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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 AFLCMC/ENRS, 2145 MONAHAN WAY, WRIGHT-PATTERSON AFB OH 45433-7017 or e-mailed to AFLCMC/EN_EZ Engineering Standards. Since contact information can change, you may want to verify the currency of this address information in the ASSIST Online database at https://assist.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 aircraft systems. The goal of this integrity program is to achieve the desired level of safety and aircraft availability at the most economic cost across the life cycle of the weapon system. 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 applies 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, 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. As the system enters into sustainment phase, the MECSIP Manager should use the contents of this document to continuously refine and optimize the MECSIP established during the development phase to address issues and risks encountered during sustainment.

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. classificatioin of the criticality of MECSIP component parts into categories for: safety critical; mission critical; durability critical; durability non-critical; or expendable and implementation of appropriate controls to prevent failure based on those classifications;

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

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

d. 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.

e. 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; and trade studies to investigate reduction of consequence via new design or backups;

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

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

h. a proactive correction of design deficiencies discovered in analysis, test or demonstration before major economic and/or production commitments are established.

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

j. structured program to guide appropriate preventative maintenance tasks to achieve the desired level of safety and aircraft availability at the most economic cost attainable;

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

l. a tracking system to measure actual usage and environment for the fielded equipment, systems and components

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. 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-1530 (i.e., those portions of the landing gear which, if failed, would lead to the inability of the landing gear to safely support the weight of the aircraft during ground operations.)), auxiliary power, crew escape, canopy, aerial delivery, aerial refueling, cockpit displays, environmental control, fire protection, flight control, fuel, hydraulic, wheels/tires/brakes, life support, mechanical systems (e.g., door drives), cargo systems, pneumatic, and electro-mechanical elements of electrical power and wiring systems that conduct power or data between major components, connectors, and sub-components (e.g.,bearings, fasteners). 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 those which are cited in the other sections of this standard. While an 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.

JOINT SERVICE SPECIFICATION GUIDE

JSSG-2006	Aircraft Structures
JSSG-2009	Air Vehicle Subsystems

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-810	Environmental Engineering Considerations and Laboratory Tests
MIL-STD-882	System Safety
MIL-STD-1530	Aircraft Structural Integrity Program (ASIP)
MIL-STD-1797	Flying Qualities of Piloted Aircraft

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-516	Airworthiness Certification Criteria
MIL-HDBK-525	Electrical Wiring Interconnect System (EWIS) Integrity Program
MIL-HDBK-1823	Nondestructive Evaluation System Reliability Assessment

(Copies of these documents are available online at https://assist.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 the Air Force E-Publishing Website: www.e-publishing.af.mil.)

DEFENSE LOGISTICS ACQUISITION DIRECTIVE

DLAD	Combined with Procedures, Guidance, and Information (PGI) with Appendices

(Copies of this document are available online at www.dla.mil/acquisition/pages/dlad.aspx.)

DEPARTMENT OF DEFENSE INSTRUCTIONS

DoDI 4151.22	Condition Based Maintenance Plus (CBM^+) for Materiel Maintenance
DoDI 5000.02	Operation of the Defense Acquisition System

(Copies of these documents are available online at www.dtic.mil.)

DEPARTMENT OF DEFENSE MANUAL

DoD 4151.22-M	Reliability Centered Maintenance (RCM)

(Copies of this document are available online at www.dtic.mil.)

U.S. NAVY INSTRUCTIONS

COMNAVAIRFORINST 4790.2B	The Naval Aviation Maintenance Program (NAMP)

(Copies of this document are available online at http://www.navair.navy.mil/logistics/4790/.)

NAVAIRINST 5000.21B	NAVAL SYSTEMS COMMAND RISK MANAGEMENT POLICY

(Copies of this document are available to qualified users online at https://mynavair.navair.navy.mil/directives/.)

U.S. NAVY TECHNICAL MANUAL

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

NAVAIR STANDARD WORK PACKAGE (SWP)

SWP 4.4.5.3	Aircraft Wiring Assessment Report, NAVAIR 4.4.5.3, Wiring Systems Branch

(Requests by qualified users of these documents should be addressed to the Naval Air Technical Data and Engineering Service Center, NAS North Island, Bldg 90, PO Box 357031, San Diego CA 92135-7031 USA; https://mynatec.navair.navy.mil.)

U.S. AIR FORCE INSTRUCTIONS

AFI 21-101	Aircraft and Equipment Maintenance Management
AFI 63-1201	Life Cycle Systems Engineering

U.S. AIR FORCE PAMPHLET

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

U.S. AIR FORCE POLICY DIRECTIVE

AFPD 62-6	USAF Airworthiness

(Copies of these documents are available online at the Air Force E-Publishing Website: www.e-publishing.af.mil.)

U.S. AIR FORCE TECHNICAL ORDERS

T.O. 00-20-1	Aerospace Equipment Maintenance Inspection, Documentation, Policies, and Procedures
T.O. 00-20-2	Maintenance Data Documentation
T.O. 00-35D-54	USAF Deficiency Reporting, Investigation, and Resolution

(Approved users may access these documents in the Enhanced Technical Information Management System (ETIMS), located at “Air Force Indexes A-Z -- Applications” on the Air Force Portal at https://www.my.af.mil/etims/ETIMS/ETIMS/menu/index.jsp; select the "E" category of the index and then "ETIMS", or e-mail atoms@wpafb.af.mil.

Alternately, users may contact their organizational TO Distribution Office. Contractors obtain TOs through their Government Contract Monitor or from Oklahoma City Air Logistics Center, Tinker AFB; (405) 736-5468 or DSN 336-5468; fax (405) 736-5013 or DSN 336-5013.)

AFLCMC/EN – EZ BULLETINS

EN-SB-12-001	Requirements for Evaluation and Authorization of Digital Radiography for Inspection of Aerospace Castings
AWB-013	Risk Identification and Acceptance for Airworthiness Determinations

(Copies of these documents are available from AFLCMC/ENRS, 2145 MONAHAN WAY, WRIGHT-PATTERSON AFB OH 45433-7017; e-mail: AFLCMC/EN_EZ Engineering Standards.)

FEDERAL AVIATION ADMINISTRATION (FAA)

ADVISORY CIRCULARS

AC 25-27A	Development of Transport Category Airplane EWIS ICA Using an Enhanced Zonal Analysis Procedure
AC 25.1309-1A	System Design and Analysis
AC 25.1701-1	Certification of EWIS on Transport Category Airplanes

ORDER

Order 8110.101	Type Certification Procedures For Military Commerical Derivative Aircraft

(Copies of these documents are available online at www.faa.gov.)

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.

AIR TRANSPORT ASSOCIATION OF AMERICA, INC.

ATA Publication MSG-3	Operator/Manufactured Scheduled Maintenance Development

(Requests for this document should be addressed to the Air Transport Association of America, Inc.; 1301 Pennsylvania Avenue, NW; Suite 1100; Washington DC 20004-1707 USA; https://publications.airlines.org.)

SAE INTERNATIONAL

AMS-A-21180	Aluminum-Alloy Castings, High Strength
AMS2175	Casting, Classification and Inspection of
AMS5343	Steel, Corrosion Resistant, Investment Castings 16Cr - 4.1Ni - 0.28Cb (Nb) - 3.2Cu Homogenization, Solution, and Precipitation Heat Treated (H1000) 150 ksi (1034 MPa) Tensile Strength (17-4)
AS50881	Wiring, Aerospace Vehicle

(Copies of these documents are available from SAE International, 400 Commonwealth Drive, Warrendale PA 15096-0001 USA; www.sae.org.)

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 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.

3.2 Analysis.

Analysis is the diagnostic effort that aims to predict system response to typical conditions encountered during operational use. 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.

3.3 Bad Actors Program.

The Bad Actors Program identifies components which exhibit unusual levels of repeat failures of specific serial number components.

3.4 Bulletin boards.

Bulletin boards are internet web-sites maintained by the Program Offices for users and maintainers to ask questions and post comments.

3.5 Cannibalization.

Cannibalization (CANN) is the removal of installed operational equipment for repair of another asset due to spare part shortage.

3.6 Critical Application Item (CAI).

Critical Application Item (CAI) is a broad term defined by the Defense Logistics Acquisition Directive, DLAD Revision 5, as “items whose failure could affect mission, performance, readiness, or safety”; and as “an item that is essential to weapons performance, operation, the preservation of life, or safety of operating personnel, as determined by the military services.” The subset of CAIs whose failure could have catastrophic or critical safety consequences is called “Critical Safety Items (CSI).” This leaves the remaining CAIs to be essential to weapons system performance.

3.7 Critical Safety Item (CSI).

The DLAD defines CSIs as a “subset of a larger category of parts known as CAIs; and “CSIs are parts whose failure potentially can cause loss of life, serious injury, loss of an aircraft, or significant damage to an aircraft or associated equipment.”

A CSI is a part, assembly, installation equipment, launch equipment, recovery equipment, or support equipment for an aircraft or aviation weapons system that contains a characteristic any failure, malfunction, or absence of which could cause a catastrophic or critical failure resulting in the loss or serious damage to the aircraft or weapons system, an unacceptable risk of personal injury or loss of life, or an uncommanded engine shutdown that jeopardizes safety. Damage is considered serious or substantial when it would be sufficient to cause a “Class A” accident or a mishap of severity category I. The determining factor in CSIs is the consequence of failure, not the probability that the failure or consequence would occur. The CSI designation is applicable for “replenishment items” only. This means items such as fire protection tubing (typically not a replenishment item), environmental control system (ECS) ducts, etc., usually are not covered by CSI. If the component is not normally a spare part, it will not be designated CSI. For that reason, not all safety-critical items are CSI, even though all CSI are safety-critical.

3.8 Damage tolerance.

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

3.9 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.

3.10 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. An example is: if a diode is specified to be able to operate at 10V and 5 Amps, and is placed into operation where it sees only 7V and 3 Amps, it is said to have been de-rated for that application.

3.11 Design loads/environment spectrum.

The design loads/environment spectrum is the spectrum of internal and external loads and environments (chemical, thermal, etc.) the equipment is expected to encounter within the design service life. The mechanical equipment must be designed to withstand these loads and environments for the duration of its design service life.

3.12 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.

3.13 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.

3.14 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.

3.14 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.

3.15 Economic Impact (Major versus Minor).

The Procuring Authority defines what constitutes "major" versus "minor" economic impact for their program.

3.16 Fault detection.

Fault detection is a process which discovers the existence of faults.

3.17 Fault injection.

Fault injection is the process of analyzing and testing a system by intentionally injecting errors into the system or its components to: (1) verify that it responds to the error(s) as expected and; (2) identify undesirable behavior that may be present in the design when encountering the error(s).

3.18 Fault isolation.

Fault isolation is identification of the fault in a unit under test to the specified fault resolution level of the item. Automatic or manual means can be utilized to achieve the specified fault resolution level.

3.19 Flammable vapor zone.

A flammable vapor zone is a fire protection zone on the aircraft where flammable fluid/vapor is routinely present, such as inside fuel tanks.

3.20 Flammable fluid leakage zone.

A flammable fluid leakage zone is a fire protection zone on the aircraft where a single failure (such as a fuel leak) will introduce the presence of flammable fluid/vapor.

3.21 Flying qualities.

The flying qualities of an air vehicle are defined as the stability and control characteristics that have an important bearing on the safety of flight and on the pilots' impressions of the ease of flying the air vehicle in steady flight and in maneuvers.

3.22 Level I flying qualities.

a. Satisfactory - Flying qualities clearly adequate for the mission Flight Phase. Desired performance is achievable with no more than minimal pilot compensation.

b. Performance Achievable

c. Minimal Pilot Workload (See MIL-STD-1797.)

3.23 Level II flying qualities.

a. Acceptable - Flying qualities adequate to accomplish the mission Flight Phase, but some increase in pilot workload or degradation in mission effectiveness, or both, exists.

b. Degradation in Performance and/or

c. Increase in Pilot Workload (See MIL-STD-1797.)

3.24 Fracture-critical part.

A fracture-critical part is a safety-critical component that is not single load path nor sized by durability or damage tolerance requirements but requires special emphasis due to the criticality of the component. Fracture-critical parts generally call for special fatigue/fracture toughness controls, quality control procedures, NDT/I practices, and analytical requirements. It is not necessary to retain and track records from the material starting stock to tail number installation and reverse if the part is not designated as fracture-critical traceable.

3.25 Fracture-critical traceable part.

A fracture-critical traceable part is a safety-critical component that is either single load path or sized by durability or damage tolerance requirements. Fracture-critical traceable parts require serialization and traceability from starting stock to tail number and reverse.

3.26 Functional Hazard Analysis.

A functional hazard analysis is a subset of hazard analysis that provides a comprehensive examination of aircraft functions to identify and classify failure conditions of those functions according to their severity.

3.27 Functional Systems Integrated Database (FSID).

The database used by the reliability analysis team to record, track and analyze maintenance and component reliability data for the purpose of deciding how best to proceed to achieve MECSIP goals of safety and aircraft availability at the most economic cost across the life cycle of the aircraft. The actual form of the database is up to the needs of the program.

3.28 Hazard Analysis (HA).

A hazard analysis is the systematic process to evaluate potential conditions that can cause injury, illness, or death to personnel; damage to or loss of a system, equipment, or property; or damage to the environment. The hazard analysis contains a detailed analysis of system hardware and software, the environment (in which the system will exist), and the intended usage or application. The hazard analysis classifies failure conditions according to their severity. Historical hazard and mishap data, including lessons learned from other systems, are considered and used.

3.29 Improbable occurrence.

An improbable occurrence is defined in AWB-013 and NAVAIRINST 5000.21B.
This is the least probable occurrence of the rate classifications presented in AWB-013 and NAVAIRINST 5000.21B.

3.30 Inspections.

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.

3.31 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.

3.32 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.

3.33 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.

3.34 Maintenance Planning Data (MPD) Document.

To support maintenance of the type certificate for Commericial Derivative Aircraft (which indicates the airplane will be maintained in a condition of airworthiness equal to its certified or properly altered condition), the aircraft manufacturer/OEM provides a Maintenance Planning Data (MPD) Document to operators. The MPD includes both FAA mandatory requirements and OEM recommended (non-mandated) requirements. Mandated tasks are the Certification Maintenance Requirements (CMRs) and Airworthiness Limitations. Other tasks originate from the Maintenance Review Board (MRB) report (which includes tasks derived through MSG analysis or other FAA approved methodology), Service Actions, and other OEM information. The MPD also addresses corrosion, structural fatigue/durability, and critical system/part reliability concerns

3.35 Maintenance Significant Item (MSI).

The term MSI is used in Maintenance Steering Group (MSG-3) Analysis and refers to parts whose failure could result in one of the following effects:

a. Impact to safety (ground or flight)

b. Be undetectable during operation (latent)

c. Impact ability to perform a mission

d. Have significant economic impact.

3.36 Maintenance Steering Group – 3 (MSG-3) analysis.

This is a structed analysis, based on Reliability Centered Maintenance principles, which identifies appropriate preventative maintenance tasks to optimize aircraft availability versus maintenance cost. MSG-3 analysis is widely used in the commercial aviation industry.

3.37 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.

3.38 Mean Time Between Failures (MTBF).

MTBF is a parameter that historically has been used to define the reliability of components. It is usually expressed as:

MTBF = [(FLYING HOURS or ACTIVE TIME or POSSESSED HOURS) * (QUANTITY PER AIRCRAFT) * (USAGE FACTOR)] / (INHERENT FAILURES)

3.39 Not Mission Capable (NMC) (M), (S) (B).

Not Mission Capable is used by the MECSIP Program to indicate the discrepancy that prevents the aircraft from being able to fly the required mission. The aircraft may be Partially Mission Capable (PMC), wherein it can fly some, but not all, required missions. The letters “M”, “S” and “B” indicate the aircraft is in NMC status due to maintenance, supply or both maintenance and supply respectively. NMC = NMCM + NMCS + NMCB.

3.40 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.

3.41 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.)

3.42 Production Quality Deficiency Report (PQDR).

The PQDR is a tool which can identify internal quality problems. A Reliability Analysis Team (RAT) member should lead the PQDR program; Maintenance should be encouraged to PQDR every defective parts meeting the criteria of 5.5.2.14 herein; and results should be analyzed until a satisfactory answer is provided. The RAT will also review troubleshooting techniques during their PQDR investigation.

3.43 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.

3.44 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.

3.45 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 system Built-in Test (BIT), Prognostic Health Monitoring (PHM), or inspection. Redundancy also may describe a component that has redundant features.

3.46 Redundancy management.

The process of managing redundant elements in order to identify a failure and then reconfiguring the system to remove the effects of the failed element and continue operation with unfailed elements.

3.47 Reliability Centered Maintenance.

Reliability Centered Maintenance (RCM) is an analytical process to determine the appropriate failure management strategies, including PM requirements and other actions that are warranted to ensure safe operations and cost-wise readiness. This process of developing PM requirements, with an auditable documentation package, is based on the reliability of the various components, the severity of the consequences related to safety and mission if failure occurs, and the cost effectiveness of the task.

3.48 Remote rate of failure.

A remote rate of failure is defined in AWB-013 and NAVAIRINST 5000.21B. Remote rate is the second lowest probability defined in AWB-013 and NAVAIRINST 5000.21B.

3.49 Restoration.

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

3.50 Reversionary control modes.

Reversionary control modes is a fail-safe design approach that employs control system modes that accommodate failures by reverting to known safe states and/or utilizing control limitations (i.e., degraded control modes) to preserve safe operation.

3.51 Safe-life.

Safe-life is a duration measure (i.e., hours, load cycles) where a low probability exists that the component will fail or degrade below safe design levels. Safe-life components are normally replaced when the design safe-life occurs.

3.52 Safety-critical.

A term applied to any condition, event, operation, process or item whose proper recognition, control, performance or tolerance is essential to safe system operation.

3.53 Safety-critical software.

Safety-critical software provides safety-critical functionality and is designated with a mechanization assurance level classification of “safety critical” so that risk mitigating processes are used in the development and verification of the software.

3.54 Serially managed part.

A serially managed part is a part whose usage is tracked for all applicable factors significant to prevent in-service failure of that part. These factors include:

a. Aircraft tail number upon which the part is installed

b. Flight Hours accumulated

c. Calendar time accumulated since installation

d. Storage time accumulated

e. Load cycles

f. Temperature cycles and/or extremes.

3.55 Serial number MTBF.

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

3.56 Severe Wind and Moisture Prone (SWAMP) areas.

These are zones on the aircraft exposed to severe wind, moisture and elevated temperatures. These areas are particularly likely to lead to degradation (aging) of wire insulation.

3.57 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.

3.58 Slow damage growth component.

A slow damage growth component is a component 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 component with damage present is not degraded below a specified limit for the period of unrepaired service usage.

3.59 Technology needs.

Technology needs refer to potential technology insertions to solve subsystem development or sustainment challenges. Each year the MECSIP Managers/Engineers are asked to identy their technology needs and that list of technologies are prioritized at the annual MECSIP technical interchange Meeting and submitted to the Air Force Research Lab for consideration for potential funding.

3.60 Test.

Test is an evaluation 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 trial, observation, and evaluation of collected data. Most ground and flight structured evaluation efforts associated with procurement and acquisition qualify as tests.

3.61 Time Change.

Time Change is the replacement of a component at a specified service / time interval. Time Change is also referred to as “hard time task” in RCM.

3.62 Time Change Item (TCI).

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.

3.63 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. Uprating is not limited to electric components, but frequently is applied to electric components.

3.64 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.).

3.65 Work Unit Code (WUC) Manual.

The WUC Manual is a manual which identifies the code assigned to each commonly-performed maintenance task, allows maintenance on specific components to be tracked, and causes for not mission capable time, maintenance man-hours, etc., to be recorded.

3.66 Acronyms.

AC	Advisory Circular
ACI	Analytical Condition Inspection
AMARG	Aerospace Maintenance and Regeneration Group
ATP	Acceptance Test Procedures
ATSRAC	Aging Transport Systems Rulemaking Advisory Committee
AWP	Awaiting Parts
BIT	Built-in Test
CAI	Critical Application Item
CANN	Cannibalization
CEI	Configured End Item
CP	Conductive Path
CSI	Critical Safety Item
DCM	Defense Contract Management
DR	Digital Radiography
EAPAS	Enhanced Airworthiness Program for Airplane System
ECS	Environmental Control System
ES	Equipment Specialist
ESA	Engineering Service Authority
EWIS	Electrical Wiring Interconnect System
EWISIP	Electrical Wiring Interconnect System Integrity Program

FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FMC	Fully Mission Capable
FSID	Functional Systems Integrated Database
HA	Hazard Analysis
HAZREP	Hazard Report
HRI	Hazard Risk Index
IAT	Individual Aircraft Tracking
JEDMICS	Joint Engineering Data Management Information and Control System
JSWAG	Joint Services Wiring Action Group
LRU	Line Replaceable Unit
MAJCOM	Major Command
MAP	Minimum Acceptable Performance
MCDA	Military Commercial Derivative Aircraft
MCO	Military Certification Office
MDC	Maintenance Data Collection
MEL	Mission Essential Listing
MICAP	Mission Impaired Capability, Awaiting Parts
MRRB	Maintenance Requirement Review Board
MRT	Maintenance Recovery Team
MSG	Maintenance Steering Group
MSI	Maintenance Significant Item
NMC	Not Mission Capable
OEM	Original Equipment Manufacturer
PDM	Program Depot Maintenance
PHM	Prognostic Health Monitoring
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
SITP	Scheduled Inspection Tracking Program
SLA	Service Level Agreement
SLAP	Service Life Assessment Program
SLEP	Service Life Extension Program
SOR	Source of Repair
SWAMP	Severe Wind and Moisture Prone
TCI	Time Change Item
TCTO	Time Compliance Technical Order
TDP	Technical Data Package
TEMP	Test and Evaluation Master Plan
WDC	When Discovered Code
WRA	Weapons Replaceable Assembly
WUC	Work Unit Code

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 established and maintained in accordance with this standard shall be tailored to satisfy specific program strategies and comply with DoDI 5000.02. 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.

4.1.1 Tailoring approach.

The Contracting Authority will establish the requirement to scope, tailor, and implement the MECSIP 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 SOW implementation.

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 started in advance of Milestone B.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 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.

A key aspect of requirements development is to recognize that aircraft being developed with a given set of operational requirements today will remain in service for decades and will see those operational missions and the installed equipment to execute those missions evolve over time. Because modern aircraft tend to have highly integrated systems, future redesign to provide growth capacity tends to be technically challenging and expensive. The investment necessary to build in provisions for growth capacity, where needed, early in the design will pay huge dividends during the operational life of the weapon system.

Each subsystem covered by MECSIP shall be analyzed to determine if growth capacity of that system should be a derived requirement and if so, what level of growth capacity is required. Where growth capacity is required, the requirement shall be included in the System Performance Specification. The Program shall define a curve showing the predicted consumption of growth capacity versus time for each applicable subsystem. The program shall then retain this as a living document, periodically updating the plot of actual growth capacity consumption against the predicted value. Two technically acceptable methods to address a subsystem growth requirement are as follow:

a. Build in excess capacity to accommodate future growth; build in provisions to increase system capacity easily in the future (e.g., insure physical size is available to accommodate increased capacity). Discipline must be maintained to prevent encroachment on the growth provisions if this approach is taken.

b. Deliver the extra capacity in the initial design to accommodate the level of growth determined appropriate in the derived growth requirement.

Historically, the two subsystems most commonly requiring growth capacity are electric power and ECS. Other subsystems may also require growth capacity.

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 latent failure modes.

5.1.5 Technical Data Package (TDP).

The Procuring Activity shall identify what level of technical data is required to flow smoothly into the sustainment phase and place requirements to obtain the appropriate level of data into the procurement contract. Experience shows it is far less expensive to contract for necessary data as early in the program life cycle as possible. If the support concept is not yet developed, the program should pursue a TDP which supports the highest level of organic sustainment that remains possible.

5.1.6 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. Appendix A shall be used as a guide to create these criteria.

5.1.7 Identify technical needs.

MECSIP Managers shall make a listing of Technical Needs encountered on an annual basis. A compiled list, from all programs, will be discussed/finalized at the MECSIP Technical Interchange Meeting and submitted into the Service-specific Research Laboratory as candidate developmental Technical Needs.

5.1.8 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 those problems which can be anticipated in the execution of the plan. The initial submittal of this plan shall shall record results of all the Task I efforts.

The MECSIP Master Plan shall be a living document, updated periodically throughout the life of the system. The Master Plan shall be initially developed during the Technology Development Phase (between Acquisition Program Milestones A and B). The document 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 shall ensure that system requirements are satisfied and that maintenance requirements can be defined and included in the overall force management plan.

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. A key effort within Task II is the classification of components and identification of appropriate control mechanisms for all safety-critical components and those mission-critical components which will not be allowed to fail in service.

5.2.1 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 (reference 5.2.9). A MECSIP representative shall be included as a member of the Corrosion Prevention Advisory Board (CPAB). The Corrosion Prevention Control Plan (published by the CPAB) shall include MECSIP equipment.

5.2.2 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.

5.2.3 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, etc.

5.2.4 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 System Specification requirements. Subsystem/component design criteria (stated in operating hours, flight hours, cycles, loads, environment, etc.) shall be derived to reflect component/system usage and service life.

5.2.5 Supportability planning.

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

a. identify which equipment will include periodic inspections or life limits (when practical, safety-critical equipment should have life limits defined);

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 components planned to be “removed for cause.” "Remove for cause" shall not be utilized on any safety-critical components.

5.2.6 Prognostic Health Monitoring (PHM) planning.

Each safety-, mission-, and durability-critical component shall be evaluated for application of PHM. Where application of PHM is determined to be technically feasible, a trade study shall be conducted to evaluate the cost of PHM (recurring and non-recurring) with the estimated benefit (reduced repair cost and reduced maintenance man-hours, NMC and PMC time).

5.2.7 Initial Failure Modes Effects and Criticality Analysis (FMECA).

The contractor shall build the initial FMECA during Task II. This will be used to identify single point failures in the system, particularly those single point failures which will result in safety- or mission-critical components as early as possible. The FMECA will be a key document in identifying safety- and mission-critical components. The FMECA will be a living document which is maintained as current throughout the life cycle of the weapon system.

5.2.8 Initial Hazard Analysis (HA).

The contractor shall build the intial HA during Task II. The HA will be used in the components classification task. The HA shall be a living document which is maintained as current throughout the life cycle of the weapon system.

5.2.9 Component classification.

MECSIP components (components include all Line Replaceable Units [LRUs] and Weapons Replaceable Assemblies [WRAs]) shall be classified for criticality as safety-, mission-, durability-critical, durability non-critical or other/expendable components. The Failure Modes, Effects, and Criticality Analysis (FMECA) and the Hazard Analysis (HA) for each specific system shall be considered in the component classification process. Within the FMECA, it is the "end effect" that should be considered for component criticality determination. Component classification shall be performed at the LRU and WRA level, if applicable. 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 components. The process detailed on figure 1 shall be used for the classification process. The MECSIP recognizes equivalency of parts classification per RCM and/or MSG-3, see below for correspondence of classification categories. Categories "a.", "b.", and "c." of the following component classification categories shall be used, as a minimum, when a Program is still in the development phase. If parts classification is accomplished when a Program is already in the sustainment phase, parts in categories "a." and "b." shall be defined:

MECSIP CLASSIFICATION		RCM/MSG-3 CLASSIFICATION
a. Safety-critical components	=	Evident Safety or Hidden Safety
b. Mission-critical components	=	Evident Operational
c. Durability-critical components d. Durability-noncritical components e. Other/expendable components.	=	Evident Ecomonic or Hidden Economic

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

NOTE: All emergency systems (e.g., Life Support, ejection, fuel dump, ram air turbine, emergency landing gear extention, fire extinguisher bottle squibs, etc.) are considered to have a flight-critical function. Components which are essential to maintaining the function of the emergency system shall be included in the Safety-critical list.

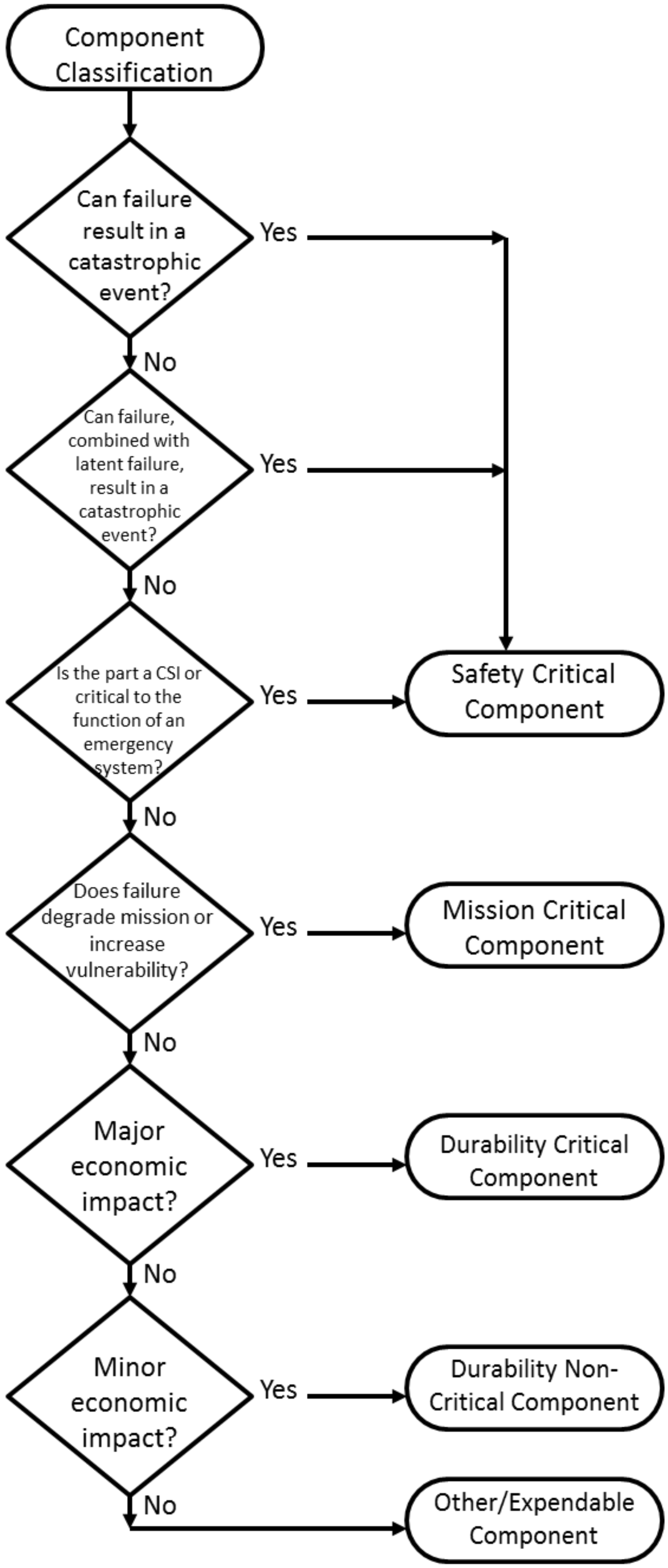

FIGURE 1. Safety-Critical part classification flowchart.

5.2.10 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 Critical Safety Items (CSI) (AV) shall be subject to sustainment requirements governing:

a. the initial determination of item criticality and subsequent changes to this determination;

b. coding and tracking of aviation CSI;

c. the process for ensuring the adequacy of technical data and proposed changes;

d. the process for approving sources of supply and repair/overhaul;

e. the surveillance process assuring that approved sources retain required capabilities;

f. authorities for one-time organic manufacture of CSIs under exigent circumstances; and

g. requirements for disposing of CSIs when no longer needed by military aviation.

A part is automatically considered a “Safety-Critical Item” in MECSIP if defined as a “CSI”.

5.2.11 Prevention of failure for Safety-Critical Parts.

Safety-critical parts shall not be allowed to fail in service; therefore for safety-critical components, it shall be necessary to:

a. Design to last the life of the aircraft (with appropriate condition feedback assessments to ensure design assumptions were correct); or

b. Define a replacement interval; or

c. Utilize a damage tolerance approach (with associated inspection interval); or

d. Show risk of failure is acceptably low with acceptance of risk at the appropriate level per MIL-STD-882.

A Business Case Analysis shall be conducted for each mission-critical and durability-critical part to determine if designing/testing of the part to operate without failure over the design life of the system is justified.

The aircraft subsystems and associated parts, considered separately and in relation to other systems, must be designed so that:

a. The occurrence of any failure condition resulting in loss of a safety-critical function is improbable per AWB-013 and NAVAIRINST 5000.21B, and

b. The combined rate of any combination of failures that lead to loss of a safety-critical function shall be improbable per AWB-013 and NAVAIRINST 5000.21B.

c. Warning information must be provided to alert the crew to unsafe system operating conditions, and to enable them to take appropriate corrective action. Systems, controls, and associated monitoring and warning means must be designed to minimize crew errors which could create additional hazards.

d. Compliance with this prevention of failure for safety-critical parts requirement must be shown by analysis and, where necessary, by appropriate ground, flight, or simulator tests. The analysis must consider:

    1. Possible modes of failure, including malfunctions and damage from external sources.

    2. The rate of multiple failure. For each safety-critical function where redundancy is the control utilized, the MECSIP Manager shall identify the level of reliability required by

the redundant parts to achieve an improbable level for safety-critical functional failure per AWB-013 and NAVAIRINST 5000.21B. The value shall be provided to the Reliability Analysis Team who will monitor actual reliability to verify redundancy controls rate of functional failure to an improbable level.

3. Latent (undetected) failures.

4. The resulting effects on the airplane and occupants, considering the stage of flight and operating conditions, and action required, and the capability of detecting faults.

e. Critical environmental conditions must be considered to depict compliance with failure conditions described in subparagraphs a. and b., immediately above.

5.2.12 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 safety, 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. Criteria shall be established to ensure that safety-critical components can safely withstand undetected flaws, corrosion, impact damage, and other types of damage throughout their design service life. Design criteria to prevent in-service failures of mission- and durability-critical parts should be implemented when cost effective. Figure 2 provides a summary of design approaches available to prevent in-service failures.

5.2.12.1 Damage tolerance design concepts.

Damage tolerance criteria shall be applied, where application is practical, to all safety-critical MECSIP components. Damage tolerance criteria shall also be considered for all mission- and durability-critical components. When a damage tolerance design approach is utilized, criteria shall establish a minimum critical flaw size for those locations which are difficult to inspect; such that, no inspection will be necessary in these areas for the life of the system. 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 component 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 by the inspection method selected 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 to failure. This concept must be used in single-load-path and non-fail-safe multiple load path components. No significant growth which results from manufacturing defects or from damage due to high-energy impact shall be allowed for composite components.

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.

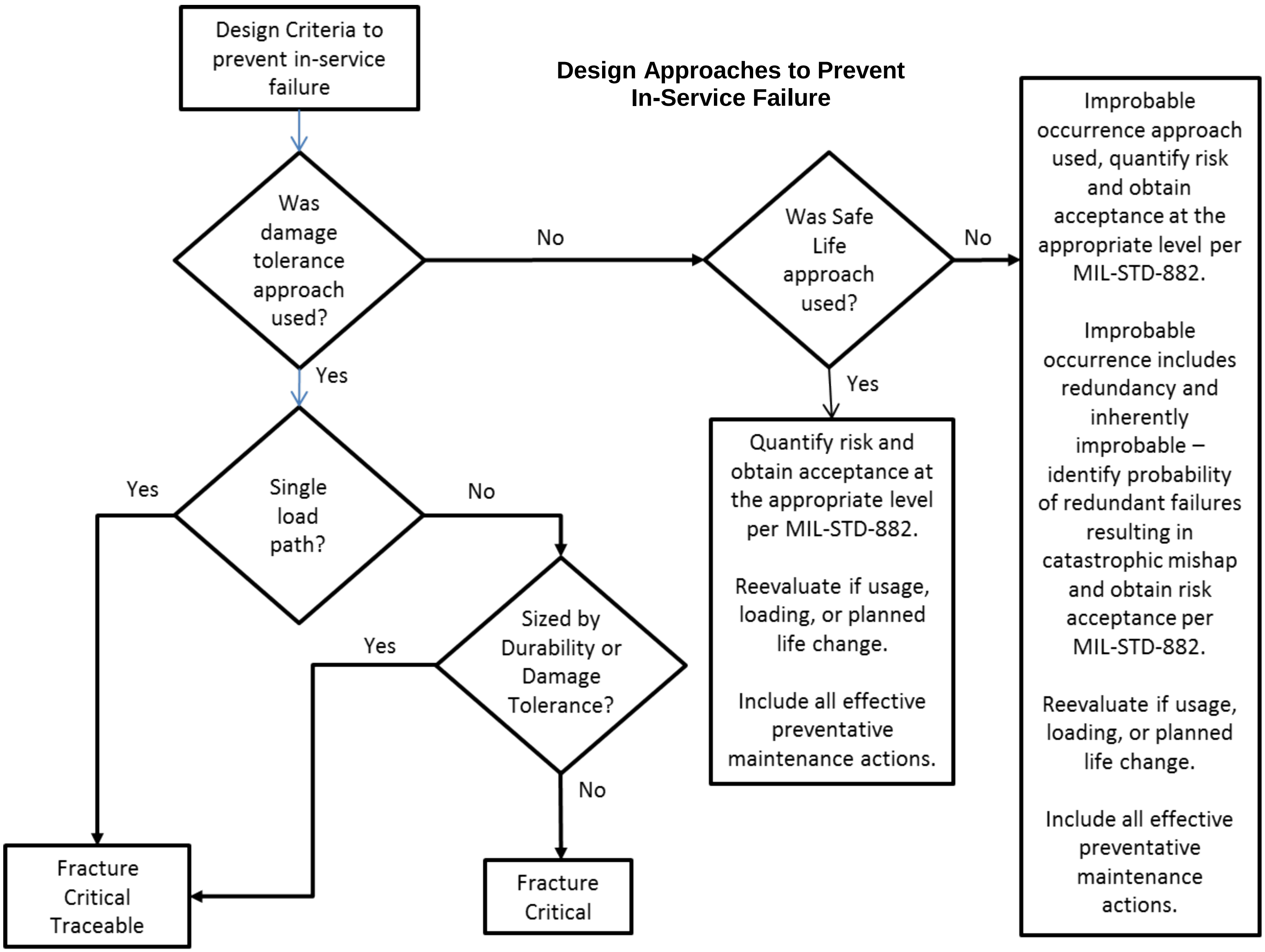

FIGURE 2. In-service failure prevention.

5.2.12.2 Other design concepts.

For those safety-critical components (and mission-, and durability-critical components determined to be feasible economically to prevent in-service failure) where damage tolerance design concepts do not apply or are not practical, other design approaches are available and shall be utilized. Use guidance provided in AWB-013 and NAVAIRINST 5000.21B to assess the component's rate of failure, the consequence of failure, and determine the hazard risk index (HRI) value. Risks that cannot be acceptably mitigated may be reviewed and accepted by the appropriate risk acceptance authority within the program risk management process. The following other design concepts are available to prevent in-service critical failures:

a. Redundant (dual/multiple) components or duplication of function to provide operational capability (without degradation) upon failure of a single component or part. Failure of a single component or part must be detectable (i.e., system is both fail operational and fail evident. Redundancy also may apply to a component or function that has redundant features, each able to sustain the critical function in event of failure of redundant part. Individual component reliability shall result in an overall rate of loss of aircraft or inadvertant store release in the improbable range per AWB-013 and NAVAIRINST 5000.21B. When redundancy is used to reduce the risk for loss of a flight-critical function, the individual components providing the redundancy shall be classified as "mission-critical." Emergency systems are those systems that provide a back-up to continue a safety-critical function or provide a means to mitigate failure of a safety-critical system. Emergency systems shall be designated as "safety-critical" and have functional failure frequency not higher than "Remote" per AWB-013 and NAVAIRINST 5000.21B. Redundant capability is acceptable for use (to maintain safety-critical function) in all cases, including those where damage tolerance is practical.

b. The safe-life design methodology may be used on a limited basis. When used, safe-life methodology shall establish replacement times for specifically-approved components. Damage tolerance evaluations shall be 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 for either eliminating defective components or otherwise mitigating threats to structural failure of the component. Such options may include design features, manufacturing processes, or inspections. The damage tolerance evaluation shall establish individual component tracking requirements so that the safe-life component replacement times and any scheduled safety inspections can be adjusted based on actual usage. Use of a "safe-life" approach for a MECSIP components shall be identified in the MECSIP Master Plan. A Hazard Analysis shall be performed for each safety-critical component designed per Safe Live design criteria (at the planned maximum life) and the resultant HRI accepted at the appropriate level per AWB-013 and NAVAIRINST 5000.21B.

c. Inherently improbable occurrence of failure per AWB-013 and NAVAIRINST 5000.21B. This concept is most applicable to generic classes of components which are very similar across a wide range of aircraft (including installation loading and environment). Examples of components for which "Improbable Occurrence" fits best are: fuel lines, fuel line couplings, and wire harnesses. In cases where "improbable occurrence" is used, the program should still look at potential for induced damage to the safety-critical parts from damage mechanisms such as chaffing. This look can be accomplished through actions such as recurring inspections or other appropriate means. Use of an "inherently improbable" approach for a MECSIP component shall be identified in the MECSIP Master Plan.

5.2.12.3 Design Criteria for in-direct failure mode effects.
The subsystem design and mitigations implemented shall reduce the predicted rate of Class A mishaps resulting for indirect failure mode effects to less than $1x10^{-7}$ per flight hour. Indirect failure mode effects are those in which the failed part is not directly involved in delivering a lost safety-critical function, but a collateral effect of failure interferes with a safety-critical function. An example is: An Auxiliary Power Unit experiences an uncontained failure sending hot turbine material into a fuel tank, resulting in a fire which causes loss of aircraft. The HA is a critical tool available to the MECSIP engineer to identify the hazards associated with each subsystem and define mitigations for those hazards. A list of indirect failure modes and the appropriate design criteria to control those hazards are listed in 5.2.12.3.1 through 5.2.12.3.5 and shown on figure 3.

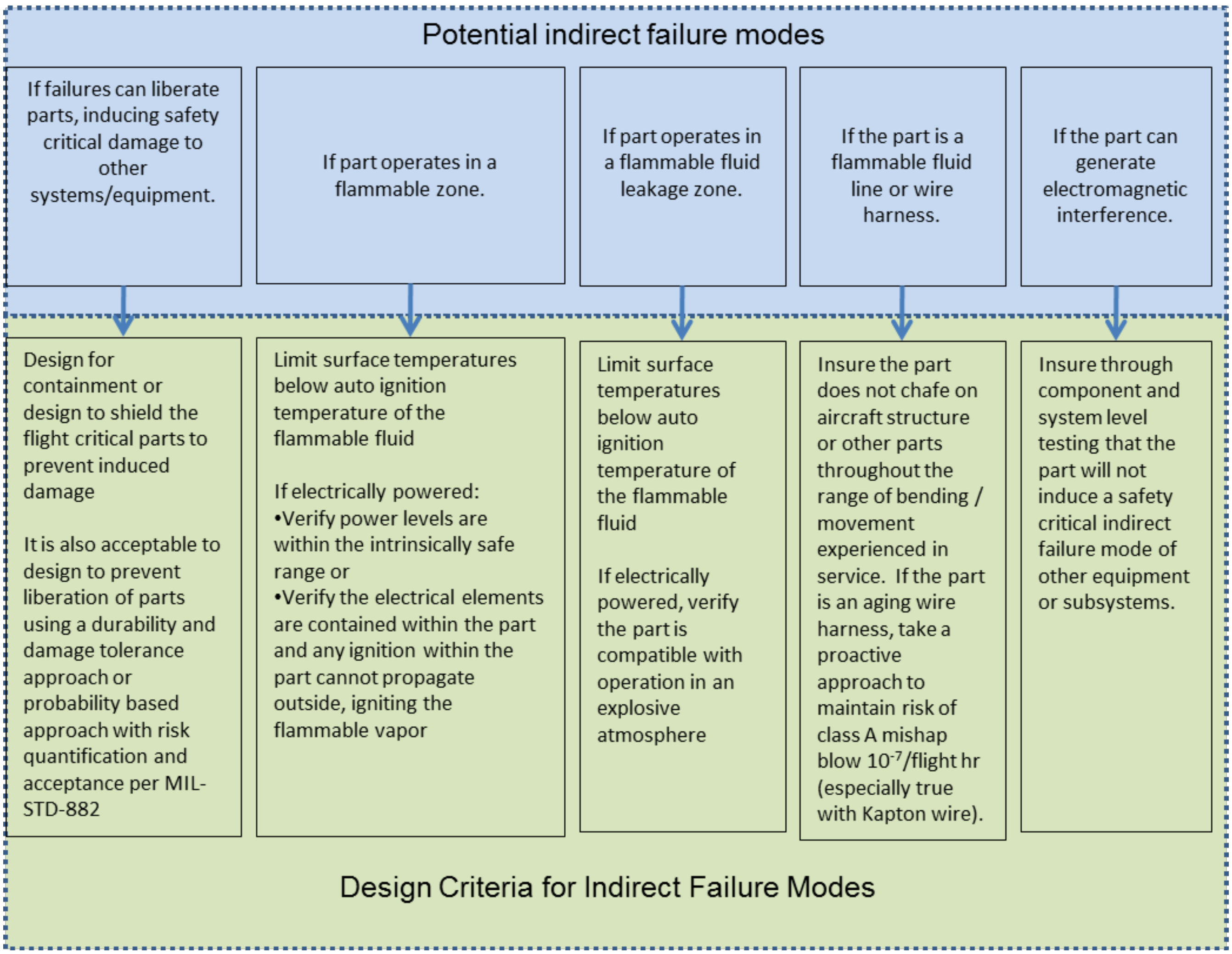

FIGURE 3. Indirect failure modes.

5.2.12.3.1 Uncontained failure control.

This refers to any failure which liberates parts which can do damage to flight-safety critical parts. Most commonly these are high-speed rotating parts, but it also can include pressure vessels and tires. For parts such as these, containment is the most common design criteria to control the hazard. In some cases it may be more advantageous to provide shielding to safety-critical components to prevent damage. For pressure vessels, a leak-before-burst or proof pressure direct failure mode approach is most commonly used design criteria, but containment or shielding can also provide adequate control.

5.2.12.3.2 Components operating in a flammable zone.

For components operating in a flammable zone (e.g., inside a fuel tank), surface temperatures shall be maintained under all conditions (including failure conditions) to less than the auto-ignition temperature of the flammable fluid. If the part is electrically powered: verify power levels are within the intrinsically safe range and/or verify the electrical elements are contained within the part and any ignition within the part cannot propagate outside, igniting the flammable vapor.

5.2.12.3.3 Components operating in a flammable fluid leakage zone.

For components operating in a flammable fluid leakage zone (e.g., drybay next to a fuel tank), surface temperatures shall be maintained under all conditions (including failure conditions) to less than the auto ignition temperature of the flammable fluid. If the part is electrically powered: verify the part is compatible with operation in an explosive atmosphere.

5.2.12.3.4 Flammable fluid carrying line and wire harnesses.

Insure the line/wire harness does not chafe on aircraft structure or other components throughout the range of bending/movement experienced in service.

5.2.12.3.5 Electromagnetic compatibility.

Insure through component level and system level testing that equipment installed on the aircraft will not induce safety-critical failures of other equipment or systems due to electromagnetic interference.

5.2.13 Aerospace castings.

The USAF has experienced numerous problems when castings are utilized in lieu of forged or machined parts. When castings are used (either in the original design or as a replacement part), 5.2.13.1 and 5.2.13.2 apply.

5.2.13.1 Casting requirements.

Castings shall be classified and inspected in accordance with SAE AMS2175. Structural castings shall be procured to guaranteed property, premium quality specifications such as SAE AMS-A-21180, AMS5343E, or equivalent. Design criteria shall be governed by the Joint Service Specification Guide for Aircraft Structures, JSSG-2006.

5.2.13.2 Guidelines for digital radiography (DR) inspections of castings.

Digital radiography inspection systems are not “drop in” replacements for film radiography. Structures Bulletin EN-SB-12-001 identifies the procedure to follow to authorize use of DR inspections for castings.

5.2.14 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 shall be included in the MECSIP Master Plan.

5.2.15 Electrical Wiring Interconnect System (EWIS) Design Actions, Task One. (See EWIS MIL-HDBK-525 for more details.)

Document overall EWIS and identify critical circuit paths and functions (AS50881, AC 25-27A, AC 25.1701-1, and AC 25.1309-1A)

a. Identify EWIS components and materials and all power and signal paths and conduct a functional hazard analysis;

b. Document wiring configuration and circuit schematics and functions;

c. Document physical wire routing throughout the aircraft;

d. Conduct an aircraft functional hazard analysis of EWIS failure modes, effects and criticality analysis (FMECA) (AC 25.1701-1);

e. Document EWIS components and characteristics such as installation and separation;

f. Identify catastrophic failure modes and mechanisms in critical EWIS components; and

g. Identify physical failures of the EWIS that can cause damage to co-located EWIS or surrounding systems, structural elements, or injury to personnel.

5.2.16 Product Integrity Control Plan.

The contractor shall implement special controls to ensure the required integrity characteristics of safety-critical parts throughout production and sustainment is achieved/maintained. Additional candidates for specialized controls are parts classified as mission-critical, durability-critical, and items which have hidden failure modes. Specialized controls may be required for materials, processes, manufacturing, quality, nondestructive inspection, corrosion prevention, etc. The Product Integrity Control Plan shall be a living document. The initial version will be submitted in Task II, and updated in each successive MECSIP Task. As a minimum, the Product Integrity Control Plan shall include:

a. The critical parts list and selection rationale;

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

c. Procedures to identify special provisions on the part drawings;

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

e. Acceptance/proof tests for individual parts, as required;

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

g. Requirements for material/part traceability for parts which require special processing and fabrication operations; and

h. All vendor and supplier controls for these items.

Economic trade studies shall be conducted to ensure the effective application, 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 Procuring Activity approval.

5.2.17 Identify Technical needs (Task II).

MECSIP Managers shall make a listing of Technical Needs encountered on an annual basis. A compiled list, from all programs, will be discussed/finalized at the MECSIP Technical Interchange Meeting and submitted into the Service-specific Research Laboratory as candidate developmental Technical Needs.

5.2.18 Update the MECSIP Master Plan.

In addition to updates to any information which has changed since the previous submission, add the following:

a. List the classification for each MECSIP Component.

b. Controls planned for all components that will not be allowed to fail in-service (including the safety analysis if a Risk Based Approach was used).

c. Where applicable, identify the technical, and logistical, rationale for selecting a design service life that is most practical.

d. Identify the time-phased scheduling and integration of system development tasks which support performance and integrity requirements for the equipment being acquired.

e. The Corrosion Prevention and Control Plan (Reference 5.2.1.)

f. The Environmental Emissions analysis (Reference 5.2.2.)

g. Identification of physical and operational interfaces (Reference 5.2.3.)

h. Design Service Life Usage (Reference 5.2.4.)

i. Supportability planning (Reference 5.2.5.)

j. Identify environmental and usage parameters for PHM that affect service life. (Reference 5.2.6.)

k. Failure Modes Effects and Criticality Analysis (Reference 5.2.7.)

l. Hazard Analysis (Reference 5.2.8.)

m. Product Integrity Control Plan (Reference 5.2.16.)

5.3 (Task III) Design Analyses and Development Tests.

Analyses and development tests shall be performed to support the Design Control 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. Development analysis and test shall address all appropriate natural and induced environmental conditions to which the equipment will be exposed in service.

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 components 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. The timing of this assessment should be after the Program Office is satisfied the specific component design is stable.

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 and tests.

These analyses shall be conducted to determine the steady-state and transient thermal environments for individual elements of the system. This analysis will subdivide the aircraft into zones exposed to the same environment (both natural and induced). Then specific environmental extremes for both operating and withstanding will be defined. Environmental conditions to consider include all those environmental conditions addressed by MIL-STD-810. These natural and induced environments shall be used in the design, analyses, and testing (e.g., strength, durability, damage tolerance, vibration/dynamics, corrosion resistance, 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.

Durability analyses shall be conducted on each MECSIP part classified as safety-, mission-, or durability-critical, for the planned service life of those components. The analysis is a risk reduction task to verify the design is likely to 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.

The durability analyses may consider the affects of scheduled maintenance. The analyses shall consider material variability, initial manufacturing quality, and functional limits for each critical failure mode. Components shall be designed and analyzed using appropriate factors, to account for variations in material properties, processes, manufacturing, etc. A minimum factor of four times the required service life using nominal properties, tolerances, etc., will be applied for safety-critical mechanical components. Mission- and durability-critical components shall use a minimum factor of twice the required service life. 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). 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, for all parts using a damage tolerance design approach, to substantiate the ability of the identified 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.

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. There inspections are necessary up to the point 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 shall establish that the required residual strength of the remaining intact component 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 and repaired prior to the failure of the remaining intact component 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 shall be accomplished to support the concept of proof testing. The analysis shall demonstrate that when the component is subjected to proof test conditions, the probably of undetected defects that would lead to failure is improbable per AWB-013 and NAVAIRINST 5000.21B. Proof tests shall then be performed on each production component to effectively demonstrate that the component is damage tolerant.

5.3.2.8 Risk-based analyses.

When a design concept (reference 5.2.12.2) is utilized to minimize risk for safety-critical failures, a Hazard Risk Index (HRI) shall be computed in accordance with MIL-STD-882, AWB-013, and NAVAIRINST 5000.21B. MECSIP requires that the resultant risk of safety-critical failure must be in the improbable range per AWB-013 and NAVAIRINST 5000.21B.

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 components 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 on the test hardware as the production hardware.

Existing data obtained from literature sources or previous Program experiences may be used. However, for safety- mission- and/or durability-critical component application (see 5.2.10), these properties shall be verified using specimens fabricated from actual parts, as required.

Materials for safety- and/or mission-critical systems and components (see 5.2.10) 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 Flight Control Systems analysis and test.

The flight control system is a particularly critical system within the MECSIP, consequently it will utilize those design and modeling techniques which have historically proven successful in providing robust, safe flight control hardware/software designs. Many of these techniques, although targeted to flight control system application, can be utilized in other subsystems.

5.3.4.1 Dynamic modeling (flight control).

Analyses techniques using dynamic performance models shall be developed for all mechanical and electrical controls and flight 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 in the MECSIP Master Plan. 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 (flight control).

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, reversionary control modes, redundancy management and their associated impacts on Level I and II flying qualities.

5.3.4.3 Stability and response (flight control).

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 (flight control).

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 components 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 (both direct and indirect damage).

5.3.6 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 Abnormal operation design margin.

Analyses of all safety- critical controls and 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.

5.3.8 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).

A database that can grow with the program to form the basis of the component/subsystem reliability tracking system shall be used. This database will grow into the “Functional Systems Integrated Database (FSID)” in Task V of MECSIP (see 5.5.2).

5.3.8.1 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.

5.3.8.2 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.

5.3.8.3 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 in the MECSIP Master Plan.

5.3.8.4 Equipment Prognostic Health Monitoring (PHM) systems.

The effectiveness of PHM systems (reference 5.2.6, Prognostic Health Monitoring planning.) shall be evaluated during component development and test. Equipment PHM 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.

5.3.8.5 Obtain Original Equipment Manufacturer (OEM) data.

Obtain information from each OEM regarding recommended preventative maintenance tasks/intervals and time changes along with the technical data/analysis supporting those recommendations (reference 5.1.5). Retain the original data for future reference and include the recommendations in the weapon system maintenance publications. This data should be retained for reference for the life of the weapon system.

5.3.9 Flight Manual.

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

5.3.10 Create Work Unit Code (WUC) Manual.

This manual must have a five-digit code for each component being monitored and the nomenclature must be in the language the technicians use (English for DoD technicians). When a component is to be time changed, serially tracked, or warranted, (i.e., in particular a safety- or mission-critical component) it will be identified with a special letter or asterisk.

5.3.11 Identify Technical Needs (Task III).

MECSIP Managers shall make a listing of Technical Needs encountered on an annual basis. A compiled list, from all programs, will be discussed/finalized at the MECSIP Technical Interchange Meeting and submitted into the Service-specific Research Laboratory as candidate developmental Technical Needs.

5.3.12 Update MECSIP Master Plan.

Update MECSIP Documents based on information learned during the analysis phase. Update any existing information which changed during Task 3 plus add:

a. OEM maintenance recommendations

b. Thermal/environmental analyses. (Reference 5.3.2.4, zoning of compartments.)

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, 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 components

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.

Safety-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 MECSIP component shall demonstrate compliance to its requirements through a combination of the following: analysis; demonstration, inspection, similarity and/or test. Testing includes both component qualification test and component bench test. 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 MECSIP safety-, mission- and durability-critical 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 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.

5.4.11 Durability testing.

For each component identified in 5.2.12 to have a maintenance free operating time, a test program shall be conducted to substantiate the overall durability of those 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. For components with periodic maintenance required to meet the installed life requirement, that maintenance shall be performed at the scheduled intervals during test.

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/or 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. Test loadings shall be combined with environmental degraders, where appropriate, to simulate actual usage (e.g., cycles with dust immersion). 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 components shall be re-analyzed and appropriate corrective actions taken.

5.4.12 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.

5.4.13 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 test and analysis shall be adequate 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 (the number of lifetimes analyzed/tested is a function of the material used—typical values used for damage tolerance evaluation are four lifetimes via analysis with testing to demonstrate two lifetimes) necessary to gain high confidence that the component will achieve one lifetime of service.

5.4.14 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.

5.4.15 Overspeed/overtemperature tests of rotating parts.

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.

5.4.16 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.

5.4.17 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.

5.4.18 Evaluation and interpretation of ground 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.

5.4.19 Evaluation and interpretation of flight test results.

Thorough, instrumented flight tests shall be planned and conducted for each subsystem with at least one safety-critical function. A careful review of the test results is critical to verify the system responds in the manner predicted by analysis as well as verification of specific performance and safety of flight requirements. A build-up approach is typically used to safely conduct the flight test evaluations. Following each build-up test point the data is evaluated to determine if the system is behaving as predicted by the analysis. This approach allows detection of potential flight-safety critical anomalies before operating in the region of the flight envelop where those anomalies may present themselves.

5.4.20 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).

5.4.21 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 approval from the Procuring Activity.

5.4.22 Maintenance planning and task development.

Required maintenance actions (e.g., inspection, repair, or replacement) shall be developed and demonstrated 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 5.4.21. 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 approval from the Procuring Activity.

5.4.23 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 Task III shall be revised to account for differences revealed between analysis and test. The certification analyses are an important engineering source data for 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.

5.4.24 Identify technical needs (Task IV).

MECSIP Managers shall make a listing of Technical Needs encountered on an annual basis. A compiled list, from all programs, will be discussed/finalized at the MECSIP Technical Interchange Meeting and submitted into the Service-specific Research Laboratory as candidate developmental Technical Needs.

5.4.25 Update MECSIP documents (including the MECSIP Master Plan).

Update MECSIP documents based on information learned during the test phase plus any other information which changed since the previous update.

5.5 (Task V, Sustainment) 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:

a. update and maintain the MECSIP Master Plan as necessary to reflect the needs associated with sustainment;

b. establish and monitor a component tracking program ;

c. establish preventive maintenance actions;

d. establish repair/overhaul procedures;

e. establish inspection criteria;

f. update and maintain FMECA and HA reports; and

g. establish appropriate life limits for all safety-critical components.

It will be easier to comply with MECSIP Force Management tasks if the program enters the sustainment phase with a robust execution of MECSIP Tasks I through IV, but completing Tasks I through IV is not essential for a successful MECSIP sustainment program. Many aircraft programs will initiate their MECSIP Programs in the sustainment phase.

TABLE I. MECSIP Tasks.

SUBTASK 1	SUBTASK 2	SUBTASK 3	SUBTASK 4	SUBTASK 5
Data Gathering and Task Planning	Develop and Utilize a Functional Systems Integrated Database	Force Management Execution	Preventative Maintenance Actions	Manage Service Life Extention and Final Five Years Prior to Retirement
1. Establish a Systems Reliability Analyses Team (RAT) to assist in administration of sustainment efforts. 2. Establish the sustainment philosophy. 3. Gather OEM available maintenance data. 4. Update/Generate FMECAs and HAs. 5. Execute EWIS Task 1. 6. Review available data and: a. Identify safety-critical components b. Identify mission-critical components. 7. Review the maintenance publications for all inspection requirements. 8. Review the Work Unit Code (WUC) Manual for accuracy. 9. Review time change requirements. 10. Verify technical data for both on- and off-equipment repairs/ overhauls is available and current. 11. Determine Maintenance Data Collection system requirements. 12. Establish PQDR procedures. 13. Equipment manufacturing and integration. 14. Develop a Cost of Unreliability Model. 15. Include MECSIP in the overall aircraft maintenance program.	1. Design a tracking and monitoring program: a. Develop safety- and mission-critical component inspection and/or replacement interval. b. Develop component MAP levels. c. Develop a program to identify items not reaching the MAP (alerts). d. Facilitate Engineering to communicate with Field personnel. e. Develop inspection tracking programs. f. Develop a tail number part tracking program. g. Develop a system to track enroute/ deployed system reliability. h. Develop a program to track MICAP hours assessed to each component. i. Develop a program to track CANNs on each component. j. Develop a program to identify and monitor MSI components. k. Develop a program to identify each component contribution to NMC status. l. Develop a program to identify components causing air aborts. m. Develop a computerized Preview and In-depth Analysis Program. n. 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. WUC Manual b. Scheduled inspection requirements and replacement schedule c. Time changes d. Inspection work cards e. PDM requirements. 3. Monitor mishaps, Hazard Reports (HAZREPs), and deficiency reports for applicability to MECSIP-controlled components. 4. Monitor data integrity. 5. Risk Assessments 6. Perform analysis: a. Preview b. In-depth c. Analytical Condition Inspection d. Equipment usage and environments. 7. Manage Safety- and Mission-Critical Components. 8. Manage Durability-Critical Components. 9. Manage Durability-Noncritical/Expendable Components. 10. Develop new MECSIP parts: a. Follow MECSIP development tasks; b. Update FMECAs and HAs; c. Replacement of obsolete equipment; d. Environmental regulations; e. Update the Safety-Critical Component list. 11. CDA/CLS tasks 12. Identify Technical needs for enhanced execution of the MECSIP Program.	1. Perform RCM/MSG-3 analysis and implement preventative maintenance actions as indicated: a. Lubrication or servicing for the purpose of maintaining inherent design capabilities; or, b. Additional operational checks to a task to determine if 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 ranging 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 actions listed, above. 2. Include periodic checks of all safety-critical emergency backup systems in the maintenance program. 3. Develop a program for routine health assessment of the EWIS.	1. MECSIP considerations for a Service Life Extenstion Program 2. Execute an EWIS program to maintain integrity of the electrical wiring interconnect system. 3. Establish an IPT with MAJCOMs, SOR, DLA, Wing Office, and AMARG to determine the most effective course of actions to take for: a. Supply b. Maintenance. 4. Establish communication with a liaison at each primary Base to assist the group Engineering team. 5. Establish special procedures with MAJCOMs to allow the Wing Office to initiate lifetime procurement of components and spare parts for future requirements. 6. Establish procedures with Item Managers to use the components and spare parts located at AMARG effectively. 7. Establish special procedures with DLA to allow all weapon-specific parts to be exempt from "excess" status.

5.5.1 Subtask 1: Data gathering and task planning.

This group of tasks is necessary when no previous MECSIP Program existed. These tasks should already be complete if a robust MECSIP Program was in place during the development phase.

5.5.1.1 Establish a Reliability Analyses Team (RAT).

The Program Office shall establish a RAT within the Engineering department to analyze field reliability, maintainability and availability metrics. (The next three sentences apply only to USAF programs: 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 will typically designate 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 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 typically be Worldwide Web-based and only be available on the secure military network. The program shall track and provide alert monitoring for all safety- and mission-critical components. Recommended metrics for monitoring are as follow:

a. identify serially-tracked components;
b. confirm that inspection and replacement intervals and life limits for all safety- and mission-critical components is current and documented in the appropriate technical orders;
c. monitor the MTBF for all safety- and mission-critical components;
d. list the “Top Ten” for each of the following categories: economic, maintenance, and supply Not Mission Capable (NMC) components;
e. provide a method to perform Preview and in-depth analysis;
f. provide a tail number management system;
g. monitor the CANNs for each Work Unit Code (WUC);
h. monitor the Mission Impaired Capability, Awaiting Parts (MICAPs) for each WUC;
i. monitor findings at scheduled inspections;
j. monitor the enroute and/or deployed base component failures;
k. monitor aborts by WUC;
l. provide an electronic bulletin board for each shop to improve communications;
m. provide a program to assist in performing risk assessments and failure modes evaluations; and
n. monitor PHM sensors and track trends in real time.

5.5.1.2 Establish the sustainment philosophy (e.g., preventative maintenance).

The MECSIP Team shall establish the sustainment philosophy for every MECSIP system component. Some weapon platforms are utilized 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 (reference 5.5.3.6.1) shall be performed to determine the functions of the components or systems and identify trends. In-depth analysis (reference 5.5.3.6.2) may be performed on key failure modes within selected components and systems. The in-depth analysis will include FMECA and risk assessments to ascertain the severity and rate 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 comparison of the available options. If an option is not immediately available (e.g., redesign, new technology), a cost-benefit analysis should be performed to compare the current available options potential future options to determine the optimum solution. 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 the appropriate maintenance publications. The Cost of Unreliability Model (reference 5.5.1.12) will be useful in evaluating the impact of aircraft downtime and reliability.

5.5.1.3 Gather available maintenance data and design information.

All OEM required maintenance actions shall be incorporated into the appropriate maintenance publications, except in cases where analysis/experience demonstrates a better approach. The OEM typically provides the initial design and testing information for weapon systems. Most drawings and manufacturing specifications can be accessed by qualified users through the Joint Engineering Data Management Information and Control System (JEDMICS) at www.jedmics.net.

5.5.1.3.1 Update or Generate Failure Mode Effects and Criticality Analysis (FMECA).

If FMECA reports are missing or out of date, those reports shall be updated or generated. The existence of FMECAs for all MECSIP Equipment is the essential first element in both component classification and application of Reliability-Centered Maintenance. It is acceptable to perform a top down System Level FMECA when generating FMECAs during the sustainment phase of a program. The system-level FMECA is initiated by identifying the functional blocks containing high risk components. These blocks are then analyzed in more detail. The FMECA results will allow the MECSIP team to classify components for criticality per 5.2.10, Component classification). During the sustainment phase, the MECSIP manager shall insure safety- and mission-critical components are identified.

5.5.1.3.2 Generate Hazard Analysis (HA).

If HA reports are missing or outdated, those reports shall be regenerated. The existence of a HA for each MECSIP system is necessary for part classification (per 5.2.10, Component classification) .

5.5.1.3.3 Execute EWIS Task 1 - Document overall EWIS and identify critical circuit paths and functions.

Execute 5.2.15 if not accomplished.

5.5.1.4 Classify MECSIP components for criticality.

All MECSIP safety- and mission-critical parts shall be classified for criticality, utilizing the procedures in 5.2.9. The outputs from the FMECA, functional hazard analysis, and hazard analysis (HA) shall be utilized per 5.2.9 to identify all safety- and mission-critical MECSIP components. 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 when appropriate. All safety-critical components shall be serialized and have their usage tracked. All safety-critical components shall be assigned a life-limit based on the original certification testing. Safety-critical components shall not be allowed to fail in service. The MECSIP Manager shall coordinate with depot and supply sources regarding implementation of serialization and serialized management of parts (newly developed versus newly procured). Specific controls utilized to prevent in-service failures of each safety-critical part shall be identified.

5.5.1.5 Review the aircraft scheduled inspection and maintenance tasks (for USAF aircraft these are found in the Dash 6 TOs).

The Program Office shall review the technical manuals for all inspection requirements on MECSIP equipment. These technical manuals shall: 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 for USAF programs); 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. 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 shall be reviewed during the annual Product Improvement Working Group (PIWG) meeting. (NOTE: The MECSIP Manager should attend the annual PIWG meeting for his/her weapon system.) The Historical Documents section lists all items which require an entry into the aircraft forms (AFTO Form 95 for USAF aircraft), 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 shall 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.

5.5.1.6 Review WUC Manual.

The WUC Manual shall be reviewed/updated at a frequency not to exceed five years. 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, is under warranty, has a scheduled time change, or requires special handing. Updating the WUC is the first step in accurate historical database maintenance.

5.5.1.7 Review Time Change Items (TCIs).

All TCIs shall be reviewed to ensure they meet time change criteria and that the correct replacement schedule is being administered. 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:

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.

5.5.1.8 Verify Technical Data for both on- and off-equipment repair/overhaul is available and current.

The Program Office shall verify that each safety-, mission- and reliability-critical components have both a Job Guide procedure (for on-equipment maintenance) and a commodity publication (for off-equipment maintenance) for repair and overhaul procedures. If unavailable, the OEM and/or Equipment Specialist (ES) shall establish the appropriate technical data 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.

5.5.1.9 Determine maintenance data requirements.

The program shall identify maintenance data system/requirements appropriate for metrics to facilitate management of MECSIP equipment in the sustainment phase. 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.

5.5.1.10 Establish Product Quality Deficiency Reporting (PQDR) procedures.

The program shall establish PQDR procedures (USAF see Technical Order 00-35D-54) and shall evaluate the all PQDR reports to identify trends and understand root cause of failure. Overhauled components should remain serviceable for a predetermined amount of time and/or flying hours. When a component fails to meet any of the PQDR requirements, a deficiency occurs. Maintenance should document defective parts with a PQDR when the criteria identified in 5.5.2.14 is encountered.

5.5.1.11 Equipment manufacturing and integration.

This requirement only applies to safety-critical components. The Program Office shall review the engineering and manufacturing plans to verify they are adequate to consistently produce components with the required attributes to insure safety in operation. All changes to the components and/or process to fabricate safety-critical components shall also be reviewed to verify integrity is maintained. Such changes shall only be implemented upon approval from the Cognizant Engineering Authority.

5.5.1.12 Cost of unreliability model.

The Program Office should consider developing 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. The 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. A simple "payback period" is identified by dividing the yearly savings due to improved reliability by the cost to implement the change. This is a powerful tool to evaluate R&M-type improvements in competition for limited funds to obtain the most cost-effective solutions. The MECSIP Technical Advisor in AFLCMC/EN - EZ at AFLCMC.EZF.Mailbox@wpafb.af.mil will provide a generic model, upon request.

5.5.1.13 Include MECSIP in the overall aircraft maintenance program.

It is recommended that Program Offices develop an overarching maintenance plan of which the MECSIP tasks are one element. The goal of this overarching maintenance plan is to achieve and continually improve aviation material readiness and safety standards, with optimum use of manpower, material, facilities, and funds. The Naval Aviation Maintenance Program (reference COMNAVAIRFORINST 4790.2B) provides specific guidance for structuring an overall aircraft maintenance program.

5.5.2 Subtask 2: Develop and utilize a Functional Systems Integrated Database (FSID).

This task is intended to build on the FSID is already in existence per 5.3.8. If a FSID does not already exist, the Program Office shall develop the FSID. If it is necessary to develop a new FSID, consideration should be given to utilization of the C-5 Program FSID database shell as a model (USAF owns the rights to this database). NOTE: Unique information system solutions should not be constructed for Program requirements without first ensuring a Department of Defense or Service-level (i.e., USAF, USN) 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. Configuration management is a major constituent of life management and OSS&E. The ability to track individual items during use plays a direct role in the fidelity of life management. New ways of collecting data to populate the FSID are often not required. The FSID typically needs only incorporate data from existing data collection systems.

5.5.2.1 Component inspection and/or replacement interval.

All safety-critical components shall be managed to preclude safety-critical in-flight failures, using either a damage tolerance or a risk-based approach. MECSIP encourages use of this same approach for mission-critical components; however, if an economic analysis does not justify the cost of implementing life limits and tracking mission-critical components, it is permissible to "fly to failure".

5.5.2.2 Component Minimum Acceptable Performance (MAP) levels.

The Program Office shall define component MAP levels for all safety-, mission- critical components. The program may want to also include MAPs for durability-critical parts. The MAP is derived by using MTBF data collected over many years (typically a minimum of three years of MTBF data is needed for the determination of MAP to be effective) . The MECSIP Manager determines the minimum MTBF each component is expected to achieve. This number becomes the MAP and can be adjusted up or down, based on experience gained in MECSIP execution and at the discretion of the MECSIP Manager. The WUC associated with each safety- and mission-critical components shall 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.

The FSID 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 critical components analysis, classification and on current data. The MECSIP Manager should rely on the Material Deficiency Report/Quality Deficiency Report system for alerts for periods preceding the collection of MTBF data.

5.5.2.3 Identify items which fail to meet the MAP (alerts).

The Program Office shall develop a program which automatically provides an alert for any safety-, or mission- critical 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 shall measure reliability at the 18-month MTBF mark. 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, the most recent 5 (or more) years of data shall be compiled and used to show trends. If the data is susceptible to season variations, use a 12-month (or 4 quarter) rolling average approach. 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.

5.5.2.4 Facilitate Engineering communication with Field personnel.

The Program Office shall 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. The Internet address shall only be available to Mil-Net users and shall be secure (HTTPS).

5.5.2.5 Develop a Scheduled Inspection (e.g., HSC and ISO) Tracking Program.

The Program Office shall develop a Scheduled Inspection Tracking Program(SITP). Isochronal Inspections are the biggest expenditure of unit funds and visibility into the discrepancies discovered from one ISO to the next are not readily available to the Field shops and Program Engineering. Each Base will enter their ISO and HSC data into the MDC system. The SITP shall list the "Top Twenty" WUCs for the components which require the most maintenance. The SITP shall display individual aircraft tail number data and list the last five inspections on a common display screen. All discrepancy data found during a scheduled inspection shall be stored in the system indefinitely. The Program shall display the last five discrepancies for each tail number and display a "Top Twenty" WUC chart for the worst performers.

5.5.2.6 Develop a tail number part tracking program for serial-number-controlled parts.

The Program Office shall develop a tail number part tracking program for serial-number-controlled parts. The tail number part-tracking shall 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 as 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 life limited part using serial tracking, and history of major repairs for each aircraft.

5.5.2.7 Develop a system to track enroute and/or deployed system reliability.

The Program Office shall develop a system to track the discrepancies at the enroute/deployed 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).

5.5.2.8 Develop a program to track MICAP hours assessed to each component.

The Program Office shall develop a program to track Mission Impaired Capability, Awaiting Parts (MICAP) data. The system should capture this data and display it by MICAP hours and number of aircraft disabled for *X* amount of days.

A MICAP 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.

5.5.2.9 Develop a program to capture CANN actions by WUC.

The Program Office shall develop a program to capture CANN actions by WUC. This aids in understanding the “whole picture” for each component.

5.5.2.10 Develop a program to identify and monitor MSIs.

The Program Office shall 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 (see section 3 for complete definition). The Program shall collect data and recommend candidates for inclusion in the MSI listing during PIWG meetings. The Program shall 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 shall be classified as “MSI” and serially tracked. Components discovered to have a major impact on operational reliability or maintenance resources shall be compiled 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 for USAF programs, the -06 WUC Manual shall be annotated to alert Maintenance; and the -6, Special Inspections Technical Order, shall be annotated to require an AFTO Form 95 Historical Document. Additionally, each item shall receive a risk assessment (AFPAM 90-902), which includes a FMECA.

5.5.2.11 Develop a program to identify component contribution to 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. Program Office shall develop a program to understand which components contribute most to "NMC" status. This shall be done for NMCS, NMCM and NMCB. 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 stored/analyzed using the FSID.

5.5.2.12 Develop a program to identify components causing aborts.

The Program Office shall develop a program to identify components causing aborts. Aborts occur when a component critical to flight has failed. The system shall capture the abort data and store it by WUC. If significant negative trends develop, the components causing those trends shall be placed on the MSI listing.

5.5.2.13 Develop a preview and in-depth analysis program.

The Program Office shall develop a computerized preview and in-depth analysis program. Use of these analysis programs will typically be triggered by a MAP alert or a significant NMC level. 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 shall be performed.

5.5.2.14 Develop a program to identify "Bad Actors."

The Program Office shall 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 (USAF see TO 00-20-1 TO 00-35D-54). The Program shall submit a listing of selected MSI components for possible submission to the Bad Actor Program. Selected WUCs will be documented and serially tracked, assigned a Configured End Item (CEI) number, and be assigned the appropriate form 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. 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.

5.5.2.15 EWIS Task Two – Develop a program for routine health assessment of Electrical Wiring Interconnect System (EWIS).

The Program Office shall develop a program to perform routine health assessments of the aircraft Electrical Wiring Interconnect System (EWIS). The 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 shall 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 shall 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 shall use this analysis to program appropriate corrective actions (replacement, modification, special training, increased inspection, etc.) to improve reliability and avoid catastrophic failures. See the EWIS Integrity Program MIL-HDBK-525 for more detailed information.

a. Collect and analyze EWIS failure and maintenance data.

b. Document how the aircraft EWIS failure and maintenance data is collected and analyzed.

c. Review and assess mishap and maintenance databases and applicable Airworthiness Directives related to EWIS.

d. Seek input from maintenance and commodity engineering support staff.

e. Examine maintenance and failure data for wiring chafing, broken wires, arcing, burned wiring, electrical fires, electrical insulation dielectric failure, and corrosion. Search electrical bonding, fiber optics, connectors, relays, switches, circuit breakers, distribution panels and other EWIS components that may exist in the system under review.

f. Review findings, maintenance actions, discrepancies and repairs carried out as part of mandatory or voluntary inspections.

g. Organize data by zone/station, and rate and seriousness of failure.

5.5.3 Subtask 3: Force Management Execution.

Force management is a roadmap on how the fleet’s components will be managed. Generally it will require more than one tracking feature (metric) to initiate an investigation. The RAT will be responsible for monitoring each component’s status.

5.5.3.1 Component repairs and overhauls.

The Program Office shall monitor component repairs and overhauls. To accomplish this requirement, the MECSIP Team will need to develop good communication with depot personnel involved in overhaul and repair of MECSIP equipment, as well as field maintenance personnel. Factors for each WUC tracked in the FSID (displayed on a single screen with monthly updates) which help the MECSIP team identify problem areas include:

a. 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. Of particular importance, when a mission-critical component which performs part of a redundant flight-critical function falls below the MAP the MECSIP manager shall determine if the risk of loss of the flight-critical function is in the unacceptable range (greater than 10E-7 per flight hour) and take appropriate action if the risk is unacceptable.

b. 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.

c. Findings during Scheduled Inspections – All findings during scheduled inspections should be stored in the system indefinitely. Display the last five discrepancies for each tail number and display a "Top Ten" WUC chart for the worst performers.

d. Mission Impaired Capability, Awaiting Parts (MICAP) – This metric is used by the MECSIP Manager to identify those parts where the supply or distribution of spares is impacting aircraft availability. The responsibility for generating and tracking MICAP normally rests outside MECSIP, and it is not the intent of MIL-STD-1798C for MECSIP to assume the responsibility for generating this data. Rather, it is understood that MECSIP can benefit through the data supplied by those generating MICAP data. It is recommended that the MECSIP Manager retrieve this data and track and analyze this data for MECSIP improvement opportunities."

e. Not Mission Capable rate (NMC) (S), (M), and (B) – Not Mission Capable is used by the MECSIP Program to indicate the discrepancy that prevents the aircraft from being Fully Mission Capable (FMC).

f. 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.

g. 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.

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

i. 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.

5.5.3.2 Monitor **component inspection and replacement criteria.**

The inspection requirements shall establish the equipment to be inspected, its inspection schedule, and its inspection and/or replacement criteria. Inspection and replacement criteria for safety- or mission-critical components shall be periodically evaluated to determine that it is still appropriate and is adequate to maintain the integrity and safety of this equipment. 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. The list of required inspections requires frequent updates 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).

5.5.3.2.1 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.

5.5.3.2.2 Scheduled inspection requirements and replacement schedule.

The Program Office shall establish scheduled inspections within the appropriate maintenance publications. These inspection requirements 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 “fly-to-fail” and will be replaced only when they fail a condition inspection. 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.

5.5.3.2.3 Time changes.

Once an item has met the requirements for time replacement**,** it must be periodically monitored to ensure the time schedule is still applicable. Safety- and mission-critical components 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.

5.5.3.2.4 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 maintenance/inspection work cards shall be reviewed periodically for accuracy especially for components classified as safety- or mission-critical. The frequency of review should be a function of the time in service. Newly deployed aircraft or aircraft with a significant mission change should hold work card reviews more frequently than aircraft with a long, stable service history. The maximum period between workcard reviews/updates shall not exceed five years.

5.5.3.2.5 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. Most condition assessments will be done during PDM.

Each safety- or mission-critical component entering the Depot shall have a Historical Record attached to the component or recorded against its serial number in a computer database. All maintenance actions shall be annotated on the form to assist in maintaining the reliability of the component. Components entering the Depot shall be overhauled and have the parts replaced, as required by the appropriate maintenance publication. If a part shortage occurs and a part that is listed for replacement during overhaul is not available, the cognizant engineering authority engineers may authorize the re-use of certain parts for one overhaul only. This shall be annotated on the Historical Record form. 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.

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. The MECSIP Manager, in concert with Engineering, is responsible for ensuring component reliability.

5.5.3.2.5.1 Overhaul of systems.

As systems are initially received for overhaul (first scheduled Depot maintenance), one or more lead-the-fleet (high time) components shall be selected for a complete disassembly and inspection. The criteria for selection of these components shall be significant maintenance drivers (NMC or MMH drivers are typically used) that have shown a tendency to degrade due to age on other similar applications. 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.

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.

5.5.3.2.5.2 Monitoring of repairs/overhauls.

The MECSIP Manager shall ensure serviceable items returned to Base supply have been “overhauled” or meet the intent of “overhaul.” It is the MECSIP engineer’s responsibility for parts which are not allowed to fail in service and are not planned to “fly to failure”, to ensure that any degradation in overall condition is acknowledged and accounted for in the overhaul process. Acknowledging and accounting for partially degraded components requires an Individual Aircraft Tracking (IAT), serialization, tracking of components, and monitoring of repairs.

To “overhaul” a component is to return it to a “like-new” condition. To “repair” a component is simply to make it serviceable. 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.

5.5.3.2.5.3 Depot-level check on organizational- and intermediate-level full and partial overhauls.

If a component is partially overhauled at the organizational or intermediate level, the component shall be returned to the Depot before the fourth overhaul to ensure the reliability continues to be met.

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 Requirements 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. The MECSIP Manager can also recommend establishment of 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 shall maintain 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.

5.5.3.2.5.4 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.

5.5.3.3 Monitor mishaps, HAZREPS and deficiency reports for applicability to MECSIP components.

The Program Office shall monitor mishaps, HAZREPS and deficiency reports for applicability to MECSIP components. If these reports apply to MECSIP components, the Program Office shall consider if the new information reveals the component classification to be more critical than previously understood. Where the classification moves to safety- or mission-critical, the Program Office shall take appropriate action, including those actions necessary to insure flight-critical component in-service failure rates do not exceed 1×10^{-7} per flight hour.

5.5.3.4 Monitor data integrity.

The Program Office shall monitor maintenance data integrity and emphasize its importance to making informed decisions to optimize aircraft safety and availability. Training classes shall 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 shall brief the importance of accurate data and identify preventive actions initiated by previously-submitted data.

5.5.3.5 Risk Assessments.

Risk decisions (acceptance of risk) for MECSIP equipment shall be made at a level of responsibility that corresponds to the degree of risk per MIL-STD-882. The Single Manager (SM) will provide a response to each SIB recommendation affecting MECSIP equipment, obtaining concurrence through the appropriate management level per MIL-STD-882 for that response.

5.5.3.6 Perform analysis.

It is essential to establish the extent to which the analysis shows there is potential 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. The Cost of Unreliability Model developed in 5.5.1.12 can be very helpful in this task.

5.5.3.6.1 Perform preview analysis.

The Program Office shall establish a process to perform a 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.

5.5.3.6.2 Perform in-depth analysis.

The Program Office shall establish a process to perform an in-depth analysis. If the Preview analysis indicates problems exist, then an in-depth analysis shall be performed. The RAT, Depot Overhaul Facility, or Contractor will perform most in-depth analyses. Before a group is selected to perform the analysis, the person requesting the analysis shall:

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; and

c. establish the funding, site, and personnel to perform the analysis; and decide when, where, and by whom the recommendation will be implemented.

5.5.3.6.3 Analytical Condition Inspections (ACIs).

The Program Office shall establish ACIs to monitor the condition of MECSIP equipment. The ACI Program shall be conducted throughout the life of the aircraft. Corrosion, fatigue, wear out, deterioration of polymers 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 to evaluate the effectiveness of prototype NDI and repair actions. The MECSIP Manager shall select safety- and mission-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 which have been identified in previous reports as possible contenders.

b. Develop inspection criteria. If no written criteria exist, develop the inspection criteria for each item identified as requiring inspection. Every item must be addressed, and the criteria assigned must involve 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.

5.5.3.6.4 Equipment usage and environments.

The usage and environments of safety- and mission-critical components shall 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 are different than expected, then maintenance, inspection, and replacement intervals shall be re-evaluated to determine when the equipment should be serviced, inspected, or replaced to maintain integrity and safety. 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. Two examples of this type of analysis are:

a. The T-38 Flight Load Data Recorder Program: the objective of the program is to develop maneuver spectra, stress spectra, and operational usage profiles for the T-38. Strain gages are installed at critical locations on the test aircraft to verify localized stress/strain conditions. This data will provide the baseline inputs for an update to the T-38 Component Tracking/Monitoring Program (CTMP). The T-38 CTMP is used to set inspection intervals for the fleet, providing an essential element for the safety of flight for each aircraft. At least 1000 hours of valid flight loads data will be collected, processed and analyzed. This program will create a usage assessment and a validation of localized stress/strains for critical components.

b. The KC-135 operators 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.

5.5.3.7 Manage Safety- and Mission-critical components.

Safety-critical components 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 the failure frequency falling within the improbable range per AWB-013 and NAVAIRINST 5000.21B. Where economically justified, mission-critical parts shall not be allowed to fail in service. Those safety- and mission-critical components with life limits shall be serialized and have their usage tracked.

5.5.3.8 Manage Durability-critical components.

Durability-critical items are classified in two groups, legacy and interfacing subsystems. If a service life extension is granted for the aircraft, legacy items shall be evaluated and deemed serviceable or a replacement program initiated. Interfacing subsystem components shall be replaced as a whole system or "system refurbishment" when replacement of one or more sections is required. Examples of Legacy and Interfacing subsystems follows:

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.

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 are a few examples of interfacing subsystems.

5.5.3.9 Manage Durability-noncritical/expendable components.

The failure of these items shall be handled during routine maintenance and will not impact mission, safety, or operational readiness.

5.5.3.10 Develop new MECSIP Parts.

Modifications to address evolving mission requirements, to correct safety deficiencies and/or to improve the overall reliability/maintainability of weapon system are common activities during the sustainment phase.

5.5.3.10.1 Follow MECSIP development tasks (Tasks I, II, III and IV).

Each modification is essentially a "mini" Engineering and Manufacturing Development (EMD) effort. The engineering organization that manages the modification shall follow all applicable sections of this MIL-STD Tasks I through IV in the development of the modification. Of particular importance is proper criticality classification of the components involved in the modification (reference 5.2.9).

5.5.3.10.2 Update FMECAs and HAs.

These documents shall be updated to address the effect of configuration changes on the failure modes and hazards, not only of the components changed but also of the components which interface with those modified components.

5.5.3.10.3 Replacement of obsolete equipment.

The Program Office shall evaluate if obsolete equipment should be replaced with newer technology or new versions of the existing technology. This analysis shall use comparative system data and the Cost of Unreliability Model (reference 5.5.1.12). Some older aircraft use antiquated equipment where replacement with newer technology may provide improved reliability and mission capable rates. 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.

5.5.3.10.4 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 (insert reference). 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.

5.5.3.10.5 Update the CSI list.

The CSI list shall be updated if the modification involves CSIs.

5.5.3.11 Tasks for Commercial Derivative Aircraft programs maintained via Contract Logistics Support (CDA/CLS).

Commercial Derivative Aircraft programs maintained via Contract Logistics Support (CDA/CLS) contain unique MECSIP Tasks. The subsystem design and aircraft maintenance plan for these aircraft are part of the FAA-certified baseline aircraft and the DoD accepts these as fundamentaly safe for operations within similar environments. In addition a CLS maintenance approach assigns the responsibility for achiving the desired level of availability to the contractor. When the DoD acquires a CDA and operates it as a military aircraft (with a military airworthiness certificate), it becomes a “Public Use Aircraft” and is exempt from mandatory FAR compliance and FAA oversight. However, the use and compliance of applicable FARs may be required by the specific service (as detailed by the AFI 21-101 for the USAF). As such, CDA are maintained as closely as possible to the FAA (airworthiness) type certificate requirements except for CDA whose primary mission is the transport of passengers. Commercial Derivative Aircraft whose primary mission is the transport of passengers shall be FAA type certified and maintained for the life of the air system.

5.5.3.11.1 Maintenance Planning Data (MPD) Document.

The Single Manager (SM) shall maintain or have access to a current copy of pertinent OEM MPD Document for reference. To support maintenance of the type certificate (which indicates the airplane will be maintained in a condition of airworthiness equal to its certified or properly altered condition), the aircraft manufacturer/OEM provides a MPD Document to operators. The MPD includes both FAA mandatory requirements and OEM recommended (non-mandated) requirements. Mandated tasks are the Certification Maintenance Requirements (CMRs) and Airworthiness Limitations. Other tasks originate from the Maintenance Review Board (MRB) report (which includes tasks derived through MSG analysis, RCM analysis, or other FAA-approved methodology), Service Actions, and other OEM information. The MPD will also address corrosion, structural fatigue/durability, and critical system/part reliability concerns.

5.5.3.11.2 CDA Maintenance Program.

The SM shall develop and sustain a customized scheduled maintenance program based on the applicable OEM MPD document. The purpose of the MPD document is to provide operators with data needed to develop a customized scheduled maintenance program. As such, CDA Program Offices accept the MPD document as the initial scheduled maintenance baseline (by which the FAA type certificate is maintained) and incorporate MPD tasks into a tailored scheduled maintenance program. FAA-mandated inspection requirements and inspection intervals are upheld for CDA and/or changes approved by FAA accordingly. MPD tasks not mandated by FAA are typically incorporated too because OEM’s recommendations usually represent best available, “initial” recommendations to optimize maintenance program for cost, reliability, maintainability, etc. With the exception of FAA mandated requirements (which includes MPD revisions and service actions), maintenance program task changes and adjustments are left up to the operator so that they may tailor tasks to their specific operation and/or improve them. Mandated requirements may also be adjusted but only to make more rigorous (to keep original inspection/interval requirement intact).

5.5.3.11.3 MPD revisions.

The Program Office shall review/evaluate MPD revisions which are periodically released from OEM, tailor as needed, and incorporate changes into maintenance program as appropriate. Some MPD revisions may not be applicable to CDA because maintenance program tailored and/or inspection item not applicable due to modification or applicable system/component not installed. Tailoring of MPD revisions will be IAW AFI 21-101 where FAA mandated inspection requirements and inspection intervals are upheld and/or changes approved by FAA accordingly.

5.5.3.11.4 Use of FAA Certified Mechanics.

To maintain FAA certificate specifications for CDA, the SM ensures that only FAA-certified repair stations or the original manufacturer perform contractual depot maintenance and use only FAA-certified commercial contractors for contract maintenance. DoD maintenance technicians and activities do not require FAA certification.

5.5.3.11.5 Service literature.

The SM receives, reviews/evaluates, and incorporates approved service actions accordingly, such as FAA Airworthiness Directives, original equipment manufacturer (OEM) service bulletins (SBs), and other service literature.

5.5.3.11.6 Service Difficulty Reports.

The SM shall participate in the FAA Service Difficulty Report program.

5.5.3.11.7 Usage monitoring.

The SM shall monitor usage of the weapon system ensure it is within the maintenance program usage parameters (e.g., 1000 FH per year) and flight constraints prescribed by pertinent aircraft flight manual. If usage thresholds exceeded or anticipated to be exceeded, the SM will adjust the maintenance program as necessary to maintain the FAA type certificate requirements. The SM shall consider use of calendar based time change for equipment on CDA with a FH based time change when the usage rate is much lower than the baseline commercial variant of the aircraft.

5.5.3.11.8 CDA Reliability Program.

The SM will establish and maintain a tailored reliability program. The FAA requires operators to develop a tailored reliability program or strategy to support the maintenance program. FAA recognizes maintenance program optimization is in the operator’s best interest (economically and operationally) and as such, FAA does not mandate specific reliability program requirements. Consequently, large fleet operators typically have an extensive reliability program in place where maintenance actions/discrepancies are documented, tracked, and analyzed in order to continuously optimize maintenance program/tasks throughout service life which improves customer satisfaction, fleet reliability, costs, etc. Tailored reliability program for small fleets (which includes most CDA) are typically not cost effective and/or may not provide statistically sufficient data; and so, an alternate program strategy is adopted such as more reliance on OEM or service literature for recommended changes based on fleet reports or other information gained from other operators.

5.5.3.11.9 CDA modifications.

When a new development effort is initiated on a CDA platform to meet emergent requirements, that new development effort shall be accomplished IAW the appropriate Service developmental processes (AFPD 62-6 and AFI 63-1201 for the USAF), and Tasks I through IV of this document (sections 5.1 through 5.4).

5.5.3.11.10 FAA support.

Because CDA are public aircraft and exempt from FAA oversight, FAA and representatives of the U.S. Armed Services created an Inter-Agency Memorandum of Agreement (MoA) and FAA Order 8110.101 to bridge the gap and allow U.S. Armed Services to leverage off the FAA and civil aerospace community to maintain type certificate requirements. In it, the FAA agreed to provide technical support, certification services, and continued airworthiness services for Military Commercial Derivative Aircraft (MCDA) through a dedicated Military Certification Office (MCO). The extent of FAA support depends upon whether the military's design, manufacturing, operational usage, and maintenance requirements are comparable to that of the civil sector or whether the military requirements differ significantly from civil applications. Under the MoA, FAA "Baseline Support Services" are centrally funded and apply when DoD and Coast Guard requirements are fundamentally the same as those in the civil sector. FAA "Program Support Services" apply when DoD or Coast Guard requirements are substantially different from the civil aircraft application. FAA "Program Support Services" are individually negotiated and funded by Program Offices and can vary widely between programs. Therefore, the MECSIP engineers need to understand the degree to which FAA support to a CDA program effectively satisfies military MECSIP Objectives, how to take best advantage of FAA approaches when they are provided, and how to address the situation when FAA approaches are not sufficient or available.

5.5.3.12 Identify Technical Needs (Sustainment Phase).

MECSIP Managers shall make a listing of Technical Requirements they have to enable improved safety or aircraft availability as it relates to MECSIP equipment. A compiled list, from all programs, will be discussed/finalized annually at the MECSIP Technical Interchange Meeting and submitted into the appropriate Service Research Laboratory as candidate Technical Needs.

5.5.4 Subtask 4: Preventative Mainenance Actions.

The preventive maintenance action should begin with a logic tree decision analysis and be implemented utilizing sound engineering judgement to balance scheduled preventative maintenance versus the risk and impact of unscheduled maintenance to correct a failure. It will be very useful to the MECSIP engineer to obtain the insight of an experienced maintainer in making these judgements. 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 preventative maintenance task to be performed, sound engineering judgement and input from experienced mechanics sould be considered to confirm the preventative maintenance task is appropriate.

5.5.4.1 Reliability Centered Maintance (RCM), Maintenance Steering Group -3 (MSG-3), CBM+, or equivalent analysis.

The Program Office shall conduct RCM, MSG-3, CBM+, or equivalent analysis to identify preventative maintenance to achieve the inherent reliability of equipment with the least expenditure of resources. (See DoDI 4151.22.) Reliability Centered Maintenance focuses on preventative maintenance as a means to avoid, reduce or eliminate the consequence of failures. Reliability Centered Maintenance concepts should be an integral part of equipment repair and overhaul task definitions. (Reference NAVAIR 00-25-403.) The preventive maintenance action should begin with a logic tree decision analysis. 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, the solution selected will best optimize:

a. Safety,
b. Cost,
c. Risk, and
d. Implementation time.

Guidance for how to perform RCMA is provided in NAVAIR 00-25-403 and DoD 4151.22-M.

Preventive maintenance actions include:

a. Any act of lubrication or servicing intended to maintain inherent design capabilities:
    1. Lubrication: A lubrication task is the application of a lubricant to a component whose design specifies lubrication for proper operation and is appropriate only if the lubricant to be used is a non-permanent type and needs to be reapplied periodically.
    2. Servicing: A servicing task entails the replenishment of consumables (e.g., fuel, oxygen, oil, and nitrogen) which are depleted during normal operations.
b. Addition of operational checks to the maintenance procedure to verify that an item is fulfilling its intended purpose.
c. An intensive visual examination of a specific area to detect damage. Visual examinations can be further broken down as follows:
    1. 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.
    2. 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.
    3. 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.

d. An act of restoration, ranging from cleaning or replacement to complete overhauls: Restoration is that work necessary to return the item to a specific standard. The scope of each assigned restoration task has to be specified since restoration may vary from cleaning or repairing, to complete overhauls.

e. A time change of the component if a specific life cycle can be determined. Time Change Items 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.

f. Periodic Checks of Emergency Systems: The MECSIP team shall implement recurring checks, at appropriate intervals,to verify all emergency systems (e.g., Life Support, fuel dump, ram air turbine, emergency landing gear extention, fire extinguisher bottle squibs, etc.) are available if needed to address aircraft emergencies.

g. Combination: any combination of the actions listed above.

5.5.4.2 Develop a program for routine health assessment of EWIS.

A schedule for routine health assessment of the Electric Wire and Interconnect System shall be developed per the guidance contained in the EWIS Integrity Program MIL-HDBK-525.

5.5.5 Subtask 5 – Manage Service Life Extension and Final Five Years Prior to Retirement.

5.5.5.1 MECSIP considerations during a Service Life Extention Program (SLEP).

During consideration of a Service Life Extention Program, it is important that all factors necessary to extend the life of the system be appropriately considered. Within MECSIP systems, some equipment is intended to remain on the aircraft over the life of the system. In addition, some equipment will cease to be sustainable due to DMS issues.

5.5.5.1.1 Service Life Assessment Program.

When 10 percent of the MDS fleet reach 50 percent of the aircraft service life based on flight hours or landings, whichever occurs first, the SM shall iniatiate a Service Life Assessment Program for MECSIP equipment. The SLAP will be the basis for aircraft program decisions concerning the future service life of the components/ systems at the same time as the airframe decisions are being made. The Service Life Assessment Plan is the document that guides the SLAP effort and includes aircraft to be examined, systems/components to be assessed, and outcome reporting requirements. The SLAP Report contains detailed results of the execution of the SLAP. The SLAP program shall examine all MECSIP equipment. NOTE: There is no requirement to perform a SLAP if there is no intention of executing a SLEP for the MDS.

5.5.5.1.2 Service Life Assessment of hydromechanical systems.

Many MECSIP components, particularly those with existing life limits, do not require assessment beyond investigation of continued availability of sources of repair. For MECSIP components which are overhauled, SLAP shall look at the overhaul procedures to see if any changes are warranted as the aircraft life is extended. Other MECSIP equipment (e.g., fuel/hydraulic/ECS tubes, brackets seals etc.) age and require a comprehensive look at the need to potentially replace the entire system or increase inspections before the fleet reaches the end of the life extention. By performing the SLAP in advance of the SLEP decision point, decisionmakers can understand all of the costs and risks associated with a SLEP program in advance of the decision. NOTE: SLAP is only required to be executed on safety-critical parts. The Program Office may wish to include other components based on cost, obsolescence, reliability drivers, etc.

5.5.5.1.3 Service Life Assessment of EWIS

5.5.5.1.3.1 EWIS Task Three. (See EWIS MIL-HDBK-525 for more details.)

a. Conduct an on aircraft physical and electrical inspection and document overall condition of the aircraft EWIS. (Reference MIL-HDBK-525's appendix D and use AC 25-27A as guidance). Results of this EWIS Task may be used to identify and target critical problem areas for further evaluation.

b. Use available wiring design and installation documents AS50881 or applicable platform specific contractual design/installation documents.

c. Conduct a physical inspection and document overall condition of aircraft electrical system using guidelines established in MIL-HDBK-525 and/or NAVAIR Standard Work Package (SWP) 4.4.5.3, AIRCRAFT WIRING ASSESSMENT REPORT.

d. Specifically examine wiring for exposed conductors, cracked or deteriorated insulation, loss of insulation mechanical properties, excessive splices or presence of contamination/corrosion.

e. Examine circuit breakers, distribution panels, and other conductive path components for corrosion, thermal damage, and electrical degradation.

f. Large or complex areas should be broken down into manageable size. Emphasize SWAMP and high-maintenance areas.

5.5.5.1.3.2 EWIS Task Four. (See EWIS MIL-HDBK-525 for more details.)

a. Conduct a destructive materials/aging analysis of wiring and electrical components removed from the aircraft based on information gathered in earlier EWIS Tasks.

b. Conduct a lab visual and optical inspection to document condition of components and follow with a detailed materials and aging analysis of selected EWIS components.

c. Wiring insulation and conductor integrity

d. Protective harness materials

e. Shield and ground terminations

f. Connector contact integrity and shield effectiveness

g. Circuit breaker contact integrity and the trip curve

h. Relay contact integrity and actuation performance

i. Switch contact integrity and actuation performance

j. Electrical distribution panels

k. Terminal boards, ground studs, and connector back shells

l. Compare condition of components with new (unused) components

m. Apply aging assessment techniques and aging/degradation models to determine remaining life of EWIS components.

5.5.5.1.3.3 EWIS Task Five. (See EWIS MIL-HDBK-525 for more details.)

a. Analyze and provide an overall risk and life assessment of the aircraft electrical system using the findings from the first four EWIS Tasks. (Reference MIL-HDBK-525's appendix F.)

b. Analyze and provide an overall EWIS risk and life assessment using collected data (EWIS Tasks 1-4).

c. Apply algorithms or models which provide an EWIS risk assessment based on failure histories, failure modes and mechanisms, materials properties, and environmental and maintenance conditions.

d. Address criticality of the wiring system and its impact on aircraft safety, reliability, and availability.

e. Review safety assessment process in MIL-STD-882.

f. Consider electrical fires and system reliability and availability.

5.5.5.1.4 Service Life Assessment Plan Report (SLAP Report).

This report shall list all of the necessary actions required to operate subsystems beyond their original certification basis. This report shall document those items where the certified life can be increased, where corrective action is required and where the certified life must be decreased. This SLAP report is to stand as the new certification basis for the subsystems contained on the platform. It should contain the necessary data to support an airworthiness assessment per MIL-HDBK-516. The SLAP report shall also address EWIS tasks six and seven (see EWIS Integrity Program MIL-HDBK-525 for more details), which include:

a. Apply Overall Analysis Toward Action Plan (i.e., no changes, implement continuous inspections, partial or total replacement, implement new technologies).

b. Provide recommendations for mitigating risk through inspection, replacement, or upgrading wiring system components; etc.

c. Recommend scheduled inspections over system life.

d. Recommend installation of new technology to improve long-term performance and reduced cost.

e. Determine, based on findings from SLAP phase, when the next iteration of EWIS tasks three through six should occur.

5.5.5.1.5 Service Life Extension Program (SLEP).

The Service Life Extension Program executes those activities identified in the SLAP Report as necessary to extend the life of MECSIP Equipment to achieve the desired MDS service life.

5.5.5.2 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.

5.5.5.2.1 Retirement IPT.

A Retirement IPT shall be established with representatives from the MAJCOMs, SOR, DLA, and the Wing Office. This IPT shall establish supply and liaison procedures.

5.5.5.2.2 Supply drawdown.

The drawdown in the supply system shall be planned, such that spares will be available as needed. Cannibalizations from depot condition “F” assets, Aerospace Maintenance and Regeneration Group (AMARG) pulls, and reuse of components (repairs instead of overhauls) can 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. Should the option of AMARG pulls be utilized, the configuration of those items pulled should be updated to the current configuration prior to installation.

5.5.5.2.3 Establish liaisons at Primary Bases.

Each Base that hosts or maintains the weapon platform shall be required to provide a liaison for Maintenance and Supply to the MECSIP Manager. The liaisons at the Primary Bases will advise the Retirement IPT regarding updates to both maintenance procedures and source of supply (new, repaired versus overhaul, and AMARG pulls).

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 this 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:

Paragraphs	Data Requirements Title
5.1.8, 5.2.18, 5.3.12, 5.4.25, and 5.5	MECSIP Master Plan
5.2.9 and 5.5.1.4	Safety-Critical and Mission-Critical Components List
5.2.16	Product Integrity Control Plan
5.4.21	Final integrity analysis
5.4.22	Maintenance planning and task development.

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

6.4 Subject term (key word) listing.

Critical Safety Item
Damage tolerance
Durability
Equipment, air vehicle
Equipment, ground vehicle
Flight Critical Part
Flight Safety Part
Flight Safety Critical Part
Maintainability
MECSIP
OSS&E
Overhaul
Reliability
Repair
Safety
Safety of Flight
Strength
Supportability
Systems, mechanical

6.5 Responsible Engineering Office (REO).

The office responsible for development and technical maintenance of this standard is AFLCMC/EZFA, 2145 MONAHAN WAY, WRIGHT-PATTERSON AFB OH 45433-7017; DSN 785-2023, Commercial (937) 255-2023; AFLCMC.EZF.Mailbox@wpafb.af.mil. 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 STANDARD

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 https://assist.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 INSTRUCTION

AFI 63-101	Integrated Life Cycle Management (ILCM)

U.S. AIR FORCE MATERIEL COMMAND INSTRUCTION

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

(Copies of these documents are available online at the Air Force E-Publishing Website: www.e-publishing.af.mil.)

A.3 DEFINITIONS

A.3.1 Acronyms.

CDR	Critical Design Review
CI	Configuration Item
EMD	Engineering and Manufacturing Development Phase
FRR	Flight Readiness Review (equivalent to IFR)
IFR	Initial Flight Release
MDD	Materiel Development Decision
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-IV 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 MDD 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. The SFR is conducted during the Technology Development Phase.

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 late in the Technology Development Phase 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. The CDR is conducted during the EMD Phase.

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. The FRR is conducted during the EMD Phase.

Functional Configuration Audit (FCA): The FCA is the is the formal examination of the "as-tested" functional characteristics of configuration items (CIs). The audit verifies that the item has achieved the requirements specified in its functional baseline documentation, and identifies and records any discrepancies. Functional configuration audits are conducted on both hardware and software configuration items to assure that the technical documentation accurately reflects the functional characteristics of each.

System Verification Review (SVR): The SVR 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. The SVR is conducted during the EMD Phase.

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. The PCA is conducted during the Production and Deployment Phase, prior to the Full Rate Production Decision Review.

A.4 GUIDANCE

A.4.1 Key elements.

Key MECSIP elements are embedded in the core process sections of AFMCI 63-1201, which implements AFI 63-101. 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-I. Task I Preliminary Planning - 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 I Preliminary Planning (5.1)**							
Technical Data Package (5.1.5)	• Identify critical hardware design features • Program Office to define level of technical data necessary for sustainment							
Technical Reviews (5.1.6)		• Contractor to map content and level of completion for each MECSIP task to program milestones.						
Identify Technical Needs (5.1.7)	• Yearly	• Yearly	• Yearly	• Yearly	• Yearly	• Yearly	• Yearly	• Yearly
MECSIP Master Plan (5.1.8)	• Initial MECSIP Master Plan drafted	• Initial MECSIP Master Plan completed	• MECSIP Master Plan updated	• MECSIP Master Plan updated	• MECSIP Master Plan updated	• MECSIP Master Plan updated		• MECSIP Master Plan (revisions)

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)**							
Corrosion Prevention and Control (5.2.1)		• Initial draft	• Final Plan	• Update	• Update		• Update	• Update
Environmental Emissions (5.2.2)		• Initial analysis	• Analysis complete	• Update	• Update		• Update	• Update
Physical and Operational Interfaces (5.2.3)			• Interfaces defined	• Update	• Update		• Update	• Update
Design service life/ design usage (5.2.4)		• Initial analysis	• Analysis complete					
Supportability Planning (5.2.5)		• Draft Plan	• Completed plan	• Update	• Update		• Update	• Update
Prognostic Health Monitoring Planning (5.2.6)		• Draft Plan	• Completed plan	• Update	• Update		• Update	• Update
FMECA (5.2.7)			• Draft FMECA	• Final FMECA	• Update		• Update	• Update
Hazard Analysis (5.2.8)			• Draft HA	• Final HA	• Update		• Update	• Update
Component Classification (5.2.9)		• Assessment of safety-, mission-, and durability-critical approach	• Approach of safety-, mission-, and durability-critical completed	• Update	• Update		• Update	• Update
Aviation-Critical Safety Items (5.2.10)		• Draft identification	• Final Identification	• Final classification	• Update		• Update	• Update
Prevention of failure for Safety-Critical Parts (5.2.11)		• Draft approach defined	• Final approach defined	• Update	• Update		• Update	• Update
Design criteria (5.2.12)		• Design criteria definition submitted • Development of initiated	• Design criteria definition completed • Development of requirements completed	• Design criteria updated for test results			• Design criteria updated for lessons learned	• Design criteria updated for lessons learned
Aerospace Castings (5.2.13)		• Determine casting applications	• Apply specialized requirements for castings				• Apply specialized casting requirements if castings are used to replace forged or machined parts	• Apply specialized casting requirements if castings are used to replace forged or machined parts
Maintenance Concepts (5.2.14)		• Initial analysis	• Finalize concept	• Updated for test results		• Updated for lessons learned	• Updated for lessons learned	• Updated for lessons learned

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)							
EWIS Task One (5.2.15)		• Initial analysis	• Finalize concept	• Updated for test results		• Updated for lessons learned	• Updated for lessons learned	• Updated for lessons learned
Product Integrity Control Plan (5.2.16)		• Initial plan	• Finalize plan	• Updated for test results		• Updated for lessons learned	• Updated for lessons learned	• Updated for lessons learned
Identify Technical Needs (5.2.17)		• Yearly	• Yearly	• Yearly	• Yearly	• Yearly	• Yearly	• Yearly
Update MECSIP Master Plan (5.2.18)			• MECSIP Master Plan updated	• MECSIP Master Plan updated	• MECSIP Master Plan updated	• MECSIP Master Plan updated		• MECSIP Master Plan (revisions)

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)							
Manufacturing Quality Assessment (5.3.1)			• Initial assessment	• Update	• Update	• Final		
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 • Maintenance publications 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	• Loads/environmental spectra survey documented	
Design stress/environment spectra development (5.3.2.2)		• Initial	• Update	• Update	• Update	• Update		
Performance and function sizing analyses (5.3.2.3)		• Initial	• Update	• Update	• Update			
Thermal/environmental analyses and tests (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		
Stress/strength analyses (5.3.2.5)		• Initial	• 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)		• Initial	• Update	• Update	• Update	• Update		

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	• Update		
Material characterization tests (5.3.3.1)		• Initial development of material characterization tests defined	• Initial development of material characterization tests conducted	• Update				
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	• Update	• Update		
Flight Control Systems analysis and test (5.3.4)		• Initial development tests defined • Test rationale, test planning developed, test risk identified	• Initial component development tests conducted					
Electromagnetic effects and lightning (5.3.5)		• Initial development tests defined • Test rationale, test planning developed, test risk identified	• Initial component development tests conducted		• Ground test rig and component tests complete	• Flight testing completed		
Software performance and testing requirements (5.3.6)		• Initial development tests defined	• Test rationale, test planning developed, test risk identified	• Critical module tests complete	• Formal Qual tests and software integration tests complete for safety-critical functions	• All testing complete		
Abnormal operation design margin (5.3.7)		• Abnormal operating conditions defined	• Test rationale, test planning developed, test risk identified	• Test plan complete	• Critical module tests complete			
Reliability and maintainability (5.3.8)		• Initial analysis	• Analysis complete					

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)**							
Electrical/optical cable maintainability (5.3.8.1)		• Initial analysis	• Analysis complete		• Formal Qualification Tests and System Integration testing complete			
Ground handling (5.3.8.2)		• Initial analysis	• Analysis complete					
De-Rating/up-rating (5.3.8.3)		• Initial analysis	• Analysis complete					
PHM assessment (5.3.8.4)		• Initial analysis	• Analysis complete					
Obtain OEM data (5.3.8.5)		• Define level of data required for sustainment		• Analysis complete				
Flight Manual (5.3.9)		• Initial draft Flt Manual				• Flight Manual Complete		
Create WUC Manual (5.3.10)			• Initial draft WUC Manual			• Obtain Data	• WUC Manual complete	
Identify Technical Needs (5.3.11)		• Yearly	• Yearly	• Yearly	• Yearly	• Yearly	• Yearly	• Yearly
Update MECSIP Master Plan (5.3.12)		• Update	• Update	• Update	• Update	• Update	• Update	• Update

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 descriptions (5.4.1)		• Initial draft	• Update	• Finalized				
Testing risk mitigation (5.4.2)		• Planning	• Planning	• Mitigation test start	• Mitigation tests complete			
Hardware and systems rig testing (5.4.3)		• Planning	• Planning	• Rig test start	• Rig tests complete			
Hardware components (5.4.4)					• Component tests complete			
Reliability growth demonstration (5.4.5)						• Reliability growth demonstration tests complete		
Oil interruption and depletion (5.4.6)					• Oil interruption and depletion tests completed			
Component fit checks (5.4.7)			• Component fit checks completed					
Component qualification (5.4.8)					• Component qualification tests completed			
Vibration and dynamic response (5.4.9)		• Test risk analysis • Test needs • Test plans • Component, rig tests designed	• Component designs reflect accommodatio n of requirements	• Component and subsystems testing completed	• Analysis updated with component and subsystems data for those environments deemed critical to safety of flight	• Vibration and dynamic response tests complete		

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)**						
Strength testing (5.4.10)		• Test risk analysis • Test needs • Test plans • Component, rig tests designed	• Component designs reflect accommodation of requirements		• Analysis updated with subsystem test data for those environments deemed critical to safety of flight	• Aircraft operating limitations established for full-envelope flight testing		
Durability testing (5.4.11)		• Test risk analysis • Test needs • Test plans • Component, rig tests designed	• Durability life test plan established.		• Component and subsystems testing completed • Analysis updated			
Vibration/dynamics/ acoustics tests (5.4.12)		• Test risk analysis • Test needs • Test plans • Component, rig tests designed	• Component designs reflect accommodation of requirements		• Component and subsystems testing completed • Analysis updated			
Damage tolerance tests (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			

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)						
Thermal, environment, and loads survey (5.4.14)		• 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 (5.4.15)		• 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			
Maintainability/repairability demonstrations (5.4.16)		• 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	• Deviation and waiver tracking system established	• Repair process controlled
Acceptance Test Procedures (5.4.17)			• Draft	• Final				

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)						
Evaluation and interpretation of ground test results (5.4.18)					• Complete for safety of flight considerations	• Complete		
Evaluation and interpretation of flight test results (5.4.19)						• Complete		
Integrated test plan (5.4.20)		• Draft	• Update	• Update	• Final			
Final integrity analysis (5.4.21)			• Draft	• Update	• Update	• Complete		
Maintenance planning and task development (5.4.22)		• Initial draft	• Update	• Update	• Update	• Final		
Airworthiness certification (5.4.23)		• Start gathering data	• Continue to gather data	• Continue to gather data	• Continue to gather data	• Continue to gather data	• Complete	
Identify technical needs (5.4.24)		• Yearly	• Yearly	• Yearly	• Yearly	• Yearly	• Yearly	• Yearly
Update MECSIP documents (5.4.25)				• Update	• Update	• Update	• Update	• Update

Custodians:
Army – AV
Navy – AS
Air Force – 11
DLA – CC

Preparing activity:
Air Force – 11
(Project SESS-2010-017)

Review activities:
Army – AR, CR, MI, TE
Navy – EC, OS, SH
Air Force - 19, 70, 71, 84, 85, 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 in the ASSIST Online database at https://assist.dla.mil.