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DEPARTMENT OF DEFENSE
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MECHANICAL EQUIPMENT AND SUBSYSTEMS INTEGRITY PROGRAM

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FOREWORD

1. This standard is approved for use by all Departments and Agencies of the Department of Defense.

2. The purpose of this standard is to establish programmatic tasks for the development, acquisition, modification, operation, and sustainment of the mechanical elements of airborne, support, and training systems. The Mechanical Equipment and Subsystems Integrity Program (MECSIP) consists of a series of disciplined, time-phased actions which, when applied in accordance with this standard, will help ensure the continued operational safety, suitability, and effectiveness of the mechanical systems throughout all phases of the weapon system life.

3. Comments, suggestions, or questions on this document should be addressed to ASC/ENRS, 2530 LOOP RD WEST, WRIGHT-PATTERSON AFB OH 45433-7101 or e-mailed to Engineering.Standards@wpafb.af.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

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1. SCOPE.

1.1 Purpose.

The purpose of this standard is to describe the general process to achieve and maintain the physical and functional integrity of the mechanical elements of airborne, support, and training systems. The goal of this integrity program is to ensure the operational safety, suitability, and effectiveness (OSS&E) of a weapon system, while reducing total life cycle cost. The process described herein establishes a disciplined engineering process that will ensure the physical and functional integrity of the system being procured and sustained. This standard allows the process to be tailored in a competitive environment to meet specific equipment, subsystem, and/or system requirements. The Mechanical Equipment and Subsystems Integrity Program (MECSIP) is implemented in the planning process and continued until retirement of the system. The MECSIP Program will be established and maintained in accordance with this standard and/or tailored to satisfy specific program strategy.

The product life cycle described herein is a "cradle-to-grave" process that applies equally to the design and sustainment phases. It applies to new development, modifications, upgrades, and sustainment. It applies equally to both development and non-development items, including those that are commercial off-the-shelf (COTS) items. For development items, the purpose of this process is to establish and sustain a design that meets the service life, mission, usage, and environmental requirements. For non-development items, the emphasis is on definition of the capabilities of the item when subjected to the intended service life, mission, usage and environments. If shortfalls are identified in the existing capabilities of a non-development item, the Program then has the necessary information to initiate the appropriate trades relative to the cost of the design change versus required performance, maintenance actions, total operating cost, and impact on mission, etc.

1.2 Use.

This standard cannot be used for contractual purposes until it is tailored with specific supplemental information pertinent to the equipment or system being procured. The information from this standard is intended for inclusion in the Request for Proposal (RFP) and contract Statement of Work (SOW). A SOW will be developed in accordance with procurement guidelines which covers the tailored tasks, subtasks, strategy, plans, and the effort to be accomplished. Once the system is fielded, the MECSIP Manager should tailor an appropriate integrity program based on the information contained in this standard and the integrity program established during the development phase.

1.2.1 Structure.

The supplemental information required is identified within the text of this standard. Electronic versions of this document contain active hyperlinks which appear in blue font. These hyperlinks provide the user a means to navigate within the document and to referenced Websites. The simplest way to return to the place of origin within a Microsoft Word® document is to utilize the "back arrow" and "forward arrow" after a hyperlink has been selected. These icons may be included in a user's "Quick Access Toolbar" in this manner: select the Microsoft Office Button ; select "Word Options"; and then select "Customize". In the "Choose commands from" list, select "All Commands" and then select "Back"; click "Add"; then select "Forward" and click "Add".

This same method can be employed in Adobe Acrobat® versions of a document: select "View" and "Toolbars" on the menu bar, and then select "Page Navigation." The "Previous View" Button and "Go To Next View" Button can be made available in the toolbar area by right-clicking the "Page Navigation" toolbar and choosing them on the context menu, or by choosing "Show All Tools."

1.3 Program approach.

The MECSIP is an organized and disciplined engineering and management process to ensure the integrity (e.g., durability, safety, reliability, and supportability) of mechanical systems and equipment is achieved in development and maintained throughout the system's operational service life. The process consists of program-phased tasks which focus on the following:

a. application of a disciplined system engineering approach to design and development which emphasizes the determination and understanding of failure modes and consequences on operational performance;

b. comprehension of total system operational and support needs and the development of the resulting mechanical system and equipment requirements;

c. emphasis on realistic integrity requirements such as operational service life, usage, and natural and induced environments (including maintenance and support) as the basis for design, qualification, and airworthiness certification.

d. early trade studies to evaluate operation and support factors in concert with cost, weight, and performance; and to ensure compatibility between design solutions, support equipment needs, and maintenance concepts;

e. a disciplined design and development process scheduled to ensure early evaluation of material characteristics, manufacturing processes, and equipment response to design usage;

f. an integrated analysis and ground test program to evaluate design performance and integrity characteristics;

g. tests and demonstrations scheduled to ensure test findings are incorporated into the design in advance of major economic and/or production commitments;

h. controls on manufacturing as required to ensure quality and integrity of hardware throughout production;

i. development of force management requirements (including maintenance and inspection) based on the results of the development process;

j. a program to measure actual usage and environment for the fielded equipment; and

k. a tracking system for components and systems.

1.4 Program overview.

The effectiveness of any military force depends on the mission effectiveness and operational readiness of its weapon systems. A major factor affecting readiness and mission reliability is the integrity (including durability, safety, reliability, and supportability) of the individual systems and equipment comprising the total weapon system. The U.S. Air Force (USAF) adopted the "Weapon System Integrity Process" as the key vehicle to develop, achieve, and maintain required performance economically for the various elements of the weapon system to enhance equipment effectiveness and meet operational needs. The integrity process advocated here was adopted from the highly-successful Aircraft Structural Integrity Program (ASIP) first employed in the late 1950's. This process captures the generic features of ASIP and builds upon the evolution and experiences gained over the last five decades.

The MECSIP description in this standard is intended to illustrate the various tasks required to achieve specific performance and supportability requirements. The goal is to establish a complete understanding of performance; e.g., mission operability or functionality, service life, endurance, weight, affordability, adaptability, and robustness of the system. Although MECSIP is generally applied at the system level, it can and will be tailored for single hardware components. The process described herein must also be tailored and applied to evaluate the capability of existing systems and equipment, including off-the-shelf components.

The MECSIP process consists of a strategy described in the Master Plan that provides mechanical systems and associated equipment with the required integrity throughout the operational service life.

1.5 Applicability.

This standard applies to all systems, equipment, and components whose primary function is mechanical in nature. Examples include: arresting and landing gear (those aspects not already covered by MIL-STD-1530C), auxiliary power, crew escape, canopy, aerial delivery, cockpit displays, environmental control, fire protection, flight control, fuel, hydraulic, wheels/tires/brakes, life support, mechanical systems (e.g., door drives), pneumatic, and electro-mechanical elements of electrical power and wiring systems that conduct power or data between major components, connectors, and sub-components. This standard also applies to ground support equipment required for maintenance of MECSIP Equipment.

2. APPLICABLE DOCUMENTS.

2.1 General.

The documents listed in this section are specified in sections 3, 4, or 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks.

The following specifications, standards, and handbooks 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.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-882	System Safety
MIL-STD-1530	Aircraft Structural Integrity Program (ASIP)

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-516	Airworthiness Certification Criteria
MIL-HDBK-1823	Nondestructive Evaluation System Reliability Assessment

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia PA 19111-5094; [215] 697-2664 USA.)

2.2.2 Other Government documents, drawings, and publications.

The following other Government documents, drawings, and publications 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.

DEFENSE DEPARTMENTS AND AGENCIES JOINT INSTRUCTION

SECNAVINST 4140.2 AFI 20-106 DA Pam 95-9 DLAI 3200.4 DCMA INST CSI (AV)	Management of Aviation Critical Safety Items

(Copies of this document are available online at www.dla.mil/dlaps.)

AIR FORCE MATERIEL COMMAND INSTRUCTION

AFMCI 21-102	Analytical Condition Inspection (ACI) Programs

(Copies of this document are available online at the Air Force E-Publishing Website: http://www.e-publishing.af.mil.)

NAVAL AIR SYSTEMS COMMAND

NAVAIR 00-25-403	Guidelines for the Naval Aviation Reliability-Centered Maintenance Process

(Requests for this document should be addressed to the Naval Air Technical Data and Engineering Service Command, NAS North Island, Bldg 90, PO Box 357031, San Diego CA 92135-7031 USA; https://mynatec.navair.navy.mil.)

2.3 Non-Government publications.

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.

RTCA, INC.

RTCA DO-178	Software Considerations in Airborne Systems and Equipment Certification

(Copies of this document are available from www.rtca.org; RTCA, 1828 L Street NW, Suite 805, Washington DC 20036 USA.)

2.4 Order of precedence.

Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS.

Definitions applicable to this standard are contained in the following subparagraphs.

3.1 Analysis.

Analysis is the diagnostic effort that illustrates contractual requirements have been achieved. This effort may include solution of equations, performance of simulations, evaluation and interpretation of charts and reduced data, and comparisons of analytical predictions versus test data. The normal reduction of data generated during ground and flight tests is not included. This effort is usually performed by the contractor.

3.2 Damage tolerance.

Damage tolerance is the attribute of a structure that permits it to retain its required residual strength for a period of unrepaired usage after the structure has sustained specific levels of fatigue, corrosion, accidental, and/or discrete source damage.

3.3 Demonstration.

Demonstration is an engineering effort performed to show contractual requirements have been met. Compliance or noncompliance is determined by observation only. Fit and function checks may be accomplished as demonstrations.

3.4 De-rating of electrical equipment.

De-rating is the process of operating an electrical component well inside its normal operating limits to reduce the rate at which the component deteriorates. This is done to enhance the component's useful life. Example: If a diode is specified to be able to operate at 10V and 5 Amps, and it is placed into operation where it only sees 7V and 3 Amps, it is said to have been de-rated for that application.

3.5 Design loads/environment spectrum.

The design loads/environment spectrum is the spectrum of internal and external loads and environments (chemical, thermal, etc.) used in the design of mechanical equipment and is representative of the spectrum that the equipment is expected to encounter within the design service life.

3.6 Design service life.

The design service life is the period of time (e.g., years, flight cycles, operating hours, landings, etc.) established at design, during which the mechanical equipment is expected to maintain its integrity when operated to the design loads/environment/usage spectrum.

3.7 Durability.

Durability is the ability of the system or component to resist deterioration, wear, cracking, corrosion, thermal degradation, and the effect of foreign object damage, for a specified period of time.

3.8 Durability-critical component.

A durability-critical component is a component whose failure may entail costly maintenance and/or part repair and replacement which, if not performed, would significantly degrade performance and operational readiness. These components are not safety- or mission-critical, but may have a major economic impact on the system.

3.9 Durability-noncritical component.

A durability-noncritical component is one whose failure would result in a minor economic impact on the system but would require maintenance and/or repair or replacement to ensure continued performance. These components do not usually require special attention during production and could be maintained on either a corrective- or preventive-maintenance basis.

3.10 Economic life.

Economic life is the operational service period during which it is judged to be more economically advantageous to repair than replace a component, based on an evaluation of data developed during system development.

3.11 Nondestructive inspection (NDI).

Nondestructive inspection is an inspection process or technique that reveals conditions at or beneath the external surface of a part or material without adversely affecting the material or part being inspected.

3.12 Improbable occurrence.

An improbable occurrence is defined as a risk of failure shown to be less than 1×10^{-7} events per flying hour (FH).

3.13 Integrity.

Integrity is comprised of the essential characteristics of systems and equipment which allows specified performance, safety, durability, reliability, and supportability to be achieved under specified operational conditions over a defined service lifetime.

3.14 Leak before burst.

A through crack in a fluid container will leak fluid before burst by demonstrating tolerance of a through thickness crack two times (2X) the wall thickness, or a size agreed upon with the Procuring Service, when subject to limit loading conditions.

3.15 Maintenance-free operating period.

This phase is that segment of the required operational service life during which no preventive maintenance is required to ensure performance and operational readiness. The results of durability testing and analysis are used to determine the maintenance-free operating period.

3.16 Mission-critical component.

A mission-critical component is a component whose failure would: (a) prohibit the execution of a critical mission, (b) significantly reduce the operational mission capability, or (c) significantly increase the system vulnerability during a critical mission.

3.17 Other/expendable components.

Other/expendable components includes all components of a system not classified as safety-critical, mission-critical, durability-critical, or durability-noncritical. The failure of these components could be handled during routine maintenance and would not impact the mission, safety, or operational readiness.

3.18 Probability of detection (POD).

A POD is a statistical measurement of the likelihood, with a specified confidence level, of finding a flaw of a defined size using a specific inspection technique. (Reference MIL-HDBK-1823.)

3.19 Proof testing.

A test is performed on each production component that can effectively demonstrate that the part is damage tolerant. The proof test must be supported by analysis.

3.20 Required operational service life.

The required operational service life is that operational life specified for the specific system, subsystem, or component—usually in terms of service or operation time.

3.21 Redundancy.

Redundancy in design incorporates dual/multiple components or duplicates function to provide operational capability (without degradation) upon failure of a single component or function. Failure of a single component or function must be detectable (i.e., system is both fail operational and fail evident). Detectability may be through the Prognostic Health Management (PHM) system or at depot inspection. Redundancy also may describe a component that has redundant features.

3.22 Safe-life.

Safe-life of a component is that number of events such as flights, landings, or operating hours, during which there is a low probability that the (strength will degrade below its design ultimate value due to fatigue cracking.)

3.23 Safety-critical component.

A safety-critical component is a component whose failure would cause loss of the air vehicle, injury to personnel, or extensive damage to critical equipment/structures which could adversely affect safety of flight or personnel.

3.24 Similarity (legacy systems).

Similarity is when significant, successful operational experience on hardware of actual or similar design and usage has occurred. Similarity is appropriate for mature designs susceptible to damage when other design verification approaches are not feasible/appropriate. Consider the following to establish similarity:

a. materials and processing;

b. design configuration and usage;

c. operating environment considerations including cycle temperatures and pressures, speeds, torques, and flows;

d. legacy component hours or cyclic history, including number of parts produced, number and type of safety-critical or mission-critical events, total number of fleet hours, and high-time component.

3.25 Slow damage growth structure.

Slow damage growth structure is structure in which damage is not allowed to attain the critical size required for unstable rapid damage propagation. Safety is assured through slow damage growth for specified periods of usage depending upon the degree of inspectability. The strength of slow damage growth structure with damage present is not degraded below a specified limit for the period of unrepaired service usage.

3.26 Test.

Test is an empirical effort performed to prove contractual requirements have been met. Documented procedures, instrumentation, and known environmental conditions are normally applicable. Compliance or noncompliance is determined by observation, where practical, and evaluation of collected data. Most ground and flight empirical efforts associated with this procurement and acquisition qualify as tests. This effort is usually performed by the contractor.

3.27 Up-rating.

Up-rating is the process of operating an electrical component outside/beyond the manufacturer recommended operating range. This is usually done to minimize design cost or weight or prevent obsolescence. It may have detrimental impacts on component useful life and requires careful analysis of its application. Example: If the manufacturer specs a diode to operate at 10V and 5 Amps and it is used in an environment of 13V and 7 Amps, it is said to have been up-rated for that application.

3.28 Usage.

Usage is defined as the operational parameters critical to function, performance, and service-life of the system and equipment (e.g., missions, duty cycles, loading, environments, etc.).

4. GENERAL REQUIREMENTS.

4.1 Mechanical Equipment and Subsystems Integrity Program (MECSIP).

The overall MECSIP includes a program strategy Master Plan that defines the basic elements, tasks, subtasks, analyses, tests, and force management actions required to achieve and maintain product integrity throughout the operational service life.

The MECSIP program established and maintained in accordance with this standard shall be tailored to satisfy specific program strategies. Application of the MECSIP requires tailoring of the various tasks, subtasks, and elements contained herein. It is intended that a separate, tailored MECSIP will be developed for the various systems or equipment, and that it will be integrated into the overarching system acquisition plan. The MECSIP is most effective when applied early in the acquisition cycle, through implementation of the initial Task I elements described herein. Early implementation generally ensures system-level requirements are appropriately translated into requirements for individual system elements—including airborne, ground support, and training systems. Early implementation will also ensure important concept and performance trade studies are influenced. Table I summarizes the various MECSIP tasks described in this standard. Refer to Appendix A for the tailorable activities that encompass a typical MECSIP effort during a Weapons System development program. Refer to Appendix B for the basic Force Management actions of the Weapon System during the sustainment phase.

TABLE I. Mechanical System Integrity Program life-cycle tasks.

TASK I	TASK II	TASK III	TASK IV	TASK V
Preliminary Planning (5.1)	Design Information (5.2)	Design Analyses and Development Tests (5.3)	Component Development and Systems Functional Tests (5.4)	Force Management (5.5)
❑ Program strategy (5.1.1)	❑ MECSIP Master Plan (5.2.1)	❑ Manufacturing and quality assessment (5.3.1)	❑ Component and rig test descriptions (5.4.1)	❑ Equipment manufacturing and integration (5.5.1)
❑ Trade studies (5.1.2)	❑ Design criteria (5.2.2)	❑ Design analyses (5.3.2)	❑ Testing risk mitigation (5.4.2)	❑ Sustainment of equipment prognostic systems (5.5.2)
❑ Requirements development (5.1.3)	❑ Damage tolerance criteria (5.2.2.1)	❑ Design stress/ environment spectra development (5.3.2.2)	❑ Hardware and systems rig testing (5.4.3)	❑ Reliability-Centered Maintenance (5.5.3)
❑ Preliminary integrity analysis (5.1.4)	❑ Damage tolerance design concepts (5.2.2.1.1)	❑ Performance and function sizing analysis (5.3.2.3)	❑ Subsystems performance (5.4.3.1)	❑ Component tracking/monitoring program (5.5.4)
❑ Technical Reviews (5.1.5)	❑ Risk-based criteria (5.2.2.2)	❑ Thermal/ environmental analyses (5.3.2.4)	❑ Dry rig (5.4.3.2)	❑ Operational usage data (5.5.4.1)
	❑ Risk-based design concepts (5.2.2.2.1)	❑ Stress/ strength analyses (5.3.2.5)	❑ Wet rig (5.4.3.3)	❑ Preventive maintenance actions (5.5.5)
	❑ Design service life/ design usage (5.2.3)	❑ Durability analyses (5.3.2.6)	❑ Mechanical systems (5.4.3.4)	❑ Flight-hour time change (5.5.5.1)
	❑ Component classification (5.2.4)	❑ Damage tolerance analyses (5.3.2.7)	❑ Hardware component (5.4.4)	❑ Calendar time change (5.5.5.2)
	❑ Aviation-Critical Safety Items (5.2.4.1)	❑ Damage tolerance inspections (5.3.2.7.1)	❑ Component development (5.4.4.1)	❑ On-equipment repairs (5.5.5.3)
	❑ Maintenance concepts (5.2.5)	❑ Damage tolerance action categories (5.3.2.7.2)	❑ Abnormal operation (5.4.4.2)	❑ Lubrication/cleaning and adjustments (5.5.5.4)
	❑ Material and process selection and characterization (5.2.6)	❑ Fail-safe (5.3.2.7.3)	❑ Reliability growth demonstration (5.4.5)	❑ Overhaul of systems (5.5.5.5)
	❑ Product integrity control plan (5.2.7)		❑ Oil interruption and depletion (5.4.6)	❑ Replacement of original equipment (5.5.5.6)
	❑ Corrosion prevention and control (5.2.8)		❑ Component fit checks (5.4.7)	❑ Replacement of obsolete equipment (5.5.5.7)

TABLE I. Mechanical System Integrity Program life-cycle tasks – Continued.

TASK I	TASK II	TASK III	TASK IV	TASK V
Preliminary Planning (5.1)	Design Information (5.2)	Design Analyses and Development Tests (5.3)	Component Development and Systems Functional Tests (5.4)	Force Management (5.5)
	❑ Environmental emissions (5.2.9) ❑ Physical and operational interfaces (5.2.10) ❑ Risk mitigation planning (5.2.11)	❑ Slow damage growth (5.3.2.7.4) ❑ Leak before burst (5.3.2.7.5) ❑ Proof test analysis (5.3.2.7.6) ❑ Risk-based analyses (5.3.2.8) ❑ Vibration/dynamics/ acoustic analyses (5.3.2.9) ❑ Development tests (5.3.3) ❑ Material characterization tests (5.3.3.1) ❑ Design development tests (5.3.3.2) ❑ Performance (5.3.4) ❑ Dynamic modeling (5.3.4.1) ❑ Failure detection and accommodation (5.3.4.2) ❑ Stability and response (5.3.4.3)	❑ Component qualification (5.4.8) ❑ Vibration and dynamic response (5.4.9) ❑ Fire proof/ fire resistance (5.4.10) ❑ Software testing (5.4.11) ❑ Functional tests (5.4.12) ❑ Strength testing (5.4.13) ❑ Durability testing (5.4.14) ❑ Vibration/ dynamics/ acoustics tests (5.4.15) ❑ Damage tolerance tests (5.4.16) ❑ Thermal, environment, and loads survey (5.4.17) ❑ Overspeed/ overtemperature (5.4.18) ❑ Maintainability/ reparability demonstrations (5.4.19) ❑ Evaluation and interpretation of test results (5.4.20)	❑ Environmental regulations (5.5.5.8) ❑ Flight manual (5.5.6) ❑ Production/ overhaul quality (5.5.7) ❑ Acceptance Test Procedures (5.5.7.1) ❑ Component test bench calibrations (5.5.7.2) ❑ Monitoring of repairs/overhauls (5.5.8) ❑ Field/Base-level maintenance (5.5.8.1) ❑ Depot-level maintenance (5.5.8.2) ❑ Inspection criteria (5.5.9) ❑ Safety-critical components (5.5.9.1) ❑ Analytical Condition Inspection Program (5.5.10)

TABLE I. Mechanical System Integrity Program life-cycle tasks – Continued.

TASK I	TASK II	TASK III	TASK IV	TASK V
Preliminary Planning (5.1)	Design Information (5.2)	Design Analyses and Development Tests (5.3)	Component Development and Systems Functional Tests (5.4)	Force Management (5.5)
		❑ Control laws, schedules, architecture, and power management (5.3.4.4) ❑ Electromagnetic effects and lightning (5.3.5) ❑ Software (5.3.6) ❑ Software performance and testing (5.3.6.1) ❑ Assessments (5.3.7) ❑ Abnormal operation (5.3.7.1) ❑ Manufacturing and assembly (5.3.7.2) ❑ Reliability and maintainability (5.3.8) ❑ Electrical/optical cable maintainability (5.3.9) ❑ Ground handling (5.3.10) ❑ Obsolescence (5.3.11) ❑ De-rating/ up-rating (5.3.12) ❑ Equipment prognostics (5.3.13)	❑ Integrated test plan (5.4.21) ❑ Final integrity analysis (5.4.22) ❑ Maintenance planning and task development (5.4.23) ❑ Airworthiness certification (5.4.24)	

4.1.1 Tailoring approach.

The USAF will establish the requirement to scope, tailor, and implement the MECSIP, in addition to other applicable integrity programs, early in the acquisition process. This information will be provided with the Instructions To the Offeror (ITO) as part of the Request For Proposal (RFP) package. In the response to the RFP, the contractor shall define their application strategy and delineate program objectives, schedules, milestones, tasking requirements, and other information that concerns the tailoring and application of the requirements of this standard. Tailoring and application shall be one of the MECSIP Task I elements, as described in 5.1. The purpose for developing a program strategy and tailoring approach is to ensure appropriate program management and planning attention is given to the implementation of the MECSIP. Especially important is the need to ensure system technical requirements and design criteria reflect overall operational needs, and that proper integration, plans, tasking, and scheduling are provided throughout the acquisition. Each weapon System tailoring approach shall be documented in the MECSIP Master Plan.

4.1.2 Implementing SOW.

The MECSIP procurement is normally accomplished through SOW tasks. In accordance with procurement guidelines, a SOW shall be developed that covers the tailored tasks, subtasks, strategy, plans, and the effort to be accomplished.

5. DETAILED REQUIREMENTS.

5.1 (Task I) Preliminary Planning.

Task I is intended to be accomplished either in advance of, or at the beginning of, the System Development and Demonstration phase (formerly known as the Engineering and Manufacturing Development phase). The purpose of Task I is to scope the tailoring, planning, and development strategy for applying the MECSIP. The tasks expected during this period for major weapon system procurements include the methods detailed in the subparagraphs which follow. Appendix A provides guidance specific to mechanical subsystems development milestones and technical reviews.

5.1.1 Program strategy.

A MECSIP Program strategy shall be developed early in the acquisition process to establish definitive objectives and definitive measures demonstrating objectives are achieved. The MECSIP strategy will support and be one of the elements of the overall acquisition strategy for the system. Areas such as materials, processes, manufacturing, testing, facilities, manpower, funds, interface, and schedules are all involved in the development of this strategy. Technology improvements and advancements necessary to achieve specific Program objectives must be defined, quantified, scheduled, and evaluated for cost benefits. The strategy will become progressively definitive as the acquisition strategy matures, and as it becomes possible to develop and weigh alternative approaches to satisfy system needs. Simply stated, the strategy should address the "what", "how", "when", and "with what" aspects of applying the MECSIP to full acquisition and deployment of the systems and equipment.

5.1.2 Trade studies.

As part of the early acquisition process, system engineering trade studies shall be conducted at both the system- and component-level, as appropriate. The purpose of these trade studies is to examine alternative approaches which satisfy the system operational safety, suitability, and effectiveness. Proper consideration must be given to supportability, reliability, maintainability, and cost, in addition to technical performance, when these trade studies are performed. The use of new computer programs and technologies for component tracking and monitoring should be included in the trade studies.

5.1.3 Requirements development.

Part of the early acquisition process shall be devoted to the study and refinement of system-level requirements as they evolve from the consideration of operational needs, supportability goals, etc. As part of this refinement process, system requirements shall be evaluated, particularly in conjunction with the early trade studies. The objective is to enter into system development with optimized and balanced design requirements.

5.1.4 Preliminary integrity analysis.

The pre-development activity shall define the critical hardware design features affecting integrity, and the mitigation plans to resolve or address these features. The preliminary analysis should also attempt to predict or estimate the potential of the candidate system concepts to achieve performance and integrity goals. This requires an understanding of the physical concepts and failure modes, and requires a limited database that defines the candidate materials, processes, and technologies. These analyses are particularly important, since they typically support the early engineering trade studies. Preliminary analyses should include, but not be limited to, equipment sizing, estimates of component and system service life potential, failure modes analysis, classification of critical components, and identification of hidden failures.

5.1.5 Technical reviews.

Criteria shall be developed that describe the content and level of completion of each MECSIP task for each program milestone. These criteria shall be used in a gated technical review process to proceed from one program milestone to the next. The intent of these criteria is to show the level of knowledge attained for the mechanical system components and that this level of knowledge is sufficient to proceed toward the next milestone. Tables A-I through A-V in Appendix A shall be used as a guide to create these criteria.

5.2 (Task II) Design Information.

This task encompasses the efforts required to identify and understand all technical criteria that will be applied to the initial design, development, materials, manufacturing processes, and production planning for each specific system or equipment application. The early definition of design objectives; the specification of subsystem design environments and usage; the identification of critical design failure modes; component and part functional criticality; and recommendations for materials selection and characterization, design analysis, and manufacturing process controls are accomplished as part of Task II. The objective is to ensure the operational and support needs are met. Tasking is initiated as early as is practical in the procurement. Several subtasks are iterated during the design development cycle and finalized later in the system development. Information in Task II shall be developed by the contractor based on instructions provided by the procuring activity in the ITO and supported by the results of Task I.

5.2.1 MECSIP Master Plan.

A Master Plan shall be developed to define and document the details for accomplishing all tasks and subtasks of the MECSIP. This plan shall be integrated into the Integrated Master Plan (IMP) and Integrated Master Schedule (IMS). The plan shall define overall strategy and the time-phased scheduling of the various integrity tasks for design, development, qualification, and force management of the specific system hardware. The plan shall include discussions of unique features of the Program, exceptions to this standard, a complete discussion of each proposed task, rationale for each task and subtask, and an approach to address and resolve all significant problems which can be anticipated in the execution of the plan. The development of the schedule shall consider other program interfaces, impact of schedule delays (e.g., delay due to test failures), mechanisms for recovery, programming, and other potential problems areas.

The plan shall include the time-phased scheduling and integration of system development tasks which support performance and integrity requirements for the equipment being acquired. The plan is intended to highlight programmatic concerns, schedules, analyses, functional tests, development and verification tests, test data, evaluation criteria, contractor/vendor tasks, milestones, etc. The plan shall identify approaches for the analyses and tests, including descriptions of proposed analytical and test methods, assumptions, data criteria, etc. The plan shall include the design criteria to be used, the basis for criteria selection, and the relationship of criteria to overall system requirements. Within the plan is the technical, logistical, and rationale for selecting a design service life that is most practical. Finally, within the plan are identified environmental and usage parameters for PHM that affect service life.

The MECSIP Master Plan shall be a living document, updated periodically throughout the life of the system. The Master Plan shall be developed by the contractor early in system development and submitted in accordance with specific Program requirements. The document will be subject to USAF approval. It should organize the approach to include all elements of each specific system application. It should address contractor, subcontractor, and vendor equipment, as well as government-furnished equipment (GFE) and off-the-shelf (OTS) equipment. It shall be the responsibility of the contractor to address GFE and OTS equipment through an assessment approach consistent with this standard. The approach must ensure that system requirements are satisfied and that maintenance requirements can be defined and included in the overall force management plan.

It is the responsibility of the Program to establish and maintain the contractual requirement for the Master Plan during the sustainment phase of the Program. The plan shall include the actions contained in Task V and shall capture the knowledge and experience gained during the previous phases. Appendix A and Appendix B reflect the tailoring activities that encompass a typical MECSIP effort during all the Phases including the Force Management. The appendices are to be tailored by the Program and are not contractual in nature. The support concepts defined by the MECSIP shall be achievable through the system life cycle.

5.2.2 Design criteria.

The contractor shall translate the system requirements into specific design criteria to be used for material selection, equipment sizing, design, analysis, and test. The objective is to ensure criteria which reflect the planned usage of the systems are applied to the development and verification process so that specific performance, operational, and maintenance/support requirements can be met. The task of developing design criteria begins as early as is practical in the development cycle. The rationale for selecting design criteria must provide a justifiable basis for meeting design performance and service life, while also meeting cost and supportability requirements. Specific criteria shall be developed to support functional performance, durability, damage tolerance, strength, vibration/dynamic response, maintenance, integrity management, and other specified requirements.

5.2.2.1 Damage tolerance criteria.

Criteria shall be established to ensure that subsystem components can safely withstand undetected flaws, corrosion, impact damage, and other types of damage throughout their design service life. The damage tolerance criteria shall be applied, where application is practical, to all safety-critical components. Damage tolerance criteria shall be considered for all mission-critical components. Criteria shall consider establishment of a minimum critical flaw size for those locations which are difficult to inspect.

5.2.2.1.1 Damage tolerance design concepts.

Subsystem damage tolerance designs shall be categorized into one of the general design concepts which follow:

a. fail-safe concepts where the required residual strength of the remaining intact structure shall be maintained for a period of unrepaired usage through the use of multiple load paths or damage arrest features after a failure or partial failure. The period of unrepaired usage necessary to achieve fail-safety must be long enough to ensure the failure or partial failure will be detected visually and repaired prior to the failure of the remaining intact structure.

b. slow damage growth concepts where flaws, defects, or other damage are not allowed to attain the size required for unstable, rapid propagation failure. This concept must be used in single-load-path and non-fail-safe multiple load path structures. No significant growth which results from manufacturing defects or from damage due to high-energy impact shall be allowed for composite structures.

c. leak before burst concept where fracture mechanics analysis is used to confirm that a through crack in a fluid container will leak fluid before burst by demonstrating tolerance of a through thickness crack two times (2X) the wall thickness, or a size agreed upon with the Procuring Service, when subject to limit loading conditions.

d. proof testing concept where a pressurization test is performed on each production component that can effectively demonstrate that the part is damage tolerant. The pressure level at which this testing is performed must be supported by analysis to document exposure to the specified proof pressure level confirms damage tolerance of the part/assembly.

5.2.2.2 Risk-based criteria.

For those safety- and mission-critical components where damage tolerance design concepts do not apply or are not practical, a risk-based design approach should be utilized. Use guidance provided in MIL-STD-882 to assess the component's probability of failure, the consequence of failure, and determine the hazard risk index value. A mishap risk acceptance level should then be identified and all risks should be presented to the appropriate risk authority for acceptance.

5.2.2.2.1 Risk-based design concepts.

Subsystem safety-critical item risk-based designs shall be categorized into one of the general design concepts which follow:

a. redundant (dual/multiple) components or duplication of function to provide operational capability (without degradation) upon failure of a single component or function. Failure of a single component or function must be detectable (i.e., system is both fail operational and fail evident). Detectability may be through the PHM system or via scheduled/routine inspection. Redundancy also may apply to a component that has redundant features. Individual component reliability shall result in an overall probability of loss of aircraft or store release less than $1x10^{-7}$ events per flying hour.

b. Safe-life design methodology may be used to establish replacement times for components (e.g., landing-gear components). Damage tolerance evaluations are required for all safe-life designed components. These evaluations shall define critical areas, fracture characteristics, stress spectra, maximum probable initial material and/or manufacturing defect sizes, and options (design features, manufacturing processes, or inspections) for either eliminating defective components or otherwise mitigating threats to safety. Additionally, the damage tolerance evaluation shall establish individual aircraft tracking requirements so that the safe-life component replacement times and any scheduled safety inspections can be adjusted based on actual usage. Safe-life limits shall result in a probability of loss of aircraft or store release less than $1x10^{-7}$ events per flying hour.

c. improbable occurrence or risk of failure shown to be less than $1x10^{-7}$ events per flying hour.

d. Not economically justified is applicable only for non-safety critical parts. This criteria is used in cases where a cost/benefit analysis shows it is not worth the cost to implement either a damage tolerance or a risk based approach to prevent in-service failures.

5.2.3 Design service life/design usage.

Design mission profiles, mission mixes, and environmental exposure mixes which are realistic estimates of expected service usage shall be established based on aircraft requirements. Design criteria (stated in operating hours, flight hours, cycles, loads, environment, etc.) shall be derived to reflect component/system service life and usage.

5.2.4 Component classification.

The Failure Modes, Effects, and Criticality Analysis (FMECA) and the System/Subsystem Hazard Analysis (S/SHA) for each specific system shall be considered in the component classification process. Criteria shall be established to select and classify critical hardware components and determine an appropriate approach for their design. The impact on safety-of-flight, mission completion, and production and maintenance costs shall be considered in the selection of critical parts. The process detailed on figure 1 should be used for the classification process and to determine the appropriate design approach to be utilized. Critical components will require the application of specific criteria related to materials, processing, manufacturing, maintenance tracking, etc. The FMECA and S/SHA shall be maintained/updated as a living document throughout the weapon system life. As a minimum, the following five critical component classification categories shall be used:

a. Safety-critical components

b. Mission-critical components

c. Durability-critical components

d. Durability-noncritical components

e. Other/expendable components.

The overall approach, analysis assumptions, and candidate component lists shall be documented in the MECSIP Master Plan.

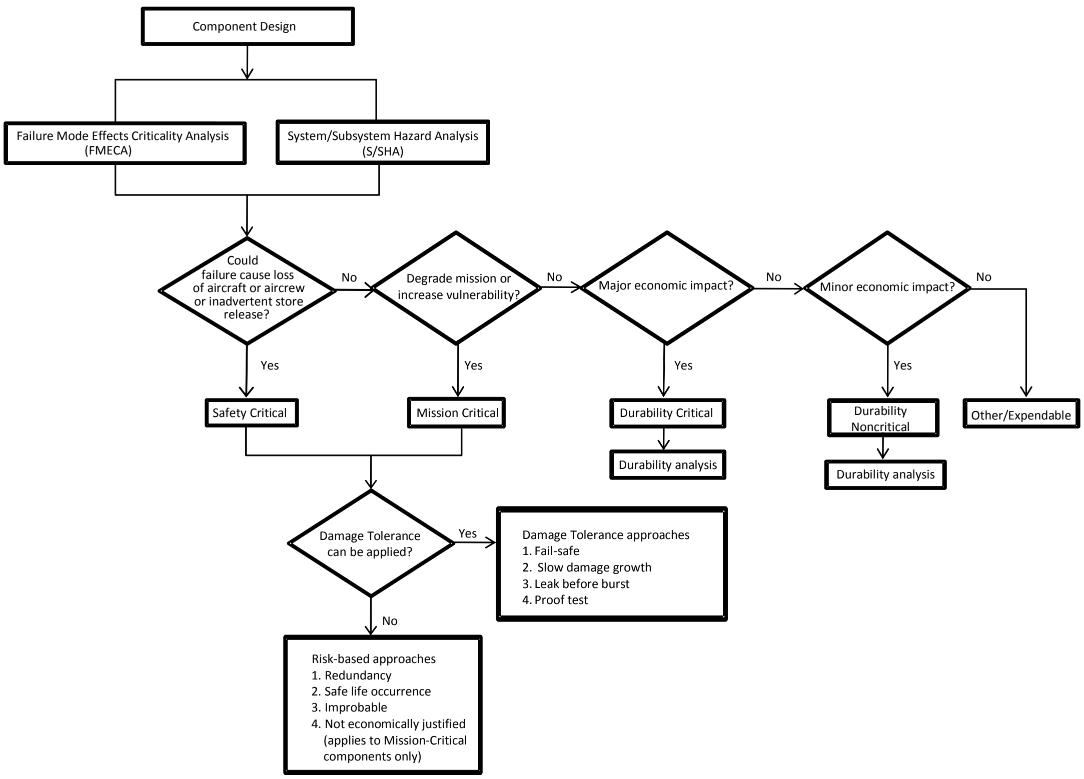

FIGURE 1. Critical part selection flowchart.

5.2.4.1 Aviation-Critical Safety Items.

Per the Joint Instruction SECNAVINST 4140.2, AFI 20-106, DA Pam 95-9, DLAI 3200.4, DCMA INST CSI (AV); Management of Aviation Critical Safety Items, all safety-critical items shall also be identified as Critical Safety Items (CSI) and subject to sustainment requirements governing the initial determination of item criticality and subsequent changes to this determination; coding and tracking of aviation CSI; the process for ensuring the adequacy of technical data and proposed changes; the process for approving sources of supply and repair/overhaul; the surveillance process assuring that approved sources retain required capabilities; authorities for one-time organic manufacture of CSIs under exigent circumstances; and requirements for disposing of CSIs when no longer needed by military aviation.

5.2.5 Maintenance concepts.

The operational service life requirements may be satisfied by a designed-in, maintenance-free operating period and scheduled preventive maintenance. In early trade studies, the contractor shall evaluate the impact of maintenance-free versus scheduled maintenance operating periods on cost, weight, performance, aircraft availability, and potential for maintenance-induced damage. The studies shall also consider the logistics and support requirements, the overall maintenance concept, and the implementation approach for component/system maintenance tracking. The tracking system must assist the MECSIP Manager in performing the duties listed in Task V. The result of these trade studies will be used to define the design service life criteria for specific components as well as in-service maintenance required to achieve the specified total required operational service life. Establishment of designed-in scheduled preventive maintenance must be consistent with the operational, logistics, and support requirements. The approach to definition and development of equipment maintenance concepts will be included in the MECSIP Master Plan.

5.2.6 Material and process selection and characterization.

The contractor shall identify and provide rationale for the materials and manufacturing processes to be used for each component of the system. Materials selection must be accompanied by an adequate material database (obtained from outside sources or generated by the program) and specifications to support design methodologies. Industry process specifications shall be used wherever possible to offer maximum benefit to the users to replace parts in aged systems and to establish second sources. The contractor shall document the complete rationale, trade studies, and evaluation criteria used in the final selection. The rationale shall consider prior operational experiences and technical data. Durability and damage tolerance controls for the design, manufacture, and quality assurance of identified safety-critical items are assigned based upon the consequence of failure and the desired reliability of the item's function. These controls include tracking of critical item environment and usage. Items supporting safety-critical functions will require traceability of material sources and process controls necessary to ensure a low probability of failure.

A plan shall be developed which describes the processes and procedures to be used to characterize and select materials and processes for all elements of the system. The plan shall contain equipment requirements, available database(s) for proposed materials, additional test requirements, and the rationale to be used for final material and process selections. The plan should identify methods and criteria for vendor substantiation, test requirements for material and process characterization, etc. The contractor shall develop an approach to ensure minimum properties and processes as required to support the product integrity control plan (see 5.2.7). The material and process selection and characterization plan shall be included as part of the MECSIP Master Plan.

5.2.7 Product integrity control plan.

The contractor shall implement special controls to ensure the required integrity characteristics of critical parts throughout production and sustainment is achieved. Candidates for specialized controls are parts classified as safety-, mission-, and durability-critical, and items which have hidden failure modes. Specialized controls may be required for materials, processes, manufacturing, quality, nondestructive inspection, corrosion prevention, etc. As a minimum, this approach and plan shall include:

a. the critical parts list and selection rationale (see 5.2.4);

b. basic material properties, allowables, and process data used in the analyses and trade studies;

c. procedures to identify critical parts and special provisions on the component drawings;

d. nondestructive inspections to be performed on safety- and mission-critical components to support damage tolerance requirements (The ASIP Nondestructive Inspection Requirements Review Board [NDIRRB] as required by MIL-STD-1530, will include MECSIP representation);

e. special nondestructive inspection capability demonstration programs to be conducted in support of damage tolerance requirements (manufacturing and in-service capability);

f. acceptance/proof tests for individual components, as required;

g. material procurement specifications and process specifications to ensure critical parts have the required properties (e.g., strength, fracture toughness, fatigue);

h. requirements for material/part traceability for safety- and mission-critical components which require special processing and fabrication operations; and

i. all vendor and supplier controls for these items.

Economic trade studies shall be conducted to ensure the effective development and implementation of this plan. Environmental and usage parameters for PHM that critically affect service life should be identified within the plan. The product integrity control plan shall be one of the primary data items submitted under the MECSIP and shall be subject to USAF approval.

5.2.8 Corrosion prevention and control.

The contractor shall define the approach to the development, evaluation, and incorporation of corrosion-resistant materials, protective treatments, finishes, etc. The selection of materials, finishes, and protection schemes shall consider the service-life requirements, environmental impacts, and sustainment costs. Effects of corrosion on the mechanical and electrical properties of the materials shall be established, as well as the suitability of dissimilar materials not to induce damage (galvanic effects). The plan to accomplish these tasks shall be incorporated in the MECSIP Master Plan. Implementation of this plan shall be in accordance with the product integrity control plan. A MECSIP representative shall be included as a member of the Corrosion Prevention Advisory Board (CPAB) as required by MIL-STD-1530. The Corrosion Prevention Control Plan (published by the CPAB) shall include MECSIP as well as Aircraft Structural Integrity Plan parts/equipment. (See 5.2.7.)

5.2.9 Environmental emissions.

Analyses of the mechanical equipment operating environment shall be performed to identify any emissions that may affect aircraft operation or the safety of ground personnel. Examples of these emissions include: electromagnetic energies, noise, smoke, acoustics, fuel or oil vapors, and overboard leakage.

5.2.10 Physical and operational interfaces.

Analyses of subsystems shall be performed to identify and characterize all internal and external physical and operational interface design concepts and requirements. Examples of these include: control/diagnostic/crew-warning interfaces, functional and physical connections, input/output electrical/electronic signals, electrical power supplies, mechanical power take-offs, gearbox speeds, torques, temperatures, flows,

5.2.11 Risk mitigation planning.

A risk mitigation plan shall be established for all components identified as "safety-critical" in 5.2.4. This risk mitigation plan shall identify the specific criterion (figure 1) utilized to preclude in-service failure of the part. These plans shall identify specific criteria related to materials, processing, manufacturing, maintenance tracking, etc., for each safety-critical part.

5.2.12 Supportability planning.

Analysis of subsystems shall be performed to identify top-level support concept for each subsystem. This analysis shall include:

a. identify which equipment will include periodic inspections;

b. identify equipment planned for inclusion in a Reliability-Centered Maintenance program;

c. develop a plan for what equipment/subsystems will include prognostics capability; and

d. a listing of parts planned to be "removed for cause."

5.3 (Task III) Design Analyses and Development Tests.

Analyses and development tests shall be performed to support the design activity and to verify that the specific performance, function, and integrity requirements have been met. The early definition of design objectives; the specification of subsystem design environments and usage; the identification of critical design failure modes; component and part functional criticality; and recommendations for materials selection and characterization, design analysis, development testing, and manufacturing process controls are accomplished as part of Task III. These tasks should be conducted using methods which have been verified on prior Programs or which will be verified during system/component development. All analytical approaches and development test plans shall be described in the MECSIP Master Plan.

5.3.1 Manufacturing and quality assessment.

An assessment of the manufacturing and quality system shall be conducted to ensure the OEM manufacturing and quality systems can consistently produce parts able to meet all specification requirements throughout the ground and flight operation. The assessment shall also include inspection capability and repairability as required to be consistent with damage tolerance actions.

5.3.2 Design analyses.

Design analyses shall include, but are not limited to, the elements detailed in the subparagraphs which follow.

5.3.2.1 Load analyses.

These analyses are used to define the magnitude and distribution of significant static, dynamic, and repeated loads which the equipment encounters when operated within the envelope established by the specific system requirements and detailed design criteria. This analysis involves identifying the internal and external operating load sources as well as inertial effects imposed by accelerations, decelerations, angular velocities, external air loads, and gyroscopic moments. Where applicable, the loads analysis shall include the effects of temperature and system installation (e.g., dynamic response and deformation of the airframe or support structure). Repeated load sources imposed by the airframe shall be included, as applicable. When applicable, these analyses shall address flight and ground operation as well as maintenance, storage, and transportation.

5.3.2.2 Design stress/environment spectra development.

This analysis shall be used to develop the design stress/environment spectra for individual system elements. The design stress/environment spectra shall characterize the repeated operating loads, pressures, thermal cycles, vibration, acoustics, and chemicals in a format which accounts for the primary functional duty cycle and usage of the equipment. The intent is to develop a spectrum that characterizes the significant usage events which may affect primary failure modes (e.g., fatigue, cracking, stress, corrosion, cracking, wear, etc.) which the system elements will experience based on the design service life and usage. This spectra shall be used to assist in material selection, component sizing, and performance/life verification.

5.3.2.3 Performance and function sizing analyses.

Analyses shall be conducted to support sizing, configuration development, and to verify specific performance requirements.

5.3.2.4 Thermal/environmental analyses.

These analyses shall be conducted to determine the steady-state and transient thermal and chemical environments for individual elements of the system. Thermal and chemical environments shall be used in the design, analyses, and testing (e.g., strength, durability, damage tolerance, vibration/dynamics, etc.) of the individual components and/or systems.

5.3.2.5 Stress/strength analyses.

These analyses shall be conducted to determine the stresses, deformations, and margins of safety which result from the applications of design conditions, loads, and environments. These analyses are required for verification of strength.

5.3.2.6 Durability analyses.

These analyses shall be conducted to verify individual system components will meet the service life requirements when subjected to the operational usage and environments. Analyses shall be conducted early in the acquisition phase to support design concept development, material selection, and weight/cost/performance trade studies. Early analyses will enable identification of failure modes and sensitive areas, particularly those with potential for early fatigue, wear, environmental degradation, or thermal distress. Allowable limits for critical failure modes, cracking, wear, chafing, and environmental degradation must be defined as part of these analyses. Early analysis shall be emphasized to minimize occurrences of deficiencies during subsequent development and functional testing. Material and process data required to support analytical methods shall be generated in accordance with 5.3.3.1.

Durability analyses shall be used to predict the operational life with and without scheduled maintenance. The analyses shall consider material variability, initial manufacturing quality, and functional limits for each critical failure mode. Analyses shall show that adverse cracking, wear, delamination, or other damage formation will not occur within the required operational service life when subjected to the required usage and environments. Components shall be designed and analyzed using appropriate factors, to account for variations in material properties, processes, manufacturing, etc. A minimum factor of twice the required service life using nominal properties, tolerances, etc., will be applied for durability-critical mechanical components. Certain applications that use a high durability margin approach (e.g., door drive systems) require more stringent factors (e.g., landing gear minimum is 4 life factors, flight control actuators as high as 7). Recommended factor for safety-critical mechanical components is a minimum of four times the service life. Individual component analytical results should be used to prove the available economic life of the total system is at least equal to the required operational service life specified in the contractual documents.

5.3.2.7 Damage tolerance analyses.

Damage tolerance design and analyses shall be conducted to substantiate the ability of the identified safety- and mission-critical components to continue to perform safely in the presence of material, manufacturing, processing, or handling- or operationally-induced damage for the minimum required maintenance-free period of unrepaired usage. Methods to achieve damage-tolerance compliance include: fail-safe concepts, slow damage growth concepts, leak-before-burst concepts, and proof testing.

5.3.2.7.1 Damage tolerance inspections.

Inspection requirements necessary to ensure damage never reaches a size able to induce catastrophic failures are inherent in damage-tolerant designs. Initial and repeat inspections are required for both fail-safe and slow damage growth designs and are described in 5.3.2.7.3 and 5.3.2.7.4, respectively. Such inspections are necessary to an estimated time, with the appropriate scatter factor, of the onset of widespread damage. At the onset of widespread damage, inspections are not sufficient to ensure safety.

5.3.2.7.2 Damage tolerance action categories and guidance.

The most appropriate damage tolerance approach shall be selected for each component based on its design, manufacturing method, application, and material, with the approval of the Procuring Service.

The specification design usage shall be the basis for load spectrum development to be used in the crack growth analysis and verification tests. The calculations of critical flaw sizes, residual strengths, safe crack growth periods, and inspection intervals shall be based on pertinent design handbook fracture test data and any additional crack growth rate data generated as a part of the design development test program. Fracture mechanics analyses performed for damage tolerance should use linear elastic fracture mechanics as the basis of the analysis method. Any additional methodology considerations should be supported by appropriate data. In general, these considerations would include time-dependent crack growth, effects of out-of-phase stress and temperature, load interaction (overload crack retardation and/or under-load crack acceleration), and consideration of residual stress fields due to surface treatments (e.g., shotpeen).

5.3.2.7.3 Fail-safe.

Fail-safe analysis should establish that the required residual strength of the remaining intact structure will be maintained for a period of unrepaired usage through the use of multiple load paths or damage arrest features after a failure or partial failure. The period of unrepaired usage necessary to achieve fail-safety must be long enough to ensure the failure or partial failure will be detected visually and repaired prior to the failure of the remaining intact structure. Initial inspections for fail-safe designs shall be established based on either: 1) fatigue analyses and tests with an appropriate scatter factor, or 2) slow damage growth analysis and tests assuming an appropriate initial flaw size. Repeat inspections shall occur at or before one-half the life from the minimum detectable flaw size (based on probability of detection) to the critical flaw size.

5.3.2.7.4 Slow damage growth.

Crack growth analysis and/or sub-element/component crack growth testing shall demonstrate that the residual strength capability is maintained for the crack growth service life requirement. The initial flaw size used is the flaw size consistent with the specified inspection process and resultant demonstrated required reliability-based probability of detection/confidence level (POD/CL) capabilities. Initial inspections for slow damage growth designs shall occur at or before one-half the life from the assumed maximum probable initial flaw size to the critical flaw size. Repeat inspections shall occur at or before one-half the life from the minimum detectable flaw size (based on probability of detection) to the critical flaw size.

5.3.2.7.5 Leak before burst.

Fracture mechanics analysis shall confirm that a through crack in a fluid container will leak fluid before burst by demonstrating tolerance of a through thickness crack two times (2X) the wall thickness, or a size agreed upon with the Procuring Service, when subject to limit loading conditions.

5.3.2.7.6 Proof test analysis.

An analysis should be accomplished to support the concept of proof testing. The analysis should demonstrate that when the component is subjected to proof test conditions, the probably of undetected defects that would lead to failure is less than 1×10^{-7} per flight hour. Proof tests should then be performed on each production component that effectively demonstrates that the component is damage tolerant.

5.3.2.8 Risk-based analyses.

Analysis shall demonstrate that the consequence of component failure results in an overall probability of loss of aircraft is less than 1×10^{-7} per flight hour.

5.3.2.9 Vibration/dynamics/acoustic analyses.

Dynamics analyses shall be conducted to establish component vibration and acoustic mode shapes and frequencies. An analytical dynamic model of the system and/or critical components shall be developed to identify critical system modes, potential forcing functions, and resonance conditions. In addition, the analyses shall show that the vibration levels are acceptable for the reliable performance of equipment throughout the design service life requirements.

5.3.3 Development tests.

The amount and type of tests required to support the design and development will vary. These shall include, but not be limited to, the tests described in the following subparagraphs.

5.3.3.1 Material characterization tests.

Material characterization data such as strength, fatigue, fracture toughness, crack growth rate, corrosion resistance, wear, and thermal stability are required to support the design and to meet specific integrity-related requirements. When the data is not available, material properties shall be established by test. Test specimens shall be fabricated to include critical manufacturing processes (e.g., forming, joining, and assembly techniques). The test plan shall identify the vendor material characterization test requirements necessary to ensure minimum required properties in finished parts throughout production.

Materials property data must be statistically significant. All materials shall be procured to existing materials and process specifications. Any changes to the materials and process specifications may require retest. Material properties should be placed under configuration control by the contractor. Section thickness, thermal treatments, and manufacturing methods shall be the same as the production hardware.

Existing data obtained from literature sources or previous Program experiences may be used. However, for safety- and/or mission-critical component application (see 5.2.4), these properties shall be verified using specimens fabricated from actual parts, as required.

Materials for safety- and/or mission-critical systems and components (see 5.2.4) should be characterized to include the full range of design, operating conditions, and natural and induced environments. Cyclic loading and time-dependent properties should reflect the environmental and design usage defined in the contractual documents or as modified in this standard.

5.3.3.2 Design development tests.

Development tests shall be conducted to support component and system sizing, material selection, durability assessment, design concept trades, and analysis verification, and to obtain an early indication of compliance with specific performance requirements. Examples of design development tests are tests of coupons, small elements, joints, fittings and sealing concepts, controls, linkages, operating mechanisms, and major components—such as pumps, reservoirs, and actuators.

The scope of development tests shall be established in the MECSIP Master Plan and shall include rationale for the tests, description of the test articles, test duration, and criteria for interpretation of test results.

5.3.4 Performance.

5.3.4.1 Dynamic modeling.

Analyses techniques using dynamic performance models shall be developed for all mechanical and electrical controls and subsystems to support their design, verification and life management activities. The basis and method of development of all mechanical and electrical controls and subsystems dynamic models shall be described. Examples of the design, verification and life management activities include: trade studies, mission assessments, component design and lifing, control law development, performance analyses, test planning and results analyses, and problem investigations.

5.3.4.2 Failure detection and accommodation (FDA).

Analyses of the controls and subsystems shall be performed to ensure safety-critical failures are identified and accommodated. Examples of these analyses include: fault injection, fault detection, fault isolation, control reversionary modes, redundancy management and their associated impacts on Level I and II flying qualities.

5.3.4.3 Stability and response.

Analyses of the controls and subsystems shall be performed to ensure they provide required levels of stability and response in relation to commanded inputs. Examples of stability and response analyses include: overshoot/undershoot, fluctuations and phase and gain margins. Analyses of the controls and subsystems shall be performed to determine their frequency and mode shape and prevention of resonant conditions resulting from any induced excitations. Examples of frequency and mode shape analyses include: critical natural frequencies determination and dynamic response characteristics.

5.3.4.4 Control laws, schedules, architecture, and power management.

Analyses of controls and subsystems shall be performed to develop control laws, schedules, control architecture, and power management such that all specification requirements are met. Examples of these analyses include: performance (thrust), control (major loop) stability, start times, acceleration, deceleration, limit loops, and stall recoverability.

5.3.5 Electromagnetic effects and lightning.

Analyses of controls and subsystems with electrical/electronic parts shall be performed to determine their electromagnetic susceptibility and emissions characteristics. Analyses of controls and subsystems shall be performed to determine their susceptibility to damage resulting from a lightning strike.

5.3.6 Software.

5.3.6.1 Software performance and testing requirements.

All controls and subsystems performance requirements shall be analyzed to ensure adequate design, performance, and testing of all initial and subsequent flight release versions of safety-critical software. Examples of these analyses include: confirmation of component and system performance versus requirements, memory usage, worst-case timing analysis, and validity of special test equipment (electronic verification benches).

5.3.7 Assessments.

5.3.7.1 Abnormal operation (design margin).

Analyses of all safety- and flight-critical controls and subsystem components shall be performed to meet program requirements in the presence of abnormal operating conditions and/or failure scenarios. Examples of these analyses include: design margin for over speeds, over temperatures, overpressures, explosive atmosphere, exposure to fire and blade-out.

5.3.7.2 Manufacturing and assembly processes.

Analyses of controls and subsystem components' manufacturing and assembly processes shall be performed to identify any materials requiring special processes or handling and any assembly hazards. Mitigations for these risks shall be identified such that program requirements can be met.

5.3.8 Reliability and maintainability.

Analyses of controls and subsystem components' reliability and maintainability shall be performed. Maintainability analyses shall be performed for both installed and uninstalled conditions. Examples of these analyses include: component Mean Flight Hours Between Failure (MFHBF) and Mean Time to Replace (MTTR).

5.3.9 Electrical/optical cable maintainability.

Analyses of controls and subsystem electrical/optical cabling shall be performed to ensure they can be properly maintained when exposed to sea level cold day conditions and the expected maintenance environments including chemical/biological attacks. Examples of these analyses include: connector removal and replacement, and cable routing and placement.

5.3.10 Ground handling.

Analyses of controls and subsystems components shall be performed to ensure they will not sustain damage when exposed to normal ground handling. Examples of these analyses include: component removal and replacement, transport loads, component mount loads, and plumbing loads.

5.3.11 Obsolescence.

All electronic controls and subsystems components shall be periodically analyzed for their vulnerability to obsolescence. Results of these obsolescence analyses along with risk mitigation plans shall be included in the Obsolescence Management Plan. The contractor shall be required to update these obsolescence analyses periodically in accordance with the Obsolescence Management Plan. Examples of obsolescence analyses include: potential loss of manufacturers of items or suppliers of items or raw materials that may cause future material shortages that endanger subsystem development, production, or post-production support capability.

5.3.12 De-rating/up-rating.

Analyses of electronic controls and subsystem components shall be performed to identify and manage de-rating or up-rating their environmental and functional performance requirements. A de-rating/up-rating methodology shall be established and documented.

5.3.13 Equipment prognostic systems.

The health of equipment shall be constantly monitored through the use of diagnostics and trending systems. Equipment prognostics systems used to support the sustainment of fielded equipment should be developed concurrently with the equipment and used throughout the sustainment portion of an aircraft program.

5.4 (Task IV) Component Development and Systems Functional Tests.

These tests are intended to verify the sub-system integrity performance and to validate design verification analysis. Tests may be conducted on sub-systems or individual components, in simulated sub-system installation environments, or during flight and ground testing. All testing shall be planned, scheduled, and conducted in accordance with the overall sub-system test plan and specific requirements. Instrumentation should be provided when test is used to validate design analysis. All Task IV testing shall be conducted post-CDR with successful completion satisfying Milestone C exit criteria associated with test. Tests shall include, but not be limited to, those described in the following subparagraphs.

5.4.1 Component and rig test descriptions.

All controls and subsystems component and rig testing (including air vehicle integration) requirements shall be defined. Test descriptions will include, at a high level, test objectives, facility requirements and capabilities, and subsystem/component descriptions.

5.4.2 Testing risk mitigation.

To the maximum extent possible, controls and subsystems component and rig testing results shall be used to support the mitigation of known design risks. An assessment of known controls and subsystems design risks shall be accomplished in order to maximize the use of component and rig testing results in their mitigation. Examples of assessment activities include: evaluation of design assumptions, trade studies, technology readiness levels (TRLs), production variations and component residual life. The risk assessment shall be updated in accordance with the overall risk management plan.

5.4.3 Hardware and systems rig testing.

5.4.3.1 Subsystem performance.

All controls and subsystem components (including air vehicle integration) shall be tested as necessary to resolve analytical uncertainty to verify performance and durability requirements are satisfied. Examples of these tests include: fuel/fuel delivery, lubrication, anti-ice, thermal management, actuation, sensing, electrical power, prognostic health management, and actuation.

5.4.3.2 Dry rig.

All electronic controls shall optimize the use of dry rig test facilities during development for hardware/software integration and software development. The extent of dry rig facilities shall be governed by factors such as system complexity, technology maturity, and simulation fidelity. Examples of dry rig testing include: electronic verification bench, performance model validation, mission simulation/pilot in loop, fault injection, fault detection, fault accommodation, etc.

5.4.3.3 Wet rig.

All controls and subsystems shall optimize the use of wet rig test facilities during development for hardware/software integration and software development. The extent of wet rig facilities shall be governed by factors such as system complexity, technology maturity, and simulation fidelity. Examples of wet rig tests include: controls system development, fuel system integration, iron bird validation, fault injection, fault detection, fault accommodation, and lubrication systems development.

5.4.3.4 Mechanical systems.

All gearboxes and drives shall maximize the use of mechanical system rig test facilities during development. The scope of these rigs shall be governed by factors such as technical risk, design uncertainty, and technology maturity. Examples of mechanical systems rig tests include: gearbox and power take-off development.

5.4.4 Hardware component.

5.4.4.1 Component development.

If required for risk reduction, each controls and subsystem component shall undergo individual development testing to ensure an acceptable risk that its design and performance requirements can be met. Examples of this development testing include: fuel pump pressure and flow, pump pressure pulses, actuator slew rate, sensor operation, electro-hydraulic servo valve operation, control stability/response, speeds, temperatures, amperes and voltages, and fault injection, detection, and accommodation.

5.4.4.2 Abnormal operation (design margin).

All controls and subsystems components shall be considered for bench and/or rig testing to verify their ability to meet program requirements in the presence of abnormal operating conditions and/or failure scenarios. The scope of these tests shall be governed by factors such as design uncertainty, system model fidelity, and operational environment uncertainty. Examples of these tests include: overspeeds, overtemperatures, proof and burst pressure, design growth capability, performance margin, and up-rating/de-rating.

5.4.5 Reliability growth demonstration.

Flight-critical controls and subsystem components shall be bench or rig tested to determine their abilities to meet reliability requirements. The scope of these tests shall consider design maturity, environmental uncertainty and severity, and safety criticality versus implementation costs. Examples of these tests include: reliability demonstration, reliability growth and test, analyze and fix.

5.4.6 Oil interruption and depletion.

All lubrication subsystem components and those that require oil lubrication shall be bench or rig tested to verify their ability to tolerate normal interruptions of oil supply without damage or failure. All lubrication subsystem components and those that require oil lubrication shall be bench or rig tested to verify their ability for continued safe operation, for a specified duration, after an oil depletion event. Examples of these tests include: maneuver-induced interruptions, oil hiding, slugging, and overboard loss.

5.4.7 Component fit checks.

All controls and subsystem components shall have their installations fit checked against specification requirements and/or ICDs. Examples of tools that may be used are: Catia® and Unigraphics® computer programs. Examples of physical checks include: envelope, clearances, and removal and replacement times. Subsystem component installation fit and rigging procedures should be assessed/adjusted/validated/verified onboard the aircraft prior to aircraft testing.

5.4.8 Component qualification.

Each controls and subsystem component shall undergo individual qualification tests to validate design and performance requirements are met. Examples of bench testing include: fuel pump pressure and flow; pump pressure pulses; actuator slew rate; sensor operation; electro-hydraulic servo valve operation; control stability/response; speeds; temperatures; amperes and voltages; and fault injection, detection, and accommodation.

5.4.9 Vibration and dynamic response.

All controls and subsystems components shall be tested to verify they do not contain any damaging resonant conditions or responses within their operating range. Examples of these tests include: pump pressure pulses, resonance response searches, ping tests and dwells, and HCF endurance.

5.4.10 Fire proof/fire resistance.

All controls and subsystems components that carry flammable fluids shall be bench tested to verify they meet fire proof and fire resistance requirements.

5.4.11 Software testing.

All initial and subsequent release versions of safety-critical controls and subsystems software, including any aircraft interface software, shall be completely tested at the applicable Unit, Computer Software Configuration (CSC), Computer Software Configuration Item (CSCI) and component levels. Examples of these tests include: peer reviews, module operation, integration (interaction and handshaking operations), fault injection, regression and full qualification (on both Application and Operational packages). All testing of initial and subsequent release versions of safety-critical controls and subsystems software, including any aircraft interface software, shall follow established government and industry standards and practices (e.g., RTCA DO-178).

5.4.12 Functional tests.

Full-scale component, system ground (e.g., iron bird, simulator), and/or flight tests shall be conducted to verify specific functional performance requirements. Examples of functional testing include fluid flow performance, leakage, brake performance, and flight control performance. When practical, these tests should be used to evaluate and verify equipment integrity. Failure Modes, Effects, and Criticality Analysis as well as Fault Detection testing on each subsystem are performed on simulators and on aircraft to validate control logic, redundancy, back-up, and emergency operations occur as designed.

5.4.13 Strength testing.

Testing of components, assemblies, and/or systems shall be performed to verify strength requirements. Thermal and other environmental effects shall be simulated along with load applications when these conditions impose significant effects on the component strength. Examples of strength testing include proof, burst, and leak before burst testing. Test results shall be used to evaluate design margins and growth capability.

5.4.14 Durability testing.

A test program shall be conducted to substantiate the overall durability of system components. Durability testing consists of component, assembly, and/or full system tests which simulate repeated loads and environmental conditions that represent design usage and design service life criteria.

Tests, particularly for expensive and long lead development items, shall be scheduled early in the test program to allow for identification and correction of critical areas and failure modes (e.g., cracking, wear, chafing, leakage, etc.). The durability test schedule should be established to support acquisition decisions which consider component criticality, risk mitigation, and lead time for all potential design issues during qualification. Testing milestones shall be established as part of the overall system test planning.

The results of durability testing shall be the basis for any design modifications, special inspections, and maintenance actions for critical components and installed systems.

Test duration requirements will vary depending on the specific application. Components shall be required to demonstrate a sufficient number (minimum two lifetimes) of design service lives to impart confidence that the component will achieve one lifetime in service. Test articles shall be selected which represent the production configurations. Test loadings and environments shall represent the significant elements of the design service usage spectrum. Truncation and simplification of the repeated loads and environments shall be substantiated by analysis and/or test to verify equivalency to the design usage spectrum.

All test results shall be evaluated and compared against the original analytical predictions for wear and life. When damage is worse than predicted, the affected parts shall be re-analyzed and appropriate corrective actions taken.

5.4.15 Vibration/dynamics/acoustics tests.

These tests shall be conducted to verify the vibration, dynamics, and acoustics response characteristics of the installed system and/or critical system components. These tests shall account for aircraft equipment installation dynamic transmissibility.

5.4.16 Damage tolerance tests.

Damage tolerance tests should be performed when deemed appropriate for specific applications. These tests shall be conducted to verify the damage tolerance characteristics of safety-critical and mission-critical components. These tests are used to establish damage tolerance margins, crack growth rates, critical crack lengths, residual strength, fail safety, leak before burst, or other characteristics defined by the specific damage tolerance criteria. No testing will be necessary for relatively-simple geometries and well-characterized materials, if there is adequate confidence in the accuracy of the analysis. Coupon, element, or component-level testing shall be necessary for all other cases. The combination of analysis and test shall demonstrate two design service lives to impart confidence that the component will achieve one lifetime of service. An in-service inspection period shall be established at one-half the validated design service life. Components which satisfy damage tolerance through high durability margins shall be tested to the appropriate number of equivalent lives (typically four or more) necessary to gain high confidence that the component will achieve one lifetime of service.

5.4.17 Thermal, environment, and loads survey.

Temperatures, loads, and other environmental factors shall be measured during the component development and system functional and flight tests. These values shall be compared against predicted values to verify design criteria. Data obtained from these surveys will be used to adjust operational limits and maintenance actions as determined from analysis and tests. The information will also be retained as "lessons learned" to assist in the development of criteria for future applications. The plan and approach for conducting this survey shall be included with the MECSIP Master Plan.

5.4.18 Overspeed/overtemperature.

Overspeed and overtemperature tests shall be conducted to substantiate/correlate analytical predictions. For the overspeed test, all rotors should be subjected to equipment operation for a stabilized period of at least five minutes duration at the required margin over maximum allowable steady-state speed at the equipment’s maximum allowable temperature.

Following the test, parts and assemblies should be within allowable dimensional limits and there should be no evidence of imminent failure. Upon successful completion of the overspeed test, the same equipment shall be operated at the required temperature over the maximum allowable temperature and at no less than maximum allowable steady-state speed for five minutes. Following the test, parts and assemblies should be within allowable dimensional limits and there should be no evidence of imminent failure.

5.4.19 Maintainability/reparability demonstrations.

The contractor shall conduct a program to develop and demonstrate maintenance procedures. The demonstrations may be conducted in conjunction with development and/or full system tests. Authorized repairs and repair limits shall be in accordance with the documented maintenance and logistics requirements. Testing will be conducted as required to validate the integrity of authorized repairs.

5.4.20 Evaluation and interpretation of test results.

The contractor shall describe the procedures to evaluate, interpret, and incorporate all test findings (e.g., cause, corrective actions, Program implications, maintenance projections, and costs). This evaluation shall define corrective actions required to demonstrate design requirements are met. Each problem (cracking, yielding, wear, leakage, etc.) that occurs during testing shall be evaluated. Inspections, disassembly, and destructive tear-down evaluations shall be conducted.

5.4.21 Integrated test plan.

All test requirements identified for the specific sub-system equipment shall be defined, scoped, and scheduled in an integrated test package. This includes tests associated with development and full qualification, as well as any subsequently-scheduled growth or margin testing. Vendor and supplier tests shall be included in this test package. The contractor shall seek the most economical balance of requirements, verification, and test articles when integrated sub-system tests are compiled. The integrated test packages shall be incorporated into the overall Test and Evaluation Master Plan (TEMP).

5.4.22 Final integrity analysis.

The design analyses (Task III) for safety-, mission-, and durability-critical components shall be updated to account for significant differences between analyses, tests, and the thermal/environmental/load survey. These updated analyses shall provide data on operational limits to be used in maintenance, inspection, and repair times for critical components. These analyses and evaluation of test results shall be utilized to develop maintenance and inspection planning. Analyses to be updated shall include, but not be limited to, the following:

a. durability;

b. strength;

c. damage tolerance;

d. loads; and

e. stress—environmental and thermal.

These final analyses shall be developed following completion of the design/development test and analysis phase and shall be submitted in accordance with specific Program requirements. This plan shall require USAF approval.

5.4.23 Maintenance planning and task development.

Required maintenance actions (e.g., inspection, repair, or replacement) shall be developed to ensure the integrity and operability of the system for the required operational service life. Initial maintenance action requirements and times shall be based on engineering data to include updated analyses and test data in accordance with 5.4.22. These actions and times will be modified, as appropriate, according to information and experience from in-service operation.

The required maintenance action times shall be based on duty cycles and usage in accordance with the specific design criteria and system requirements. The initial maintenance plan shall be developed following completion of the design/development test and analysis phase and shall be submitted in accordance with specific Program requirements. This plan shall require USAF approval.

5.4.24 Airworthiness certification.

The final design analyses correlated to ground and flight testing are major steps to establish the air vehicle subsystems' airworthiness certification and are herein referred to as "certification analyses." The design analyses described in 5.3 shall be revised to account for differences revealed between analysis and test. Selected systems development and demonstration tests, the full-scale tests described in 5.4, and the interpretation and evaluation of test results shall be used in the air vehicle airworthiness certification effort. The certification analyses provide the engineering source data for the Technical Orders (TOs) that document the operational procedures, limitations/restrictions, and maintenance requirements to ensure safe operation. Approval of the certification analyses shall constitute a critical step in achievement of airworthiness certification for the aircraft in accordance with procedures outlined in MIL-HDBK-516.

5.5 (Task V) Force Management.

Force management includes those actions necessary to ensure that the performance, safety, reliability, and durability requirements established in Tasks I through IV are met and maintained throughout the entire life of the weapon system. The MECSIP Manager has overall responsibility to manage the health of the systems, regardless of the overhauling Depot. The MECSIP Manager shall be part of any management process that impacts the safety, suitability, effectiveness, reliability, and durability of a system or its components. The MECSIP Manager shall: 1) update and maintain the MECSIP Master Plan as necessary to reflect the needs associated with sustainment, 2) establish and monitor a component tracking program, 3) establish preventive maintenance actions, 4) establish repair/overhaul procedures, and 5) establish inspection criteria. Appendix B defines the basic force management actions required to establish a MECSIP program for a system already in sustainment.

5.5.1 Equipment manufacturing and integration.

For safety-critical parts, the program office shall review the engineering and manufacturing plans to verify they are adequate to consistently produce parts with the required attributes to insure safety in operation. For these safety-critical parts, all changes to the parts and/or process to fabricate the parts shall also be reviewed to verify integrity is maintained.

5.5.2 Sustainment of equipment prognostic systems.

Equipment prognostics systems used to support the sustainment of fielded equipment should be used throughout the sustainment portion of an aircraft program. Data from these systems should be made available (in conjunction with the mission usage/life analysis data) for continued engineering analysis and monitoring.

5.5.3 Reliability-Centered Maintenance (RCM).

Reliability-Centered Maintenance focuses on preventative maintenance as a means to avoid, reduce or eliminate the consequence of failures. RCM may be defined as a disciplined methodology used to identify preventative maintenance tasks to realize the inherent reliability of equipment with the least expenditure of resources. RCM concepts should be an integral part of equipment repair and overhaul task definitions. (Reference NAVAIR 00-25-403.)

5.5.4 Component tracking/monitoring program.

Configuration management is a major constituent within life management as well as in support of OSS&E. The ability to track individual items during use plays a direct role in the fidelity of life management. Moreover, it provides the additional flexibility needed to accomplish trend analysis, identification, and elimination of “Bad Actors”. In-service failure data shall be constantly monitored. Three years of data shall typically be collected before premature failures can be effectively identified. After three years, the MECSIP Manager’s tracking program shall automatically provide notification if the Mean-Time-Between-Failure (MTBF) rate changes more than twenty-percent (20%) over an 18-month time period. The MECSIP Manager shall review the situation and determine if further engineering analysis is required. If an analysis is required and it exceeds the facilities or skills of the assigned personnel, contractual assistance may be used. The intent of the analysis is to increase the Component Time to Failure (CTTF) (the point at which a component experiences an inherent failure that requires its removal from the air vehicle) to an acceptable level. The tracking program shall provide periodic (typically, monthly) failure listing for each system to alert the MECSIP Manager of potential failures. The MECSIP Manager shall establish a priority schedule for each system based on 5.2.4 (critical parts analysis and classification) and on current data. The MECSIP Manager shall rely on the Material Deficiency Report/Quality Deficiency Report system for alerts prior to the three years of collected data.

5.5.4.1 Operational usage data.

Operational usage data shall be collected (during Task V) to validate the environmental and loading assumptions remain valid during operational usage for all parts which utilize a durability tolerance, safe-life or improbable occurrence approach to preclude failures in service. (Reference figure 1.) Operational usage data should also be gathered and systems engineering analysis conducted on that data to look for changes in planned usage of the system with potential unintended consequences. An example of this type of analysis is the KC-135 started using the hydraulically driven aerial refueling pumps to feed engines. These pumps did not have the same capability to safely run dry that the electrically powered boost pumps possess, therefore they created a potential for a catastrophic mishap. It is critical that the program maintain constant vigilance of new usage of the weapon system and update the FMECA as appropriate as existing equipment is used in new or different applications or environments.

5.5.5 Preventive maintenance actions.

Preventive maintenance is designed to preclude component failure. Based upon the maintenance-free operating period established in Tasks III–IV, as well as available field data, a time-change or other preventive maintenance action can be planned during scheduled downtimes to prevent loss of scheduled missions and to ensure a high level of safety. A unit's mission profile may have a significant effect on the CTTF. For example, Bases which perform pilot training will generally have an increase in landing gear and flight control malfunctions, thereby reducing their CTTF. The trade studies performed in Tasks I through III will help the MECSIP Manager select a tracking program that will best establish the CTTF. Similarly, there may be a need for redesign activity for production aircraft to reduce life cycle cost and meet mission reliability requirements. Failure Reporting, Analysis & Corrective Action System (FRACAS) reporting of failure events provides evidence of the need for redesign activity.

5.5.5.1 Flight-hour time change.

A flight-hour time change shall be considered for problematic components which are durability-critical or have a hidden failure mode, and have an established, reliable CTTF. Components shall be replaced at or prior to the CTTF in conjunction with regularly-scheduled maintenance (Home Station Checks (HSC), major Isochronal (ISO) Inspections, Phase or Periodic Depot Maintenance). Prime candidates for time change are mechanical assemblies such as actuators, jackscrews, valves, pumps, and tension regulators. Safety- and mission-critical components have their own unique set of requirements, which are defined in 5.5.9.1.

5.5.5.2 Calendar time change.

Calendar time change (identified in the dash 6 Tech Order) is a useful technique for relatively low cost components for which serial tracking of individual items is not economically justified and which have a limited life that can be estimated via calendar life (e.g., months or years). These components, especially if they are mission- or durability-critical components and their failure will measurably impact operational utility of the overall system, should be considered for Calendar Time Change. Calendar time change parts can be repaired or replaced during scheduled maintenance (such as ISO Inspections, and Phase or Periodic Depot Maintenance) reducing overall maintenance burden. Similar to time change, these components are repaired or replaced on a calendar-inspection basis, not a flight-hour basis.

5.5.5.3 On-equipment repairs.

It may be more advantageous during the operational service life of a component to make minor repairs or replace an attaching Line Replaceable Unit (LRU) than to replace the component. Repairs may include replacement of the elastomeric seals, rod ends, bearings, wiring harnesses, etc. These repairs shall be identified in Task IV, and technical data relative to the repairs shall be made available for reference.

5.5.5.4 Lubrication/cleaning and adjustments.

The system may require periodic maintenance if it is to perform correctly. For example, the MECSIP Manager must ensure that proper wash and lube are scheduled to prevent corrosion, that wiring systems are secured to avoid damage or shorting during cleaning, and that any necessary adjustments (e.g., to flight controls or landing gear) are made during the scheduled maintenance. Wartime conditions do not preclude performance of these scheduled maintenance tasks.

5.5.5.5 Overhaul of systems.

As systems age, wear in individual components may lead to unreliable and eventually failed systems. The tendency is to replace the component in the system that has the most wear and to return the air vehicle to service. This type of "piece-meal" repair lasts only until the next component fails. Once a unit or system reaches this condition, the refurbishment of the entire unit or system to "like-new" condition becomes more economical than the continued removal of an air vehicle from service to accomplish what are essentially temporary repairs. Analysis and, eventually, repair history must provide the basis to distinguish parts of the system to be overhauled from those that are not. While entire system replacement may seem expensive, the cost must be compared to the time lost for air vehicle downtime. Items such as torque tubes, rod end bearings, quadrants, pulleys, wiring harnesses, and related electrical equipment are prime candidates for this type of maintenance. These items require little attention from the MECSIP Manager in the beginning but must be part of the preventive maintenance actions as the air vehicle ages.

As systems are initially received for overhaul (first scheduled Depot maintenance), one or more lead-the-fleet (high time) units shall be selected for a complete disassembly and inspection. The purpose is to compare the degradation against that predicted. If degradation is found in areas not expected, or the degradation is more severe than predicted, appropriate actions shall be taken to prevent in-service failure and/or unscheduled maintenance.

5.5.5.6 Replacement of original equipment.

Many components are designed with a service life that exceeds that of the air vehicle. As a result, little or no preventive maintenance is required. Examples include actuating cylinders, electrical connectors, and bleed ducts. Wear-out mechanisms for other components become well defined as the system ages. Identification and correction of these components are becoming increasingly important as more aircraft continue to remain in service past their original design lives. In some cases, upgrades to the same equipment can easily be provided with advanced materials which will increase the component's life.

5.5.5.7 Replacement of obsolete equipment.

Some older aircraft may use antiquated equipment. Newer technology may enable replacement with improved reliability. An example of this would be the new fly-by-wire versus the mechanical linkage for flight controls. It may be cheaper and more feasible to replace these systems with the newer technology. The MECSIP Manager must be ready to make this type of decision based on collected data and trade studies.

5.5.5.8 Environmental regulations.

Environmental regulations shall be considered in the selection of materials. Changes in the environmental laws may also drive replacement programs. Any replacement material shall be analyzed and/or tested to ensure it meets the original design and service life requirements. For uncharacterized materials, characterization testing shall be conducted in accordance with 5.3.3.1. Asbestos seals and clamps are examples of items which must be replaced. Depleted uranium flight control counter-weights must be refurbished to prevent hazardous materials contamination. Paint, plating, cleaning, and corrosion control systems must be updated. The MECSIP Manager shall receive periodic briefings on environmental changes to ensure safe maintenance and operational procedures.

5.5.6 Flight manual.

The subsystems data necessary for preparation of the flight manuals shall be developed. The data would include but not be limited to cautions and warnings and special pilot procedures.

5.5.7 Production/overhaul quality.

5.5.7.1 Acceptance Test Procedures.

Subsystem component Acceptance Test Procedures (ATP) shall be developed by the principle integration engineering authority. The approved acceptance test procedures shall be used to evaluate the performance of all new production and overhauled components. New production part acceptance limits and overhauled component service limits shall be developed.

5.5.7.2 Component test bench calibrations.

Subsystem component test benches shall be routinely calibrated to ensure consistent performance measurement. The subsystems test bench calibration methodology and limits shall be approved by the principle integration engineering authority.

5.5.8 Monitoring of repairs/overhauls.

If a component fails, it can be either thrown away or returned for overhaul, based upon the results of a life cycle cost analysis. To “overhaul” a component is to return it to a “like-new” condition. To “repair” a component is simply to make it serviceable. The MECSIP Manager shall ensure serviceable items returned to Base supply have been “overhauled” or meet the intent of “overhaul.” Unfortunately, it is difficult or impossible to restore a used part to a “like-new” condition. Parts which were not replaced during overhaul have some percentage of their original life consumed. Plating landing gear to build-up areas where corrosion was removed can affect the overall properties of the unit. It is the MECSIP engineer’s responsibility to ensure that any degradation in overall condition is acknowledged and accounted for in the overhaul process. This activity requires an Individual Tracking System (IAT), serialization, tracking of parts, and monitoring of repairs.

5.5.8.1 Field/Base-level maintenance.

The MECSIP Manager shall either ensure each Field or Base has the proper “overhaul” capabilities (i.e., test equipment, TOs, plating equipment, etc.) for a specific component, or prohibit performance of the overhaul at that location. This can be best accomplished by ensuring the Aircraft Scheduled Inspection and Maintenance Requirement TOs are current and enforced. If a component is repaired at the Field/Base level, then consideration shall be given to a requirement that the component be periodically returned to the Depot (e.g., after the third Field/Base-level overhaul) to ensure the reliability of the component continues to be met. The MECSIP Manager can recommend no Field/Base-level repairs, and establish regional repair facilities. The cost of training technicians and test equipment may prohibit Field/Base-level repairs and may lead to regional or “Queen Bee” facilities. The MECSIP Manager must have a list of contacts for each Field/Base and be aware of their capabilities. If an overhaul is performed, the master maintenance action log originated by the owner Depot must be updated.

5.5.8.2 Depot-level maintenance.

The Depot strongly influences the continued reliability of the components and systems. One-of-a-kind test equipment, special tools, and chemical plating are combined with special training to ensure components are returned to a “like-new” condition. Components which enter the Depot shall be overhauled and have the parts replaced, as indicated by the maintainability/reparability demonstrations contained in 5.4.19. The MECSIP Manager, in concert with Air Logistic Center Engineering, is responsible for ensuring component reliability.

5.5.9 Inspection criteria.

The inspection criteria are established during Tasks III and IV. The list is constantly updated using data collected from operational units, personal contacts, Field/Base or Depot inspections, maintenance deficiency reports, or changes as a result of Engineering Change Proposals (ECPs). The inspection requirements shall establish the equipment to be inspected, its inspection schedule, and its inspection criteria. The inspection process is a key to ensuring the MECSIP process is effective. Computer programs must link all Fields/Bases which perform inspections, compile and list common deficiencies, and identify potential problem areas. Systems are generally modified based on inspection reports and maintenance man-hours annotated in the reports. The MECSIP Manager shall meet yearly with all major inspection chiefs to discuss improvements and new inspection criteria. The MECSIP Manager shall establish an electronic bulletin board to assist in the daily communication with Maintenance personnel and shall establish a list of contacts for each Field/Base.

5.5.9.1 Safety-critical component maintenance requirements.

Safety shall be maintained such that failure is not expected to occur throughout the operational life. The components shall be inspected and/or replaced at some portion of their demonstrated service life to ensure failure-free operation. This is to account for variability that exists in service life due to scatter in material properties and damage that occurs during manufacturing and maintenance. The initial and recurring inspections shall be established based on one half the time required for a detectable flaw to grow to critical size. The MECSIP Manager shall determine the demonstrated life for each safety-critical component and establish the maintenance (inspection or replacement) intervals that result in a probability of failure per flight hour equal to or less than 1×10^{-7}.

5.5.10 Analytical Condition Inspection (ACI) Program.

An ACI Program shall be conducted throughout the life of the aircraft per Air Force Materiel Command Instruction (AFMCI) 21-102. Corrosion, fatigue, wear out and other damage scenarios shall be considered in the selection of inspection locations and schedules for aircraft mechanical equipment. The ACI Program shall be conducted with special emphasis on determination of when and where corrosion occurs and on prototypes of NDI and repair actions.

6. NOTES.

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use.

Mechanical equipment and subsystems which provide power, control, and other contributory functions are essential elements of weapon systems. This standard is intended to be used to establish programmatic tasks for the development, acquisition, modification, operation, and sustainment of the mechanical elements of airborne, support, and training systems developed to perform combat and combat-support missions in environments unique to military weapon systems.

6.2 Acquisition requirements.

Acquisition documents should specify the following:

a. Title, number, and date of the standard.

6.3 Data requirements.

When this standard is used in an acquisition which incorporates a DD Form 1423, Contract Data Requirements List (CDRL), the data requirements identified below may be developed as specified by an approved Data Item Description and delivered in accordance with the approved CDRL. When the Defense Federal Acquisition Regulation Supplement (DFARS) exempts the requirement for a DD Form 1423, the data specified below may be deliverable by the contractor in accordance with the contract requirements. The deliverable data may include:

Paragraph	Data Requirements Title
5.2.1	MECSIP Master Plan
5.2.7	Product integrity control plan
5.4.22	Final integrity analysis
	Final integrity/qualification test report
	Test Failure Resolution Reports (TFRR)
5.4.23	Maintenance planning and task development.

The ASSIST database should be researched at http://assist.daps.dla.mil/quicksearch/ to ensure only current and approved DIDs are cited on the DD Form 1423.

6.4 Subject term (key word) listing.

Damage tolerance
Critical safety item
Durability
Equipment, air vehicle
Equipment, ground vehicle
Flight-safety part
Flight-critical part
Maintainability
MECSIP
OSS&E
Overhaul
Reliability
Repair
Safety
Strength
Supportability
Systems, mechanical

6.5 Responsible Engineering Office (REO).

The office responsible for development and technical maintenance of this standard is ASC/ENFA, 2530 LOOP ROAD WEST, WRIGHT-PATTERSON AFB OH 45433-7101; DSN 785-8609, Commercial (937) 255-8609. Any requests for information that relates to government contracts must be obtained through Contracting Offices.

6.6 Changes from previous issue.

Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

APPENDIX A

GUIDANCE FOR MECSIP TASK COMPLETION CRITERIA AT SPECIFIC PROGRAM MILESTONES

A.1 SCOPE.

This appendix provides guidance for developing the Technical Review criteria for various program milestones. Task I of the MECSIP has a requirement for criteria to be established for each MECSIP task for the program milestones. The intent of this appendix is to provide guidance specific to mechanical subsystems development milestones and technical reviews. Guidance is also provided to the designers of aircraft mechanical subsystems with a disciplined process for organizing their tasks for the development and verification of systems integrity. The focus of guidance provided by this appendix involves the definition and scheduling of the Integrity Program activities over five program-phased tasks. It is a summary of the types of activities that constitute the Mechanical Equipment and Subsystems Integrity design. This appendix is not a mandatory part of the standard. The information contained herein is intended for guidance only and is not to be placed on contract.

A.2 APPLICABLE DOCUMENTS.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-1521	Technical Reviews and Audits for Systems, Equipments, and Computer Software *(This standard is cancelled and is cited for reference only.)*

(Copies of this document are available online at http://assist.daps.dla.mil/quicksearch/ or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094; [215] 697-2664.)

U.S. AIR FORCE INSTRUCTIONS

Air Force Materiel Command Instruction

AFMCI 63-1201	Implementing Operational Safety Suitability and Effectiveness (OSS&E) and Life Cycle Systems Engineering

(Copies of USAF Instructions are available at www.e-publishing.af.mil.)

A.3 DEFINITIONS.

A.3.1 Acronyms.

CDR	Critical Design Review
CI	Configuration Item
FRR	Flight Readiness Review (equivalent to IFR)
IFR	Initial Flight Release
PCA	Physical Configuration Audit
PDR	Preliminary Design Review
PRR	Production Readiness Review
SDR	System Design Review (equivalent to SFR)
SFR	System Functional Review
SRR	System Requirement Review
SVR	System Verification Review

A.3.2 Milestone definitions.

Milestone definitions for the program milestones listed in table A-I through table A-V are provided below as defined by the legacy MIL-STD-1521:

System Requirement Review (SRR): The SRR is a multi-functional technical review to ensure that all system and performance requirements derived from the Capability Development Document are defined and consistent with cost (Program budget), schedule (Program schedule), risk, and other system constraints. Generally this review assesses the system requirements captured in the system specification. The review ensures consistency between the system requirements and the preferred system solution and available technologies. It ensures a balance has been struck between requirements and solution approach risk—that there has been convergence on a system solution that has acceptable risk and that system requirements satisfy customer requirements. The assigned manager may convene an SRR prior to Program initiation or during Technology Development; the Program Manager may convene an SRR during System Development and Demonstration.

System Design Review (SDR) or System Functional Review (SFR): The SFR is a multi-disciplined technical review to ensure the system under review can proceed into preliminary design, and that all system requirements and functional performance requirements derived from the Capability Development Document are defined and are consistent with cost (Program budget), schedule (Program schedule), risk, and other system constraints. Generally this review assesses the system functional requirements as captured in system specifications (functional baseline), and ensures all required system performance is fully decomposed and defined in the functional baseline. System performance may be decomposed and traced to lower-level subsystem functionality that may define hardware and software requirements.

Preliminary Design Review (PDR): The PDR is a multi-disciplined technical review to ensure the system under review can proceed into detailed design, and can meet the stated performance requirements within cost (Program budget), schedule (Program schedule), risk, and other system constraints. Generally, this review assesses the system preliminary design as captured in performance specifications for each configuration item (CI) in the system (allocated baseline), and ensures each function in the functional baseline has been allocated to one or more system configuration items. A series of PDRs are normally held in the System Development & Demonstration phase for new developments. A PDR is held for each CI or aggregation of CIs in the specification tree. Individual CI PDRs should ensure a preliminary CI architecture is complete; a CI development specification is complete or the development specification approved; and that a preliminary allocated baseline is complete or the allocated baseline approved. A system PDR is held after completion of all CI and aggregate of CIs PDRs.

Critical Design Review (CDR): The CDR is a multi-disciplined technical review to ensure the system under review can proceed into system fabrication, demonstration, and test; and can meet the stated performance requirements within cost (Program budget), schedule (Program schedule), risk, and other system constraints. A series of CDRs are normally held in the System Development & Demonstration phase for new developments. A CDR is held for each CI and aggregation of CIs in the specification tree. A system CDR is held after completion of all CI or aggregation of CI CDRs. Even when the government elects not to bring the allocated baseline under configuration control by the time of this review, an assessment of the flowdown of requirements from the functional baseline to the lowest-level CI for each item in the specification tree should be included in the review. Any changes in the performing activity's draft allocated configuration documentation since the PDR are reviewed by the tasking activity and their impact on the functional baseline assessed and validated. This review assesses the system final design as captured in product specifications for each configuration item in the system (product baseline), and ensures each product in the product baseline has been captured in the detailed design documentation. Product specifications for hardware enable the fabrication of configuration items, and may include production drawings. Product specifications for software (e.g., Software Design Documents) enable coding of a Computer Software Configuration Item captured in product specifications for each configuration item in the system (product baseline), and ensures each product in the product baseline has been captured in the detailed design documentation. Product specifications for hardware enable the fabrication of configuration items, and may include production drawings. Product specifications for software (e.g., Software Design Documents) enable coding of a Computer Software Configuration Item.

Flight Readiness Review (FRR) or Initial Flight Release (IFR): The Flight Readiness Review (FRR) is a multi-disciplined product and process assessment to ensure the system under review can proceed into flight test with airworthiness standards met, objectives clearly stated, flight test data requirements clearly identified, and an acceptable risk management plan defined and approved. This review also ensures proper coordination has occurred between engineering and flight test and that all applicable disciplines understand and concur with the scope of effort that has been identified and how this effort will be executed to derive the data necessary to satisfy airworthiness and test and evaluation requirements. As such, this review will include appropriate level of detail for each configuration to be evaluated within the flight test effort.

System Verification Review (SVR): The SVR (replaces the Functional Configuration Audit) is a multi-disciplined technical review to ensue the system under review can proceed into Low-rate Initial Production and Full-Rate Production within cost (Program budget), schedule (Program schedule), risk, and other system constraints. Generally this review is an audit trail from the Critical Design Review. It assesses the system final product, as evidenced in its production configuration, and determines if it meets the functional requirements (derived from the Capability Development Document and draft Capability Production Document) documented in the Functional, Allocated, and Product Baselines. The SVR establishes and verifies final product performance. It provides inputs to the Capability Production Document. The SVR is often conducted concurrently with the Production Readiness Review.

Physical Configuration Audit (PCA): The PCA is conducted around the time of the full-rate production decision. The PCA examines the actual configuration of an item being produced. It verifies that the related design documentation matches the item as specified in the contract. In addition to the standard practice of assuring product verification, the PCA confirms that the manufacturing processes, quality control system, measurement and test equipment, and training are adequately planned, tracked, and controlled. The PCA validates many of the supporting processes used by the contractor in the production of the item and verifies other elements of the item that may have been impacted/redesigned after completion of the System Verification Review (SVR). A PCA is normally conducted when the government plans to control the detail design of the item it is acquiring via the Technical Data Package.

A.4 GUIDANCE.

A.4.1 Key elements.

Key MECSIP elements are embedded in the core process sections of AFMCI 63-1201. Specific guidance for the MECSIP tasks are included in table A-I. Table A-I provides guidance for the common Task I, Task II, Task III, Task IV, and Task V described in section 5 of this document. The guidance provided in this section is intended to assist Programs in the structure of the MECSIP. Completion of the described integrity activities provides a basis for the development of the MECSIP.

TABLE A-I. Task I Preliminary Planning.

Program Milestone	A	B					C	
Acquisition Phase	Technology Development	System Development and Demonstration					Production and Deployment	Operations and Support
Reviews and Audits	**SRR**	**SDR(SFR)**	**PDR**	**CDR**	**FRR(IFR)**	**SVR**	**PCA**	
MECSIP TASK	**TASK I Preliminary Planning (5.1)**							
Program strategy (5.1.1)	• Initial definition of: design objectives, identification of critical design failure modes, recommendations for materials selection and characterization, development testing, and manufacturing process controls	• Matrix defined with milestones consistent with MECSIP Master Plan and IMP/IMS	• Matrix updated	• Matrix updated	• Matrix updated	• Matrix updated	• Matrix updated	
Trade studies (5.1.2)	• Initial assessment complete • Trade studies and Program impacts defined	• Assessment revised to consider evolution of final mechanical system requirements	• Trade studies updated	• Assessment updated to reflect knowledge gained from detailed design	• Assessment updated to reflect knowledge gained from test		• Assessment updated to reflect knowledge gained from flight test	
Requirements development (5.1.3)	• Concept for requirements management defined and coordinated	• Specific approach and tool defined • Tool populated with initial requirements	• Tool deployed and updated with latest requirements	• Tool updated with latest requirements	• Tool updated with latest requirements	• Tool updated with latest requirements	• Tool updated with latest requirements	
Preliminary integrity analysis (5.1.4)	• Preliminary trade studies identified to determine the most cost-effective life requirements • Preliminary Integrity analysis for sizing, strength, durability, and damage tolerance estimates • Initial diagnostic capability estimates for critical items	• Integrity analysis for sizing, strength, durability, and damage tolerance analysis for preliminary design completed	• Integrity analysis for sizing, strength, durability, and damage tolerance analysis for preliminary design update	• Integrity analysis of detailed design completed • Diagnostic capability Completed for critical items	• Integrity Analysis reviewed to ensure SDF criteria has been met			

TABLE A-II. Design Information.

Program Milestone	A	B					C	
Acquisition Phase	Technology Development	System Development and Demonstration					Production and Deployment	Operations and Support
Reviews and Audits	**SRR**	**SDR(SFR)**	**PDR**	**CDR**	**FRR(IFR)**	**SVR (FCA)**	**PCA**	
MECSIP TASK	**TASK II Design Information (5.2)**							
MECSIP Master Plan (5.2.1)	• Initial MECSIP Master Plan and schedule estimate	• Initial MECSIP Master Plan submitted	• MECSIP Master Plan updated	• MECSIP Master Plan updated	• MECSIP Master Plan updated	• MECSIP Master Plan updated	• MECSIP Master Plan updated	• MECSIP Master Plan (revisions)
Design criteria (5.2.2)	• Design criteria definition submitted • Development of requirements	• Design criteria definition completed • Development of requirements updated	• Development of requirements completed	• Design criteria updated for test results			• Design criteria updated for lessons learned	• Design criteria updated for lessons learned
Design service life/ design usage (5.2.3)		• Design service life and design usage completed	• Reviewed/updated	• Reviewed/updated	• Reviewed/updated	• Reviewed/updated		
Component classification (5.2.4)	• Assessment of safety-, mission-, and durability-critical approach	• Approach of safety-, mission-, and durability-critical completed	• Reviewed/updated	• Reviewed/updated	• Reviewed/updated	• Reviewed/updated		
Maintenance concepts (5.2.5)	• Material characterization impacting durability identified • Selections of material data-base established	• Material characteristics finalized	• Component designs reflect accommodation of requirements • Material characterization database updated	• Design analysis of components show that material properties meet the structural requirements • Characterization completed	• Analysis updated with components test data for those environments deemed critical to safety of flight	• Analysis updated with system test data for those environments deemed critical to safety of flight	• Analysis updated for all required operation	• Materials characterization updated for lessons learned incorporation
Material and process selection and characterization (5.2.6)	• Criticality control logic estimate • Durability and damage tolerance methodologies estimate		• Integrity critical parts control plan estimate • Preliminary integrity critical parts estimate • Component failure mechanism assessments estimate	• Component failure mechanism assessments updated • Critical hardware and software control plan estimate		• Critical hardware and software control plan updated	• Critical hardware and software plan managed	• Critical hardware and software plan managed
Corrosion prevention and control (5.2.8)	• Initial characterization for corrosion control/ prevention plan	• Materials characterization for corrosion control/ prevention plan updated	• Materials characterized for corrosion control/ prevention updated	• Corrosion control/prevention plan updated			• Corrosion control/ prevention plan implemented	• Corrosion control/ prevention plan updated

TABLE A-II. Design Information - Continued.

Program Milestone	A	B					C	
Acquisition Phase	Technology Development	System Development and Demonstration					Production and Deployment	Operations and Support
Reviews and Audits	**SRR**	**SDR(SFR)**	**PDR**	**CDR**	**FRR(IFR)**	**SVR (FCA)**	**PCA**	
MECSIP TASK	**TASK II Design Information (5.2)**							
Environmental emissions (5.2.9)	•	•	•	•	•	•	•	•
Physical and operational interfaces (5.2.10)	•	•	•	•	•	•	•	•
Risk mitigation planning (5.2.11)	•	•	•	•	•	•	•	•
Supportability planning (5.2.12)	•	•	•	•	•	•	•	•

TABLE A-III. Design Analyses and Development Tests Task Completion Criteria.

Program Milestone	A	B					C	
Acquisition Phase	Technology Development	System Development and Demonstration					Production and Deployment	Operations and Support
Reviews and Audits	**SRR**	**SDR(SFR)**	**PDR**	**CDR**	**FRR(IFR)**	**SVR**	**PCA**	
MECSIP TASK	**TASK III Design Analyses and Development Tests (5.3)**							
Design analyses (5.3.2)	• Analysis initiated	• Component designs reflect accommodation of requirements • Preliminary design analysis initiated	• Component designs reflect accommodation of requirements • Component failure mechanism assessment established	• Design system used to finalize design • FMECA updated • FRACAS implemented	• Analysis updated with subsystems test data for those environments deemed critical to safety of flight	• Analysis updated and validated to provide identified flight limitations	• Analysis updated with test data for all required operating environments • Reliability and maintainability predictions updated • FMECA updated • FRACAS updated • TOs validated	• Mechanical subsystems monitored to provide basis for changes to operational hardware or upgrade programs
Load analyses (5.3.2.1)	• Initial	• Update	• Update	• Update	• Update	• Update	• Loads/environmental spectra survey documented	
Design stress/environment spectra development (5.3.2.2)	• Initial	• Update	• Update	• Update	• Update	• Update		
Performance and function sizing analyses (5.3.2.3)	• Initial	• Update	• Update	• Update	• Update			
Thermal/environmental analyses (5.3.2.4)	• Installed location environments established • Conduct initial analysis	• Update installed location for subsystems equipment complete • Develop Environmental Criteria Document (ECD)	• Update to analysis • Thermal profiles created for both ambient and operational transient conditions	• Update	• Update	• Update		
Stress/strength analyses (5.3.2.5)	• Initial	• Update	• Update	• Update	• Update	• Update		
Durability analyses (5.3.2.6)		• Initial	• Update	• Update	• Update	• Update		
Damage tolerance analyses (5.3.2.7)		• Initial	• Update	• Update	• Update	• Update		
Risk-based analyses (5.3.2.8)	•	•	•	•	•	•	•	•

TABLE A-III. Design Analyses and Development Tests Task Completion Criteria - Continued.

Program Milestone	A	B					C	
Acquisition Phase	Technology Development	System Development and Demonstration					Production and Deployment	Operations and Support
Reviews and Audits	**SRR**	**SDR(SFR)**	**PDR**	**CDR**	**FRR(IFR)**	**SVR**	**PCA**	
MECSIP TASK	**TASK III Design Analyses and Development Tests (5.3)**							
Vibration/dynamics/ acoustic analyses (5.3.2.9)			• Initial	• Update	• Update	• Update		
Material characterization tests (5.3.3.1)	• Initial development of material characterization tests defined	• Initial development of material characterization tests conducted						
Design development tests (5.3.3.2)	• Initial development tests defined • Test rationale, test planning developed, test risk identified	• Initial component development tests conducted	• Components and subsystems development tests completed and data provided to designers to update design environment					
Performance (5.3.4)	•	•	•	•	•	•	•	•
Electromagnetic effects and lightning (5.3.5)	•	•	•	•	•	•	•	•
Software (5.3.6)	•	•	•	•	•	•	•	•
Assessments (5.3.7)	•	•	•	•	•	•	•	•
Reliability and maintainability (5.3.8)	•	•	•	•	•	•	•	•
Electrical/optical cable (5.3.9)	•	•	•	•	•	•	•	•
Ground handling (5.3.10)	•	•	•	•	•	•	•	•
Obsolescence (5.3.11)	•	•	•	•	•	•	•	•
De-rating/up-rating (5.3.12)	•	•	•	•	•	•	•	•
Equipment prognostics (5.3.13)	•	•	•	•	•	•	•	•

TABLE A-IV. Component Development and Systems Functional Tests Task Completion Criteria.

Program Milestone	A	B					C	
Acquisition Phase	Technology Development	System Development and Demonstration					Production and Deployment	Operations and Support
Reviews and Audits	**SRR**	**SDR(SFR)**	**PDR**	**CDR**	**FRR(IFR)**	**SVR**	**PCA**	
MECSIP TASK		**TASK IV Component Development and Systems Functional Tests (5.4)**						
Component and rig test (5.4.1)	•	•	•	•	•	•		
Testing risk mitigation (5.4.2)	•	•	•	•	•	•		
Hardware and systems rig testing (5.4.3)	•	•	•	•	•	•		
Hardware component (5.4.4)	•	•	•	•	•	•		
Reliability growth demonstration (5.4.5)	•	•	•	•	•	•		
Oil interruption and depletion (5.4.6)	•	•	•	•	•	•		
Component fit checks (5.4.7)	•	•	•	•	•	•		
Component qualification (5.4.8)	•	•	•	•	•	•		
Vibration and dynamic response (5.4.9)	•	•	•	•	•	•		
Fire proof/fire resistance (5.4.10)	•	•	•	•	•	•		
Software testing (5.4.11)	•	•	•	•	•	•		

TABLE A-IV. Component Development and Systems Functional Tests Task Completion Criteria - Continued.

Program Milestone	A	B					C	
Acquisition Phase	Technology Development	System Development and Demonstration					Production and Deployment	Operations and Support
Reviews and Audits	**SRR**	**SDR(SFR)**	**PDR**	**CDR**	**FRR(IFR)**	**SVR**	**PCA**	
MECSIP TASK		**TASK IV Component Development and Systems Functional Tests (5.4)**						
Functional tests (5.4.12)	• Test rationale, test planning developed, test risk identified	• Component designs reflect accommodation of requirements	• Component and subsystems tests conducted, Results compared to analytical predictions • Analytical tools updated with test data	• Component and subsystem tests completed • Preparation made for full-scale testing	• Component and subsystem tests used in planning and executing full-scale tests	• Test results used to validate analysis		
Strength testing (5.4.13)	• Test risk analysis • Test needs • Test plans • Component, rig, tests designed	• Component designs reflect accommodation of requirements	• Component and subsystems testing completed	• Analysis updated with subsystem test data for those environments deemed critical to safety of flight	• Aircraft TO established for full envelope flight testing			
Durability testing (5.4.14)	• Test risk analysis • Test needs • Test plans • Component, rig, tests designed		• Durability life test plan established. • Components test conducted and analysis updated	• Full-scale durability test plan completed	• Analysis updated with component and subsystems data for those environments deemed critical to safety of flight	• Final		
Vibration/dynamics/ acoustics tests (5.4.15)	• Test risk analysis • Test needs • Test plans • Component, rig, tests designed	• Component designs reflect accommodation of requirements	• Component and subsystems testing completed	• Analysis updated with component and subsystems data for those environments deemed critical to safety of flight				
Damage tolerance tests (5.4.16)	• Test risk analysis • Test needs • Test plans • Component, rig, tests designed	• Component designs reflect accommodation of requirements		• Component and subsystems testing completed	• Analysis updated with component and subsystems data for those environments deemed critical to safety of flight	• Final		
Thermal, environment, and loads survey (5.4.17)		• Define initial environment	• Update	• Update		• Update MECSIP report with actual values to establish baseline		• Determine any significant changes due to usage and environment
Overspeed/overtemperature (5.4.18)		•	•	•		•		•

TABLE A-IV. Component Development and Systems Functional Tests Task Completion Criteria - Continued.

Program Milestone	A	B					C	
Acquisition Phase	Technology Development	System Development and Demonstration					Production and Deployment	Operations and Support
Reviews and Audits	**SRR**	**SDR(SFR)**	**PDR**	**CDR**	**FRR(IFR)**	**SVR**	**PCA**	
MECSIP TASK		**TASK IV Component Development and Systems Functional Tests (5.4)**						
Maintainability/ reparability demonstrations (5.4.19)		• Maintainability requirements established and allocated				• Maintainability predictions validated	• Maintainability predictions updated	
Evaluation and interpretation of test results (5.4.20)					• FRACAS issues analyzed	• FMECA updated • FRACAS updated		
Integrated test plan (5.4.21)			• Test plan established	• Test plan complete		• Testing complete, test plan reviewed for compliance		
Final integrity analysis (5.4.22)		• Preliminary integrity analysis	• Detailed design of life management subsystem completed			• FMECA updated • FRACAS updated • TOs validated	• Estimated stress to actual compared for: - Loads, usage, & environments life estimate - Lead-the-fleet evaluation for service life - TOs, and FRACAS updates - Integrity analysis updated to establish life management baseline	
Maintenance planning and task development (5.4.23)	• Manufacturing plan initiated • Baseline manufacturing process identified • Quality system used to produce parts and components Identified	• Define initial manufacturing and quality system	• Update manufacturing and quality assessment	• Implement manufacturing and quality planning	• Finalize baseline inspection capability and reparability	• Update inspection capability and reparability	• Deviation and waiver tracking system established	• Repair process controlled
Airworthiness certification (5.4.24)		• Initial plan	• Update as needed	• Update as needed	• Update as needed	• Final airworthiness certification plan	• Assurance	• Sustain

TABLE A-V. Force Management.

Program Milestone	A	B					C	
Acquisition Phase	Technology Development	System Development and Demonstration					Production and Deployment	Operations and Support
Reviews and Audits	**SRR**	**SDR (SFR)**	**PDR**	**CDR**	**FRR (IFR)**	**SVR**	**PCA**	
MECSIP TASK	**TASK V Force Management (5.5)**							
Equipment manufacturing and integration (5.5.1)		•	•	•		•	•	
Sustainment of equipment prognostic systems (5.5.2)		•	•	•		•	•	
Reliability-Centered Maintenance (5.5.3)			•	•		•		•
Component tracking/ monitoring program (5.5.4)		• Subsystem specific life tracking program identified	• Installed inspection and maintenance capability estimate • Preliminary subsystem specific life tracking parameters updated	• Installed inspection and maintenance capability completed • Tracking of hardware estimate • Life-limited items updated		• Individual component tracking system established	• Tracking for accumulated stresses and life-remaining estimates • Repairs/removals/ inspections/ overhauls • Lead-the-fleet implemented • Software transitioned to support	• Risk assess tracking systems in place for: - Repair/removals - Inspections - Overhauls
Operational usage data (5.5.4.1)			• Initial tracking requirements defined	• Update tracking requirements		• Finalize tracking requirements		• Tracking systems in place for monitoring selected components
Preventive maintenance actions (5.5.5)			• Initial preventive maintenance actions defined	• Update preventive maintenance actions defined		• Finalize preventive maintenance actions defined		• Select preventive maintenance actions: - Time change - On-equipment repairs - Lube cleaning adjustments - Refurbish legacy equipment - Replace interfacing components - Replace obsolete equipment
Flight-hour time change (5.5.5.1)			• Initial flight-hour time change defined	• Update flight-hour time change defined		• Finalize flight-hour time change defined		• Implement preventive actions

TABLE A-V. Force Management - Continued.

Program Milestone	A	B					C	
Acquisition Phase	Technology Development	System Development and Demonstration					Production and Deployment	Operations and Support
Reviews and Audits	**SRR**	**SDR (SFR)**	**PDR**	**CDR**	**FRR (IFR)**	**SVR**	**PCA**	
MECSIP TASK	**TASK V Force Management (5.5)**							
Calendar time change (5.5.5.2)			• Initial calendar time change defined	• Update calendar time change defined		• Finalize calendar time change defined		• Implement preventive actions
On-equipment repairs (5.5.5.3)			• Initial on-equipment repairs defined	• Update on-equipment repairs defined		• Finalize on-equipment repairs defined		• Implement preventive actions
Lubrication/cleaning and adjustments (5.5.5.4)			• Initial lubrication/ cleaning and adjustments defined	• Update lubrication/ cleaning and adjustments defined		• Finalize lubrication/ cleaning and adjustments defined		• Implement preventive actions
Overhaul of systems (5.5.5.5)			• Initial overhaul requirements defined	• Update overhaul requirements defined		• Finalize overhaul requirements defined		• Track recorded degradation versus predicted • Update maintenance requirements
Replacement of original equipment (5.5.5.6)								• Track recorded degradation versus predicted • Update maintenance requirements
Replacement of obsolete equipment (5.5.5.7)								• Trade studies • Reliability assessment

TABLE A-V. Force Management - Continued.

Program Milestone	A	B					C	
Acquisition Phase	Technology Development	System Development and Demonstration					Production and Deployment	Operations and Support
Reviews and Audits	**SRR**	**SDR (SFR)**	**PDR**	**CDR**	**FRR (IFR)**	**SVR**	**PCA**	
MECSIP TASK	**TASK V Force Management (5.5)**							
Environmental regulations (5.5.5.8)	• Initial	• Update	• Update	• Update	• Update	• Update	• Update	• Periodic reviews of environmental requirements • Update maintenance requirements
Flight manual (5.5.6)				•		•		•
Production/overhaul quality (5.5.7)				•		•		•
Monitoring of repairs/ overhauls (5.5.8)				• Define		• Define		• Monitor: fleet MTBF, serial number MTBF, ISO/HSC failures, MICAPs, air aborts, bulletin boards, PQDRs
Field/Base-level maintenance (5.5.8.1)				• Define		• Define		• Develop program to ensure component reliability
Depot-level maintenance (5.5.8.2)				• Define		• Define		• Develop program to ensure component reliability
Inspection criteria (5.5.9)				• Define	• Review/ update	• Update	• Define	• Validate or update components inspection requirements
Safety-critical component maintenance requirements (5.5.9.1)			• Define	• Update	• Update	• Update	• Update	• Validate or update safety-critical components inspection requirements
Analytical Condition Inspection Program (5.5.10)			•	•	•	•	•	•

APPENDIX B

TYPICAL FORCE MANAGEMENT MECSIP TAILORING ACTIVITIES

B.1 SCOPE.

This appendix defines the basic force management actions required to transition the weapon platform from the acquisition phase of the MECSIP to its sustainment phase. It is intended that MECSIP Managers use this appendix as a general guide for constructing and/or modifying their MECSIP Master Plan and supplement it as required by tailoring-in their own respective weapon system unique MECSIP requirements. The overall purpose is to achieve and maintain system safety and operational reliability throughout the weapon system's operational life cycle. This appendix is not a mandatory part of the standard. The information contained herein is intended for guidance only.

B.2 APPLICABLE DOCUMENTS.

U.S. AIR FORCE TECHNICAL ORDERS

TO 00-20-1	Aerospace Equipment Maintenance Inspection, Documentation, Policies, and Procedures
TO 00-20-2	Maintenance Data Documentation
TO 00-35D-54	USAF Deficiency Reporting, Investigation, and Resolution
TO 1-1-300	Acceptance/Functional Check Flight and Maintenance Operational Checks
TO 1-*XXX*-6	-6 TOs, Aircraft Scheduled Inspection and Maintenance Requirements

(Information about USAF Technical Order availability for military users is online at https://www.toindex-s.wpafb.af.mil/, and http://www.pdsm.wpafb.af.mil/toprac/ and http://www.tinker.af.mil/library.)

U.S. AIR FORCE PAMPHLET

AFPAM 90-902	Operational Risk Management (ORM) Guidelines and Tools

(USAF Pamphlets are available online at www.e-publishing.af.mil.)

AIR TRANSPORT ASSOCIATION OF AMERICA (ATA)

MSG-3 Publication	Operator/Manufacturer Scheduled Maintenance Development

(Information about this document's availability is online at http://www.airlines.org/products/pubs.)

B.3 DEFINITIONS.

B.3.1 Acronyms.

ACI	Analytical Condition Inspection
AMARC	Aerospace Maintenance and Regeneration Center
AWP	Awaiting Parts
CANN	Cannibalization
CEI	Configured End Item
CP	Conductive Path
DCM	Defense Contract Management
ES	Equipment Specialist
ESA	Engineering Service Authority
EWIS	Electrical Wiring Interconnect System
FMC	Fully Mission Capable
FSID	Functional Systems Integrated Database
JEDMICS	Joint Engineering Data Management Information and Control System
MAJCOM	Major Command
MAP	Mean Acceptable Performance
MDC	Maintenance Data Collection
MEL	Mission Essential Listing
MICAP	Mission Impaired Capability, Awaiting Parts
MRRB	Maintenance Requirement Review Board
MRT	Maintenance Recovery Team
MSI	Maintenance Significant Item
NMC	Not Mission Capable
OEM	Original Equipment Manufacturer
PDM	Program Depot Maintenance
PIWG	Product Improvement Working Group
PQDR	Product Quality Deficiency Reporting
RAT	Reliability Analyses Team
RCMA	Reliability-Centered Maintenance Analysis
REMIS	Reliability and Maintainability Information System
SLA	Service Level Agreement
SOR	Source of Repair
SSHA	System Safety Hazard Analysis
TCI	Time Change Item
TCTO	Time Compliance Technical Order
WDC	When Discovered Code
WUC	Work Unit Code

B.4 GUIDANCE.

B.4.1 Objectives of a MECSIP Master Plan.

The objective of a MECSIP Master Plan is to describe the force management actions required to achieve and maintain product integrity throughout the operational service life of the weapon system. Some of the specific objectives of the MECSIP in the sustainment phase are to:

a. Sustain and evaluate the integrity of the weapon platform functional systems.

b. Insure safety- and mission-critical components are properly identified, and appropriate damage-tolerance controls are in place and being properly executed.

c. Conduct appropriate safety and/or mission component risk assessments and acknowledge all identified risks by having the appropriate authority accept the risk.

d. Acquire, evaluate, and apply operational usage data to provide a continual update of the serially-controlled components on the weapon platform eProvide a basis for improving systems criteria and methods of design, evaluation, and substantiation for future weapon platform and modifications using principles of probabilistic analysis.

e. Restore component safety, reliability, and durability to their inherent levels when deterioration has occurred.

f. Provide “one-person” ownership of the weapon platform and components as directed by OSS&E.

g. Ensure the weapon platform minimizes unscheduled maintenance.

h. Accomplish all of the above at a minimum total cost to the taxpayers.

B.4.1.1 MECSIP Master Plan for legacy weapon systems.

A MECSIP Master Plan for a legacy weapon system can be divided into a series of five subtasks, described in table B-I:

a. Data gathering and task planning (B.4.1.1.1)

b. Development of a functional systems integrated database (FSID) (B.4.1.1.2)

c. Force management execution (B.4.1.1.3)

d. Preventive maintenance actions (B.4.1.1.4)

e. Management in the final five years prior to system retirement (B.4.1.1.5).

TABLE B-I. MECSIP Master Plan for legacy systems.

SUBTASK 1	SUBTASK 2	SUBTASK 3	SUBTASK 4	SUBTASK 5
Data Gathering and Task Planning **(B.4.1.1.1)**	**Develop a Functional Systems Integrated Database** **(B.4.1.1.2)**	**Force Management Execution** **(B.4.1.1.3)**	**Preventive Maintenance Actions** **(B.4.1.1.4)**	**Manage System's Final Five Years Prior to Retirement** **(B.4.1.1.5)**
1. Establish a Systems Reliability Analyses Team (RAT) to assist in administration of sustainment efforts. 2. Establish an IPT to form the sustainment philosophy. 3. Gather OEM available maintenance data. 4. Review available data and: a. Identify safety-critical components b. Identify mission-critical components c. Identify durability-critical items d. Identify durability-noncritical e. Identify expendable/other components. 5. Review the -6 TOs for all inspection requirements. 6. Review the -06 Work Unit Code (WUC) Manual for accuracy. 7. Identify OEM time change requirements. 8. Ensure technical data for both on- and off-equipment repairs/overhauls is available and current. 9. Determine Maintenance Data Collection system requirements. 10. Establish PQDR procedures.	1. Design a tracking and monitoring program: a. Develop risk assessment and FMECA program b. Develop safety- and mission-critical component inspection and/or replacement interval. c. Develop component MAP levels d. Develop a program to identify items not reaching the MAP (alerts) e. Develop a program to allow Engineering to communicate with Field personnel f. Develop HSC and ISO inspection tracking programs g. Develop a tail number component tracking program h. Develop a system to track enroute system reliability i. Develop a program to track MICAP hours assessed to each component j. Develop a program to track Cannibalizations (CANNs) on each component k. Develop a program to identify and monitor MSI components l. Develop a program to identify each component with NMC status m. Develop a program to identify components causing air aborts n. Develop a computerized Preview and In-depth analysis program o. Develop a "Bad Actor" program.	1. Monitor component repairs and overhauls: a. Fleet MTBF b. Serial number MTBF c. ISO/HSC failures d. MICAPs e. NMC (S)(M)(B) f. Air aborts g. Bulletin boards h. CANNs i. PQDRs. 2. Monitor component inspection and replacement criteria: a. -06 WUC Manual b. Scheduled inspection requirements and replacement schedule (-6 TOs) c. Time changes d. Inspection work cards e. PDM requirements. 3. Monitor data integrity: a. G081 entries b. Risk assessments. 4. Perform analysis: a. Preview b. In-depth c. Analytical Condition Inspection. d. Equipment usage and environments	1. Implement preventive actions: a. Lubrication or servicing for the purpose of maintaining inherent design capabilities, or; b. Additional operational checks to a task to determine that an item is fulfilling its intended purpose, or; c. An intensive visual examination of a specific area to detect damage, or; d. An act of restoration carrying from cleaning or replacement to complete overhauls, or; e. A time change of the component if a specific life cycle can be determined, or; f. Any combination of the above.	1. Establish an IPT with MAJCOMs, SOR, DLA, Wing Office, and AMARC to determine the most effective course of actions to take for: a. Supply b. Maintenance. 2. Establish communication with a liaison at each primary Base to assist the group Engineering team. 3. Establish special procedures with MAJCOMs to allow the Wing Office to initiate lifetime procurement of components and spare parts for future requirements. 4. Establish procedures with Item Managers to use the components and spare parts located at AMARC effectively. 5. Establish special procedures with DLA to allow all weapon-specific parts to be exempt from "excess" status.

B.4.1.1.1 Subtask 1: data gathering and task planning.

The purpose of data gathering and task planning is to gather the data and tailor specific strategy for applying the tasks outlined in the MECSIP life cycle, Task V (table I) to the respective weapon platform. At this stage, system engineers for all aspects of the weapon platform should understand their involvement and responsibilities. A clear chain of command and line of communication will be established at this stage.

B.4.1.1.1.1 Establish a reliability analyses team within the Engineering department to develop and monitor the system management program.

Air Force Materiel Command Instruction (AFMCI) 63-1201, Implementing Operational Safety Suitability and Effectiveness (OSS&E) and Life Cycle Systems Engineering, assigns the Chief Engineer the sole engineering responsibility for the weapon system and in effect gives him/her final authority over any component being used on the weapon system. This includes all supply, procurement, and maintenance facilities involved with any component repair/overhaul. Depots, Major Commands (MAJCOMs), and Using Activities act as key advisors for many areas, but the final decisions rest with the Chief Engineer. The Chief Engineer has designated the MECSIP Manager to act on his/her behalf for matters involving the management of the weapon platform functional systems. To accomplish this task, the MECSIP Manager will establish a Reliability Analyses Team (RAT) to assist him/her in developing a system management program. Establishment of a RAT composed of the proper mix of personnel is instrumental to a cost-effective life cycle management program. The program will be Worldwide Web-based and only be available on the secure military network. The program will track and provide alert monitoring for all safety- and mission-critical components. Specifically, the program will:

a. identify safety-critical components;

b. identify mission-critical components;

c. identify durability-critical controlling devices;

d. identify serially-tracked components;

e. confirm that inspection and replacement intervals for all safety- and mission-critical components is current and documented in the appropriate technical orders

f. monitor the MTBF for all safety- and mission-critical components;

g. list the “Top Ten” economic, maintenance, and supply Not Mission Capable (NMC) components;

h. provide a method to perform Preview and In-depth analysis;

i. provide a tail number management system;

j. monitor the CANNs for each Work Unit Code (WUC);

k. monitor the Mission Impaired Capability, Awaiting Parts (MICAPs) for each WUC;

l. monitor the ISO and HSC major inspections;

m. monitor the enroute Bases component failures;

n. monitor aborts by WUC;

o. provide an electronic bulletin board for each shop to improve communications; and

p. provide a program to assist in performing risk assessments and failure modes evaluations.

B.4.1.1.1.2 Establish the sustainment philosophy (i.e., preventive maintenance versus current USAF philosophy of fly to fail).

The USAF has kept some weapon platforms much longer than originally programmed and the reliability or downtime is below the acceptable standards. Additionally, the cost of sending Maintenance Recovery Teams (MRTs) to repair the aircraft off station may be greater than the cost to apply preventive maintenance. Preventive maintenance is any action performed periodically to maximize the probability that a component or system will achieve the desired level of safety and reliability. When safety or mission reliability is affected by a component or system, a Preview analysis will be performed to determine the functions of the components or systems and identify trends. In-depth analysis may be performed on key failure modes within selected components and systems. The In-depth analysis will include FMECA as well as risk assessments to ascertain the severity and probability of each occurrence. The risk assessment metrics will be used to begin the priority process for implementation. The use of logic trees on failure modes will assist in determining the preventive maintenance task to be performed. The best solution for dealing with a failure mode is determined by comparing each of the available options with the others. If an option is not immediately available (e.g., redesign, new technology), the analysis should evaluate current options for implementation and then compare the chosen option against the potential for further improvement. The cost of each possible solution plays a significant part in determining which one is ultimately selected. At times, the least expensive option will not be the best solution when the operational consequences are considered. Aircraft downtime and reliability must be part of the decision logic. Document all new preventive maintenance actions in TOs.

B.4.1.1.1.3 Gather available maintenance data and design information.

The Original Equipment Manufacturer (OEM) provided the initial design and testing information for many weapon platforms. Some of these documents are stored within the Program. Sometimes additional copies can be acquired from the OEM if a particular report cannot be located. Most drawings and manufacturing specifications can be accessed by qualified users through the Joint Engineering Data Management Information and Control System (JEDMICS) at https://webjedmics.dla.mil/. Ensure all required maintenance actions are incorporated in TOs.

B.4.1.1.1.3.1 Review available data.

Four different types of components must be identified: a) safety-critical components, b) mission-critical components, c) durability-critical items, and d) durability-noncritical and other/expendable components. The process of identifying the system components will use engineering best judgments based on anticipated consequences of failure.

B.4.1.1.1.3.1.1 Identify safety- and mission-critical components.

The identification of safety- and mission-critical components is accomplished in accordance with 5.2.4 using the results of mission reliability analysis, FMECA, functional hazard analysis, and system safety hazard analysis (SSHA). Engineering Service Authority (ESA) approval is required for identification of safety- and mission-critical components. An inspection and/or service life interval shall be imposed for all safety- and mission-critical components. Safety-critical components shall be serialized and have their usage tracked. Safety-critical components shall not be allowed to fail in service.

B.4.1.1.1.3.1.2 Identify durability-critical items.

Durability-critical items may or may not have any inspection criteria published. Durability-critical items are classified in two groups, legacy and interfacing subsystems:

a. Legacy items such as wiring, circuit breakers, rack mounts, depleted uranium, and indicators are generally designed for the original life of the aircraft and do not require any special maintenance. As the aircraft ages and service life extensions are granted, these items must be evaluated and deemed serviceable or a replacement program initiated.

b. Interfacing subsystems are items that are linked and associated such that changing one would cause the other to wear or weaken at a higher rate. Items like torque tubes, quadrants, rod end bearings, and hot air ducts should be replaced as a whole system or “system refurbishment” when replacement of one or more sections is required.

B.4.1.1.1.3.1.3 Analytical Condition Inspections (ACIs).

Both legacy and interfacing subsystems will require Analytical Condition Inspections (ACIs) to determine their conditions. The MECSIP Manager will select durability-critical subsystems upon which ACIs must be performed. The ACI will be in four parts:

a. Identify components to be inspected. Identify all items in the subsystem to be inspected. This process will include a review of all the critical items which comprise the subsystem that may have an impact on the system itself, or have been identified in previous reports as possible contenders.

b. Develop inspection criteria. Develop inspection criteria for each item identified as requiring inspection if no written criteria exist. Every item must be addressed and the criteria assigned must be a pass or fail-type inspection.

c. Perform the inspection. The inspection will be performed using the criteria outlined in the inspection phase.

d. Analyze the collected data. The inspection results will be analyzed and, if required, a program will be developed to refurbish that subsystem.

B.4.1.1.1.3.1.4 Identify durability-noncritical /expendable components.

Other/expendable components are all components of a system not classified as safety-, mission-, or durability-critical. The failure of these items could be handled during routine maintenance and would not impact mission, safety, or operational readiness.

B.4.1.1.1.4 Review the -6 TOs for all inspection requirements.

The -6 TOs, Aircraft Scheduled Inspection and Maintenance Requirements, list all scheduled and special inspections required (ISO, HSC, preflight, hard landings, high winds, hot brakes, etc.); Programmed Depot Requirements, if applicable; Functional Check Flights; Historical Documents (AFTO Form 95); Replacement Schedule (e.g., time changes); Base-level Repair Restrictions; and Work Cards for ISO, HSC, Preflight, Thru-flight, etc. The Scheduled Inspection section lists all requirements for the ISO, HSC, Preflight, Post-flight, and other inspections; and are numbered -6WC-1, -2, etc. The Special Inspection section lists inspection requirements that will be accomplished upon the accrual of a specified number of flying hours, equipment hours, a lapse of calendar time, or after occurrence of a specified or unusual condition. The Special Inspection section will be reviewed during the annual Product Improvement Working Group (PIWG) meeting. The Historical Documents section lists all items which require an AFTO Form 95, and provides a permanent record or history of events and conditions encountered during the use of the equipment. The Replacement Schedule lists items replaced upon the accrual of a specified number of flying hours, equipment hours, or a lapse of calendar time, or after the occurrence of a specific or unusual condition. The Replacement Schedule will be updated when items are added or deleted during the PIWG meeting. The Base-Level Repair Restrictions section lists items by WUC and Noun for which Base-level (Intermediate Maintenance) repair restrictions are established and describes the repairs that are not authorized at Base-level for the items listed. All other repairs required to return an item to a serviceable condition can be accomplished at Base-level, consistent with resident capabilities.

B.4.1.1.1.5 Review WUC Manual.

This manual must be easy to interpret by the technicians and a WUC must exist for each item being monitored. The manual must reflect if a component is to be serially tracked, under warranty, has a scheduled time change, or requires special handing. Updating the WUC is the first step in accurate historical database maintenance.

B.4.1.1.1.6 Review identified OEM-recommended time change items (TCIs).

The primary objective of a TCI program is to achieve maximum utilization of components, consistent with the economic operation of the weapon systems, without jeopardizing flight or operational safety. Time change replacement requirements are prescribed only for those items that have a measured service life expectancy and that display an age-related failure pattern. Additionally, the item must fall into one or more of the following categories to be a valid candidate for time change (TO 00-20-1):

a. items whose failure due to location or function within a system would compromise safety of flight

b. items whose failure would cause a mission to abort or cause excessive aircraft downtime

c. items for which a failure might cause damage beyond economical repair

d. items that have a predictable in-use service life.

All items selected by the OEM will be reviewed to ensure they meet time change criteria and the correct replacement schedule is being administered.

B.4.1.1.1.7 Ensure technical data is available for Field and Depot users.

Each safety- and mission-critical component will have both a Job Guide procedure (for on-equipment maintenance) and a commodity TO (for off-equipment maintenance) for repair and overhaul procedures. If unavailable, the OEM and/or Equipment Specialist (ES) must establish one on a priority basis. Engineering and associated ESs have the responsibility for the technical content contained in these manuals and Job Guides. Additionally, the MECSIP Manager and Source of Repair (SOR) must ensure each Base that requests in-shop overhaul capability has the proper “overhaul” test equipment, facilities, and training, or restrict that Base from performing the overhaul.

B.4.1.1.1.8 Field/Base-level maintenance.

If a component is partially overhauled at the Base level, the component should be returned to the Depot before the fourth overhaul to ensure the reliability continues to be met. The AFTO Form 95 is the best tool for counting the overhauls and all components will have an AFTO Form 95. If the Field shops overhaul a component, the AFTO Form 95 must be annotated with the overhaul date and any special instructions. If the defective component is simply repaired, the AFTO Form 95 will be so annotated (Overhauled—return to like-new condition; Repaired—brought back to a serviceable condition).

B.4.1.1.1.9 Depot-level maintenance.

Each safety- or mission-critical component entering the Depot should have a Historical Record (AFTO Form 95) attached to the component or recorded against its serial number in a computer database. All maintenance actions should be annotated on the form to assist in maintaining the reliability of the component. Components entering the Depot will be overhauled and have the parts replaced, as required by the TO. If a part shortage occurs and a part that is listed for replacement during overhaul is not available, the ALC engineers may authorize the re-use of certain parts for one overhaul only. This must be annotated on the AFTO Form 95. If the Field shops return a part to the Depot after the forth overhaul, the Depot should perform a condition assessment to see if the part should be continued in-service or be disposed.

B.4.1.1.1.10 Determine maintenance data requirements.

Example: The G081 Maintenance Data Collection (MDC) is the system the Air Mobility Command (AMC) has chosen to use for the C-5. G081 has the capability to track components by WUC and serial number. If required, it provides for historical documentation for selected components using an AFTO Form 95. Additionally, an aircraft's NMC status and systems reliability data (i.e., maintenance man-hours, failure analysis, enroute failures, air abort data, and ISO and HSC documentation) can be extracted.

B.4.1.1.1.11 Establish Product Quality Deficiency Reporting (PQDR) procedures.

Overhauled components should remain serviceable for a predetermined amount of time and/or flying hours. When a component fails to meet any of the four requirements in TO 00-35D-54, a deficiency occurs. Technical Order 00-35D-54 gives specific instructions for the initiation of the PQDR report for all deficiencies. The MECSIP Manager's task is to monitor and evaluate PQDR for potential impact to the MECSIP Master Plan and ensure every Using Activity is aware of the consequences of not using the PQDR system.

B.4.1.1.2 Subtask 2: development of a Functional Systems Integrated Database (FSID).

NOTE: Unique information system solutions should not be constructed for Program requirements without first ensuring a Department of Defense or USAF enterprise information system solution does not already exist, is ready to deploy, or could easily be modified to accommodate the weapon system's MECSIP requirements.

B.4.1.1.2.1 Design a tracking and monitoring program for system components.

New ways of collecting data are often not required. The tracking and monitoring program typically need only incorporate data from existing data collection systems. This program should be able to perform a risk assessment on each WUC, establish a Mean Acceptable Performance (MAP) for each safety- and mission-critical component, develop an automatic alert system for each safety- or mission-critical item, establish bulletin boards for better communications, track HSC and ISO discrepancies, develop a tail number tracking program to display location of serially-controlled components, analyze enroute failures, monitor MICAP conditions, monitor each component CANN, identify Maintenance Significant Items (MSIs), evaluate the health of the wiring system using maintenance data with a How Malfunction (HOWMAL) Code 689 – CP Malfunction (see B.4.1.1.2.17), and perform Preview and In-depth analyses.

B.4.1.1.2.2 Develop risk assessment and FMECA program.

Risk assessments must be performed on all components requiring attention. The assessment will not only indicate the severity of the problem, it will also be an indication of the probability. The purpose of the FMECA program is to identify and document the failure modes, effects, and criticality for each safety- or mission-critical component. The purpose of the risk assessments is to identify the mishap's probability of occurrence and its severity. Together they will help determine the significance of each failure in terms of safety, operations, and economics

B.4.1.1.2.3 Define safety- and mission-critical component inspection and/or replacement interval.

Safety-critical components shall be managed to preclude safety-critical in-flight failures using either a damage tolerance or a risk-based approach."

B.4.1.1.2.4 Develop component MAP levels.

The MAP is derived by using MTBF data collected over many years. The MECSIP Manager calculates how much of the multi-year MTBF will be the acceptable level, or target, each component is expected to achieve. This number becomes the MAP and can be adjusted up or down as the MECSIP Manager desires. Each WUC's part number will be analyzed and a MAP assigned to it. If the MAP is too high or too low to allow an alert, the RAT will recommend adjustments to it using their best judgment.

B.4.1.1.2.5 Develop a program to identify items which fail to meet the MAP (alerts).

A reliability alert must automatically be given for any component that fails to meet its MAP. The alert does not mean there is a problem; it means a problem may exist. Once the MECSIP Manager establishes the component's MAP, an automatic alert can be set at any number or percentage below the MAP. The program will measure reliability at the 18-month MTBF mark. After the 18 months, MTBF data is collected and stored and will be divided into the MAP. Any component that does not meet 80 percent (80%) of the MAP will be considered as failing the reliability test. To assist in making decisions, a 3-month average will be compiled and used to show trends. The trend data is not used for any computations. Like the MAP, the alert is adjustable by the MECSIP Manager. The alert begins the investigation process.

B.4.1.1.2.6 Develop a program to allow Engineering to communicate with Field personnel.

Establish shop bulletin boards via the Internet to enhance communication between Engineering and Field shops (e.g., clarify a TO system; direct users to procedures in the TO). The bulletin boards will not be used by Base personnel to request waivers or technical details for a specific aircraft condition. This will continue to be accomplished via e-mail, fax, or AFMC Form 202. The Internet address should be available only to Mil-Net users and be secure (HTTPS).

B.4.1.1.2.7 Develop HSC and ISO inspection tracking programs.

Isochronal Inspections are the biggest expenditure of unit funds and the discrepancies from one ISO to the next are not readily available to the Field shops and Program Engineering. Each Base enters their ISO and HSC data into the MDC system. The Program should list the "Top Twenty" WUCs for the components which require the most maintenance, display individual aircraft tail number data, and list the last five inspections on a common display screen.

B.4.1.1.2.8 Develop a tail number component tracking program for serial-number-controlled components.

The tail number component-tracking should be composed of the following:

a. List all aircraft information such as tail number, Base, model, last Program Depot Maintenance (PDM), last ISO, and last HSC.

b. List all MSIs by serial number, date installed and location, hours remaining until time change, and other information the MECSIP Manager may deem necessary.

c. List all existing waivers and/or flight limitations associated with MECSIP parts on the specific aircraft.

The intent of the tracking program is to capture the history from cradle to grave for each aircraft being monitored. Additionally, this tracking program will enable the Maintenance superintendents, MAJCOMs, and Program Engineering to know immediately the remaining service life for each critical component using serial tracking, and history of major repairs for each aircraft.

B.4.1.1.2.9 Develop a system to track enroute system reliability.

Track the discrepancies at the major enroute Bases and, when trends allow, implement preventive maintenance actions. To accomplish this, the system should be looking at the NMC status (Supply (S), Maintenance (M), or Both (B))and When Discovered Codes (WDCs).

B.4.1.1.2.10 Develop a program to track MICAP hours accessed to each component.

The Mission Impaired Capability, Awaiting Parts condition occurs when parts must be shipped from lateral storage facilities, in combination with at least one of the following conditions:

1) Supply does not have enough spares in the system to satisfy scheduled/unscheduled maintenance; or

2) Supply does not have the capability to produce spares to keep up with demand (i.e., manpower, facilities, parts, poor scheduling); or

3) Maintenance is improperly troubleshooting the system and replacing parts at an unexpected pace.

The system should capture this data and display it by MICAP hours and number of aircraft disabled for *X* amount of days.

B.4.1.1.2.11 Develop a program to capture CANN actions by WUC.

The program should capture the CANN data and store it by WUC. This will aid in creating the "whole picture" for each component.

B.4.1.1.2.12 Develop a program to identify and monitor MSIs.

Develop a program to identify and monitor MSIs. Maintenance Significant Items are those items selected by the Program due to economic or operational impact to the Maintenance community. The Program will collect data and recommend candidates for inclusion in the MSI listing during PIWG meetings. The Program will collect and correlate data from all sources (i.e., G081, MICAPS, Awaiting Parts (AWP) documentation, NMC (S/M/B), PQDRs). Components which require Time Compliance Technical Order (TCTO) control or weapon system compatibility will be classified as "MSI" and serially tracked. Components discovered to have a major impact on operational reliability or maintenance resources will be complied and presented to the annual

PIWG conference for special tracking. Items approved by the PIWG will be classified as MSIs. If serial tracking and/or historical documentation is required, the -06 WUC Manual will then be annotated to alert Maintenance; and the -6, Special Inspections Technical Order, will be annotated to require an AFTO Form 95 Historical Document. Additionally, each item will receive a risk assessment (AFPAM 90-902), which includes a FMECA. Subsequent negative trends can be justification to recommend items be serially tracked and monitored under the Air Force Bad Actor Program IAW TO 00-35D-54, Chapter 7*.* The Program will use the MSI listing to identify candidates for the Bad Actor Program at the annual PIWG (see B.4.1.1.2.16).

B.4.1.1.2.13 Develop a program to identify each component with Not Mission Capable (NMC) (S)(M)(B)) status.

Not Mission Capable is a maintenance aircraft status reporting term. The last letter in the status report indicates if the cause for the NMC is (S) Supply, (M) Maintenance, or (B) Both. If any aircraft is NMC, the data collection system must be changed to reflect which WUC is causing the NMC and indicate "(S)", "(M)", or "(B)" as the reason. The information will be extracted from the data collection system and displayed on the MECSIP Program.

B.4.1.1.2.14 Develop a program to identify components causing aborts.

Aborts occur when a component critical to flight has failed. The system should capture the abort data and store it by WUC. If negative trends develop, the components causing the aborts will be placed on the MSI listing.

B.4.1.1.2.15 Develop a computerized Preview and In-depth analysis program.

A Preview analysis is simply a paper review of the data available. The main goal of the preview is to validate the data and determine if a "real" problem exists. If the paper trail was in error, the analysis can be closed. If a more vigorous analysis is required to identify the problem, an In-depth analysis should be performed. A Preview analysis will be performed on functional and potential failures. Functional failures occur when there is an actual failure during component operation. Most functional failures will require an In-depth analysis. Most potential failures will not require an In-depth analysis but will require extensive coordination with other agencies for resolution. If either failure mode warrants an In-depth analysis, it will be performed by the MECSIP Team.

B.4.1.1.2.16 Develop a program to identify Bad Actors.

The purpose of the Air Force Bad Actor Program is to identify serial-numbered items that enter the repair cycle at an abnormally high rate when compared to the total population of like assets, and to repair them or remove them from supply. The PIWG meeting is the forum where the Field and Depot personnel identify part numbers or WUCs for Bad Actor management as set forth in TO 00-20-1, chapter 6; and TO 00-35D-54, chapter 7. The Program will submit a listing of selected MSI components for possible submission to the Bad Actor Program. Selected WUCs will be documented in the -6 TO, section II, part D, IAW TO 00-20-2 and be serially tracked, assigned a Configured End Item (CEI) number, and be assigned an AFTO Form 95 to record historical data. (If an item being considered for Bad Actor management does not contain a serial number, the selection of that LRU should not be excluded if it is cost effective to inscribe a serial number on each component.) The PIWG team will assign a minimum number of service life hours each WUC must fail at or below to be declared a "Bad Actor". This minimum number of service life hours will be documented in the -6 TO, section II, Part D. When the WUC component fails, the length of service life used will be compared with the minimum number assigned to it. If it is less than the minimum, the part will be submitted as a PQDR exhibit.

When the Depot receives the component, every avenue will be exhausted to find the cause of the failure. If no cause can be found, it will be destroyed and become salvage.

B.4.1.1.2.17 Develop a program to perform routine health assessment of the aircraft Electrical Wiring Interconnect System.

The Electrical Wiring Interconnect System (EWIS), also known as aircraft wiring, is defined as any wire, fiber optic link, wiring or fiber device, or a combination of these items (including terminations) installed in any area of the aircraft for the purpose of transmitting electrical energy, signals, or data between two or more electrical end points. A failure of the EWIS external to LRUs can lead to mission failure, loss of mission capability, and, at the extreme, catastrophic loss of the aircraft as the result of fire or LRU malfunction. The health of the system should be assessed on a regular schedule using maintenance history data, inspection results, and special on-aircraft wiring assessments. A special “HOWMAL Code 689 – EWIS Malfunction” has been created and implemented in the three main maintenance data collection systems: IMDS, CAMS-FM, and REMIS. Maintenance technicians have been instructed to use this HOWMAL code to record all failures of the EWIS by part number, failure location, and the nature of the failure. Weapon System Engineers should analyze this data on a regular basis for adverse trends on selected conductive paths, at specific locations, evidence of repeated wire abrasion, insulation breakdown, corrosion, arcing, or overheating. Engineers should use this analysis to program appropriate corrective actions (replacement, modification, special training, increased inspection, etc.) to improve reliability and avoid catastrophic failures.

B.4.1.1.2.18 Develop a model to quantify the cost of unreliability for the weapon system.

Reliability and Maintainability improvements must be justified from a financial perspective for those improvements to “buy” their way onto the aircraft. This cost of unreliability model will allow the program office to estimate the current cost of unreliability and compare it to the expected future cost of unreliability if an R&M improvement change is made. By dividing the yearly savings due to improved reliability by the cost to implement the change, a simple “payback period” is identified. This is a powerful tool to evaluate R&M-type improvements in competition for limited funds to obtain the best “bang-for-the-buck” solutions.

B.4.1.1.3 Subtask 3: force management execution.

Force management is a roadmap on how the fleet’s components will be managed. No one indicator will be rated higher than the others. Generally it will require more than one tracking feature to initiate an investigation. The RAT will be responsible for monitoring each component’s status.

B.4.1.1.3.1 Monitoring of components’ repairs and overhauls.

The FSID must be monitored by personnel with extensive aircraft systems knowledge. Factors which assist the team to identify problem areas are: close personal contact with field units and overhauling Depots, PDM personnel, supply briefings, bulletin board inquiries, reliability status, and MAJCOM concerns. The computer program will help resolve problems by listing most of the information needed to make system decisions on a single computer screen. The following information is available for each WUC and is updated monthly.

B.4.1.1.3.1.1 Fleet MTBF.

Mean Time Between Failures is a parameter that historically has been used to define the reliability of components. Establish a MAP for each WUC. An alert should be generated when the current status drops below the MAP.

B.4.1.1.3.1.2 Serial number MTBF.

Mean Time Between Failure data captured by serial number is for individual components and is generally more reliable than fleet MTBF. The system should serially track critical parts (safety, mission), MSIs, all Bad Actors, TCIs, and special-attention components.

B.4.1.1.3.1.3 ISO/HSC inspections.

All ISO discrepancy data should be stored in the system indefinitely. Display the last five ISO discrepancies for each tail number and display a “Top Ten” WUC chart for the worst performers.

B.4.1.1.3.1.4 Not Mission Capable (NMC) (S)(M)(B).

Not Mission Capable is used by the MECSIP Program to indicate the discrepancy that prevents the aircraft from being Fully Mission Capable (FMC).

B.4.1.1.3.1.5 Aborts.

Aborts are the results of component failures. All aborts will be investigated and the cause eliminated. Preventive maintenance will be applied where possible and/or overhaul procedures updated to ensure reliability is restored.

B.4.1.1.3.1.6 Bulletin boards.

Bulletin boards open communications between Engineering and Maintenance. The MECSIP will ensure all maintenance activities are reported in the total ownership of the weapon system. Use the bulletin boards to identify user complaints or concerns.

B.4.1.1.3.1.7 Cannibalizations.

Cannibalizations will be investigated for future preventive maintenance actions to correct the root cause.

B.4.1.1.3.1.8 PQDRs.

The PQDR is a tool which can identify internal quality problems. A RAT member should lead the PQDR program; Maintenance should be encouraged to PQDR every defective part; and results should be analyzed until a satisfactory answer is provided. Poor troubleshooting techniques will also be part of the RAT’s investigation.

B.4.1.1.3.2 Monitor component inspection and replacement criteria.

The inspection requirements should establish the equipment to be inspected, its inspection schedule, and its inspection criteria. Inspection and replacement criteria for safety- or mission-critical components must be periodically evaluated to determine that it is still appropriate and is adequate to maintain the integrity and safety of this equipment. Replacement parts must meet the requirements listed in TO 00-35D-54.

B.4.1.1.3.2.1 Work Unit Code (WUC) Manual.

The WUC Manual is the initial resource to obtain data for the analysis process. This manual must have a five-digit code for each component being monitored and the nomenclature must be in the language the technicians use. When a component is to be time changed, serially tracked, or warranted, (i.e., in particular a safety- or mission-critical, or fail-safe component) it will be identified with a special letter or asterisk.

B.4.1.1.3.2.2 Scheduled inspection requirements and replacement schedule.

The inspection requirements contained in the TOs are designed to direct the attention of Maintenance personnel to components and/or areas where defects are suspected to occur as a result of usage under normal operating conditions. Once an area is inspected and documented, the findings will be used to plan logistic and maintenance procedural support and provide coverage for routine cleaning, washing, etc. These inspections are not designed to lead to the detection of isolated discrepancies that are the result of carelessness, abuse, or poor maintenance practices. During accomplishment of the specified requirements directed by the WUC Manual, Maintenance personnel should observe both the equipment being inspected and the components in the surrounding area for defects or irregularities. The replacement schedule lists components whose expected service life has been determined. The failure of these items could compromise safety, mission accomplishment, or cause the failure or condemnation of high-value components. Items not listed in the WUC Manual will be known as “on condition” and will be replaced only when they fail. In conjunction with TO 1-1-300, the WUC Manual provides the conditions which require a Functional Check Flight, which is designed to assure the aircraft is operational and capable of mission accomplishments after completion of certain scheduled and unscheduled maintenance. The repair restrictions chapter lists items where Base-level repair restrictions have been established and describes the repairs which are not authorized. The historical documents section contains a listing of all aircraft components requiring an AFTO Form 95. This form provides a permanent record of events or conditions encountered during the use of the equipment. When a component is to be time changed, serially tracked, identified as a MSI or a Bad Actor, it will be identified in the WUC Manual. Any changes to the WUC Manual will entail a corresponding and mandatory change to the Reliability and Maintainability Information System (REMIS). The MECSIP Manager will review the ES’ recommended changes to the manual before any changes are made.

B.4.1.1.3.2.3 Time changes.

Once an item has met the requirements for time replacement outlined in TO 00-35D-54, identified in the WUC Manual, and in the replacement schedule of the -6 TO**,** it must be periodically monitored to ensure the time schedule is still applicable. Safety- and mission-critical equipment must be changed at the specified interval of service (i.e., they cannot be allowed to fail in service). Of concern, is the potential for usage to be more severe than anticipated which will necessitate the removal of a component earlier than expected.

B.4.1.1.3.2.4 Inspection work cards.

Inspection work cards provide the mandatory inspection requirements for the weapon platform. These work cards are prepared in checklist form and will be used in performance of inspections to ensure no item is overlooked. To afford efficient maintenance planning and assignment of work, these inspection requirements are arranged by work zones and separate work cards are used for those requirements to be accomplished by each type of mechanic or specialist. All work cards should be reviewed annually for accuracy especially for components classified as safety- or mission-critical.

B.4.1.1.3.2.5 Program Depot Maintenance requirements.

Depot maintenance is the most complex of all the scheduled maintenance programs. It requires the use of special test equipment, long-term storage of the aircraft, and a highly-trained workforce. Program Depot Maintenance work requirements are reviewed yearly during the Maintenance Requirement Review Board (MRRB) and each task is agreed to by all the MAJCOMs. The MECSIP Manager will be a team member of the MRRB and participate during the review. New initiatives for the PDM package must be adequately justified and should have a risk assessment performed IAW AFPAM 90-902. Most condition assessments will be done during PDM.

B.4.1.1.3.3 Monitor data integrity.

B.4.1.1.3.3.1 Data entries.

Training classes can be initiated by the working group to ensure each technician is aware the information entered will be used by Engineering to initiate preventive maintenance actions for unreliable components. Additionally, during each PIWG hosted by the Program, the RAT will brief the importance of accurate data and identify preventive actions initiated by previously-submitted data.

B.4.1.1.3.3.2 Risk assessments.

Risk decisions must be made at a level of responsibility that corresponds to the degree of risk; the significance of the mission and the timeliness of the required decision must be considered.

B.4.1.1.3.4 Perform analysis.

It is essential to establish the extent to which the analysis is expected to improve performance and to track the component to determine how well it improved relative to the total cost of the analysis before any analysis is actually begun. The analysis performed will be Preview, In-depth, or ACI.

B.4.1.1.3.4.1 Preview analysis.

A Preview analysis is simply a paper review of the data available. The main goal of the Preview is to validate the data and determine if a" real" problem exists. If the paper trail was in error, the analysis can be closed. If a more thorough analysis is required to identify the problem, an In-depth analysis should be performed. A Preview analysis will be performed on functional and potential failures. Functional failures occur when there is an actual failure during operation of the component. Most functional failures will require an In-depth analysis. Most potential failures will not require an In-depth analysis but will require extensive coordination and Service Level Agreements (SLAs) with other agencies to resolve. If either failure mode warrants an In-depth analysis, it will be performed by the RAT.

B.4.1.1.3.4.2 In-depth analysis.

If the Preview analysis indicates problems exist, then an In-depth analysis should be performed. The RAT, Depot Overhaul Facility, or Civilian Contractor will perform most In-depth analyses. Before a group is selected to perform the analysis, the person requesting the analysis will:

a. establish the objectives of the analysis (quantified wherever possible), and agree when and how the achievement is to be measured;

b. estimate how much time will be required to perform the analysis and what skills and facilities will be needed;

c. establish the funding, site, and personnel to perform the analysis; and

d. decide when, where, and by whom the recommendations will be implemented.

B.4.1.1.3.4.3 Analytical Condition Inspections.

Durability-critical and legacy and interfacing subsystems must have ACI to ensure the subsystems will remain serviceable until the next inspection date. Wiring, wiring connectors, wiring components, circuit breakers, pivot bearing, torque tubes, etc., deserve the same attention as the components they are designed to engage or operate. If possible, these inspections should be performed during PDM due to the long aircraft downtime already scheduled.

B.4.1.1.3.4.4 Equipment usage and environments.

The usage and environments of safety- and mission-critical equipment should be monitored and tracked to determine if usage and environments are in accordance with definitions used in equipment design. If it is determined that usage or environments is different than expected, then maintenance, inspection, and replacement intervals must be re-evaluated to determine when the equipment should be serviced, inspected, or replaced to maintain integrity and safety.

B.4.1.1.4 Subtask 4: preventive maintenance actions.

The preventive maintenance action should begin with a logic tree decision analysis and be implemented with a "common sense" approach (see B.4.1.1.4.7) to improve reliability. The Air Transport Association of America (ATA) Publication MSG-3 outlines procedures to develop preventive maintenance requirements through the use of Reliability-Centered Maintenance Analysis (RCMA) for functional systems. Once RCMA identifies a preventive maintenance task to be performed, a "common sense" approach to the solution must be developed. Preventive maintenance includes:

B.4.1.1.4.1 Lubricating or servicing.

Any act of lubrication or servicing intended to maintain inherent design capabilities:

a. Lubrication: A lubrication task is the application of a lubricant to a component whose design specifies lubrication for proper operation. A lubrication task is appropriate only if the lubricant to be used is a non-permanent type and needs to be reapplied periodically.

b. Servicing: A servicing task entails the replenishment of consumables (e.g., fuel, oxygen, oil, and nitrogen) which are depleted during normal operations.

B.4.1.1.4.2 Operational checks.

Additional operational checks to a task to determine that an item is fulfilling its intended purpose:

Operational checks: system checked and serviced to ensure serviceability.

B.4.1.1.4.3 Visual examination.

An intensive visual examination of a specific area to detect damage:

a. Detailed inspection: An intensive visual examination of a specific structural area, system, installation, or assembly to detect damage, failure, or irregularity. Available lighting is normally supplemented with a direct source of good lighting at an intensity deemed appropriate by the inspector. Inspection aids such as mirrors or magnifying lenses may be used. Surface cleaning and elaborate access procedures may be required.

b. Surveillance inspection: A visual examination of a interior or exterior area, installation, or assembly to detect obvious damage, failures, or irregularity. This level of inspection is made under normally available lighting conditions such as daylight, hangar lighting, flashlight, or droplight and may require removal or opening of access panels or doors. Stands, ladders, or platforms may be required to gain proximity to the area being checked.

c. Special detailed inspections: An intensive examination of a specific item(s), installation, or assembly to detect damage, failure, or irregularity. The examination is likely to make extensive use of specialized inspection techniques and/or equipment. Intricate cleaning and substantial access or disassembly procedures may be required.

B.4.1.1.4.4 Restoration.

An act of restoration, ranging from cleaning or replacement to complete overhauls:

Restoration: That work necessary to return the item to a specific standard. Since restoration may vary from cleaning or repairing to complete overhauls, the scope of each assigned restoration task has to be specified.

B.4.1.1.4.5 Time change.

A time change of the component if a specific life cycle can be determined:

Time change item: Items designated as TCI are replaced at specified intervals. The primary objective of a time change is to achieve maximum utilization of components consistent with the economic operation of the weapon system, support systems, and equipment without jeopardizing flight or operational safety. Time change item identifiers are only prescribed for those items that have a measured service life expectancy and display an age-related failure pattern.

B.4.1.1.4.6 Combination.

Any combination of the five actions listed above.

B.4.1.1.4.7 “Common sense” approach.

a. Easiest to hardest. The “common sense” approach provides a solution to the discrepancy in the minimum amount of time, improved overhauls versus redesign, critical interior components replaced at a 100-percent (100%) rate during overhaul, carcasses limited to the number of overhauls they can endure, and obligates the minimum amount of funds.

b. Experienced personnel. Only personnel experienced in component overhauls procedures as well as component performance while installed on the aircraft will be chosen to oversee or monitor the overhaul.

B.4.1.1.5 Subtask 5: manage system's final five years prior to retirement.

An Integrated Product Team (IPT) should be established to determine the most effective course of actions to take in the final five years prior to weapon system retirement.

B.4.1.1.5.1 Establish IPT.

Representatives from the MAJCOMs, SOR, DLA, and the Wing Office shall comprise the IPT which will establish supply and liaison procedures.

B.4.1.1.5.1.1 Supply.

The impact of drawdown in the supply system must be evaluated and planned for so that spares will be available as needed. Cannibalizations from depot condition "F" assets, Aerospace Maintenance and Regeneration Center (AMARC) pulls, and reuse of parts (repairs instead of overhauls) will likely provide spares in the event new spares are not available. Installation and usage records of in-service components will be relied upon for replacement actions.

B.4.1.1.5.1.2 Establish liaisons at Primary Bases.

Each Base that hosts or maintains the weapon platform will be required to provide a liaison for Maintenance and Supply to the MECSIP Manager. These individuals will have to be empowered by Defense Contract Management (DCM) to make decisions which involve either maintenance procedures or source of supply (new, repaired versus overhaul, and AMARC pulls).

Custodians:
Army – AV
Air Force – 11

Preparing activity:
Air Force – 11
(Project SESS-2009-023)

Review activities:
Air Force – 70, 84, 99

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at http://assist.daps.dla.mil.