 6.4.3, Operational concepts documentation ensures that all mission operational data interactions and transactions are validated in operationally relevant tests.

c. As part of Design Definition, clause 6.4.5, the validated, approved, and maintained design release baseline shall be validated through customer involvement to ensure that operationally relevant tests to support design decisions are architected and designed to reflect mission usage, including appropriate selection of mission characteristics, and critical fault risk assessment for deviations from mission characteristics or usage.

d. As part of Integration, clause 6.4.8, the contractor shall allocate operationally relevant validation tests to appropriate levels of hardware, software, and hardware/software integration; to appropriate vendors; and to levels of mission functional integration. The customer or customer representative shall coordinate multiagency and/or multicontractor operationally relevant integration test planning and discrepancy resolution.

(1) Assembly/integration and verification procedures shall ensure that:

a. Assembly/integration, verification, and operationally relevant test validation of component/software unit interfaces and mission functionality/interoperability.

b. Assembly/integration, verification, and operationally relevant test validation of hardware/software item interfaces and mission functionality/interoperability.

(2) Discrepancy reporting, causal analysis, and corrective action procedures shall ensure that discrepancy reporting, causal analysis, and corrective action procedures are integrated with the assembly and verification procedures and operationally relevant test validation procedures

(3) Operationally relevant test architecture and design plans, test procedures, test exceptions and associated fault risk assessment, and test results and discrepancies shall ensure that operationally relevant test information is correlated to provide context and significance:

a. Each test objective is mapped to mission phase objectives, first-time events, mission-critical events, and/or fault paths.

b. Test-specific exceptions are mapped to mission characteristics and MCFA fault paths.

c. Each test discrepancy is mapped to an identified test exception(s) or MCFA fault path(s), where possible.

e. As part of System Realization Verification, clause 6.4.9, the contractor shall ensure that the:

(1) System Validation Plan includes plans for accomplishing operationally relevant test assessments, including a mission readiness test.

(2) System Validation Data

a. Documents any discrepancies between the operationally relevant test characteristics and mission characteristics.

b. Includes operationally relevant test results, discrepancies, and exceptions.

f. As part of Project Assessment and Control, clause 6.3.2 and System Realization Verification, clause 6.4.9, the contractor shall ensure that each documented assessment includes the critical fault list with the following attributes:

(1) Includes critical fault risks associated with decisions to not perform operationally relevant tests and with test exception faults that cannot be mitigated within allocated resources for test/repair/rework/retest.

(2) Elevates to program risk management any operationally relevant test necessary to validate the executability of a first-time event, mission critical activity, or mission sequence that cannot be performed within element test resources.

3.2.20 Space System Verification

a. AIAA-S-117A-2016 may be used for development of:

(1) space system verification process

(2) associated verification outputs

3.2.21 Systems Engineering Data Item Descriptions

NOTE: Address as part of IEEE 15288.1 clause 6.3.1, Project Planning.

1.	Systems Engineering Management Plan (SEMP)	DI-SESS-81785A
2.	System/Segment Interface Control Specification	DI-SESS-81314A
4.	System/Subsystem Specification	DI-IPSC-81431A
5.	Human Systems Integration Plan	DI-HFAC-81743A

Data Item Descriptions (DIDs) are maintained in an online database, Acquisition Streamlining and Standardization Information System (ASSIST), maintained by the Defense Logistics Agency. ASSIST contains standardization documents and data item descriptions that have been approved or adopted for contractual application in DOD acquisitions.

4. Applicable Documents

The following documents form a part of this document to the extent specified herein. Unless otherwise specified the issues of these documents are those cited in the solicitation or contract.

- ISO/IEC/IEEE-15288:2015, *Systems and Software Engineering — System life cycle processes*. 2015.
- IEEE-15288.1:2014, IEEE *Standard for Application of Systems Engineering on Defense Programs*. 2014.
- *Systems Engineering Requirements and Products*, Aerospace Report Number TR-2013-00001. The Aerospace Corporation, El Segundo, CA. February 28, 2013.
  also published as SMC-S-001 (2013), *Systems Engineering Products and Requirements*. 2013.
- *Space Vehicle Test and Evaluation Handbook*, Aerospace Report Number TOR-2011(8591)-2 Volume 1, Chapter 15: *Test Like You Fly – Assessment and Implementation Process for Prelaunch Mission Testing*. The Aerospace Corporation, El Segundo, CA. 2012.
- *Test Like You Fly: Assessment and Implementation Process*. Aerospace Report Number TOR-2010(8591)-6. The Aerospace Corporation, El Segundo, CA. 2010.
- *The Test Like You Fly Process Guide for Space, Launch, and Ground Systems*. Aerospace Report Number TOR-2014-02357-REV A. The Aerospace Corporation, El Segundo, CA. 2016.
- AIAA-S-117A-2016, *Space Systems Verification Program and Management Process*. American Institute of Aeronautics and Astronautics (AIAA). 2016.

SMC Standard Improvement Proposal

INSTRUCTIONS

1. Complete blocks 1 through 7. All blocks must be completed.
2. Send to the Preparing Activity specified in block 8.

NOTE: Do not use this form to request copies of documents, or to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements. Comments submitted on this form do not constitute a commitment by the Preparing Activity to implement the suggestion; the Preparing Authority will coordinate a review of the comment and provide disposition to the comment submitter specified in Block 6.

SMC STANDARD CHANGE RECOMMENDATION:	**1. Document Number** SMC-T-006	**2. Document Date** 2017

3. Document Title	Specialty and Software Engineering Supplement to IEEE 15288.1

4. Nature of Change
(Identify paragraph number; include proposed revision language and supporting data. Attach extra sheets as needed.)

5. Reason for Recommendation

6. Submitter Information

a. Name	**b. Organization**
c. Address	**d. Telephone**
e. E-mail address	**7. Date Submitted**

8. Preparing Activity

Space and Missile Systems Center
AIR FORCE SPACE COMMAND
483 N. Aviation Blvd.
El Segundo, CA 91245
Attention: SMC/EN