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**DEPARTMENT OF DEFENSE
STANDARD PRACTICE**

AIRCRAFT STRUCTURAL INTEGRITY PROGRAM (ASIP)



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FOREWORD

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

2. This standard implements Air Force Policy Directive (AFPD) 63-10, Aircraft Structural Integrity; and Air Force Instruction (AFI) 63-1001, Aircraft Structural Integrity Program. These two documents define policies, procedures, and responsibilities that ensure the safe operation of USAF aircraft. The requirements of these two documents are not repeated in higher-level policy (e.g., DoD-5000 Series documents) and have no commercial equivalent (e.g., Federal Aviation Administration [FAA] regulations).

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

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1. SCOPE.

1.1 Scope.

This standard describes the USAF Aircraft Structural Integrity Program (ASIP) which defines the requirements necessary to achieve structural integrity in USAF aircraft while managing cost and schedule risks through a series of disciplined, time-phased tasks. It provides direction to government personnel and contractors engaged in the development, production, modification, acquisition, and/or sustainment of USAF aircraft.

1.1.1 Application.

This standard applies to the entire structure of an aircraft, as defined in section 3.1, regardless of aircraft type or procurement strategy, for the entire service life of the aircraft.

1.1.2 Tailoring.

Every aircraft program must address all sections of this standard (including all tasks and elements within each task) and document this in its ASIP Master Plan. An ASIP Master Plan is required for all programs. Tailoring is only permitted when all of the following conditions exist:

- a. The overall aircraft reliability (probability of failure) is established and approved by the appropriate Risk Approval Authority as defined in MIL-STD-882, "Standard Practice for System Safety."
- b. The aircraft structure reliability is defined and supports the overall aircraft reliability requirement.
- c. The effect of each tailored ASIP task and/or element and its associated impact on aircraft structure is determined.
- d. The combined impact of all tailored ASIP tasks and/or elements on aircraft structural reliability is determined and achieves the allocated overall aircraft reliability requirement.
- e. The tailored ASIP tasks and/or elements and the impact of this tailoring on aircraft structural reliability is documented in the ASIP Master Plan and approved in accordance with AFPD 63-10 and AFI 63-1001.

2. APPLICABLE DOCUMENTS.

2.1 General.

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

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks.

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

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DEPARTMENT OF DEFENSE

SPECIFICATIONS

JSSG-2006	Aircraft Structures
MIL-DTL-87929	Technical Manuals, Operation and Maintenance Instructions in Work Package Format (for USAF Equipment)

STANDARDS

MIL-STD-882	Standard Practice for System Safety
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HANDBOOKS

MIL-HDBK-516	Airworthiness Certification Criteria
MIL-HDBK-1568	Materials and Processes for Corrosion Prevention and Control in Aerospace Weapon Systems
MIL-HDBK-1823	Nondestructive Evaluation System, Reliability Assessment
MIL-HDBK-6870	Inspection Program Requirements, Nondestructive, for Aircraft and Missile Materials and Parts

(Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Bldg 4D, Philadelphia PA 19111-5098; [215] 697-2179.)

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.

Department of Defense Policy Directives and Instructions

DFARS 207.105(b)(13)(ii) Oct 04	Defense Federal Acquisition Regulation, Part 207- Acquisition Planning, Subpart 207.1 – Acquisition Plans
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DoD Corrosion Prevention and Control Planning Guidebook (Spiral II)

(Copies of DFARS Part 207 are available online at: <http://farsite.hill.af.mil/reghtml/regs/far2afmcfars/fardfars/dfars/dfars207.htm>; copies of the DoD Corrosion Prevention and Control Planning Guidebook are available at: <http://www.dodcorrosionexchange.org/>.)

U.S. Air Force Policy Directives and Instructions

AFPD 21-1	Air and Space Maintenance
AFMCI 21-102	Analytical Condition Inspection (ACI) Programs
AFI 21-105	Air and Space Equipment Structural Maintenance
AFPD 63-14	Aircraft Information Programs

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AFI 63-1001/ AFMC SUPPLEMENT 1	Aircraft Structural Integrity Program
AFI 63-1401	Aircraft Information Programs

(Copies of Directives and Instructions are available from the U.S. Air Force Publications Distribution Center, 2800 Eastern Blvd, Baltimore MD 21220-2898; [410] 687-3330; <http://afpubs.hq.af.mil>.)

U.S. Air Force Technical Orders

T.O. 1-1B-50	Basic Technical Order for USAF Aircraft Weight and Balance
T.O. X-YY-38*	Aircraft Structural Integrity Program Technical Order

(*The T.O. number will correlate to the weapon system. Copies of T.O.s are available from Oklahoma City Air Logistics Center (OC-ALC/LGLDT); 3001 Staff Drive STE 1AB1 100; Tinker AFB OK 73145-3042; [405] 736-3779; <https://wwwmil.tinker.af.mil/til/tild/tildt-home.html#techorder>.)

Federal Aviation Administration

MMPDS-Handbook	Metallic Material Properties Development and Standardization
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(Copies are available from Battelle Memorial Institute, 505 King Avenue, Columbus OH 43201-2681; [614] 424-5000.)

U.S. Air Force Technical Reports

WL-TR-94-4052/3/4/5/6 (Accession Number ADA311686/87/88/89/90) http://www.dtdesh.wpafb.af.mil/Handbook.asp	Damage Tolerant Design Handbook (5 Volumes) Damage Tolerant Design Handbook: Guidelines for the Analysis and Design of Damage Tolerant Aircraft Structures
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(Copies of the five-volume DT Design Data Handbook are available from the Defense Technical Information Center [DTIC], 8725 John J. Kingman Road, Suite 0944, Fort Belvoir VA 22060-6218, 1-800-CAL-DTIC, <http://stinet.dtic.mil>; and from the Center for Information and Numerical Data Analysis and Synthesis (CINDAS) at Purdue University, 500 Center Drive, West Lafayette IN 47907-2022; 1-765-494-7039; <https://engineering.purdue.edu/MSE/Research/CINDAS/Pubs.html>).

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.

Center for Information and Numerical Data Analysis and Synthesis

CINDAS	Aerospace Structural Metals Handbook (6 Volumes)
CINDAS	Structural Alloys Handbook (3 Volumes)

(Copies are available from Center for Information and Numerical Data Analysis and Synthesis (CINDAS) at Purdue University, 500 Center Drive, West Lafayette IN 47907-2022; 1-765-494-7039; <https://engineering.purdue.edu/MSE/Research/CINDAS/Pubs.html>).

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International Society of Allied Weight Engineers, Inc.

SAWE RP No. 7

Mass Properties Management and Control for Military Aircraft

(Copies are available from Society of Allied Weight Engineers, P.O. Box 60024, Terminal Annex, Los Angeles CA 90060-0024; <http://www.sawe.org>.)

2.4 Order of precedence.

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.

3.1 Aircraft structure.

The structure of an aircraft includes the fuselage, wing, empennage, landing gear, rotorcraft rotor and drive systems, propellers, control systems and surfaces, airframe-engine interface components (including engine mounts), nacelles, air induction components, weapon mounts, structural operating mechanisms, components that perform a structural function, and other components as described in the contract specification.

3.2 Baseline operational loads/environment spectrum (baseline spectrum).

The baseline operational loads/environment spectrum is an update of the design spectrum based on measured data from operational aircraft (e.g., data obtained from the loads/environment spectra survey).

3.3 Baseline service life.

The baseline service life is the period of time (e.g., years, flight cycles, hours, landings, etc.) established subsequent to design, during which the structure is expected to maintain its structural integrity when flown to the baseline loads/environment spectrum.

3.4 Certification.

Certification is a repeatable process implemented to verify an aircraft can be safely maintained and operated within its described operational envelope.

3.5 Corrosion.

Corrosion is the deterioration of a material or its properties due to the reaction of that material with its chemical environment.

3.6 Critical location.

A critical location in an aircraft structure is one that has been identified through analysis, test, or service history as a being especially sensitive to the presence of damage.

3.7 Damage.

Damage to aircraft structure is any crack, flaw, corrosion, disbond, delamination, and/or other feature that degrades, or has the potential to degrade, the performance of the affected component.

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3.8 Damage tolerance.

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

3.9 Design loads/environment spectrum.

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

3.10 Design service life.

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

3.11 Durability.

Durability is the ability of the aircraft structure to resist cracking, corrosion, thermal degradation, delamination, wear, and the effects of foreign object damage for a prescribed period of time.

3.12 Economic life.

The economic life is the period during which it is more cost-effective to maintain and repair an aircraft than to replace it. Economic life can be applied on a component, aircraft, or force basis.

3.13 Equivalent flight hours.

Equivalent flight hours are the actual flight hours accumulated by an aircraft adjusted for the actual usage severity compared to the design spectrum or to the baseline spectrum.

3.14 Equivalent initial flaw size (EIFS) distribution.

The equivalent initial flaw size distribution is a characterization of the initial quality of the aircraft structure. The EIFS distribution is derived by analytically determining the initial flaw size distribution that must be used to obtain the measured flaw size distribution discovered following exposure to the test or actual usage stress spectra.

3.15 Fail-safe structure.

A fail-safe structure is a structure that retains its required residual strength for a period of unrepaired usage after the failure or partial failure of safety-of-flight structure.

3.16 Fracture-critical part.

As shown on [figure 1](#), a fracture-critical part is a safety-of-flight structural 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.

3.17 Fracture-critical traceable part.

As shown on [figure 1](#), a fracture-critical traceable part is a safety-of-flight structural component that is either single load path or sized by durability or damage tolerance requirements.

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3.18 Initial quality.

Initial quality is a measure of the condition of the aircraft structure relative to flaws, defects, or other discrepancies in the basic materials or introduced during manufacture of the aircraft structure.

3.19 Inspectability.

Inspectability means that materials and manufactured components (relative to geometry and access) which result from the application of processes and joining methods can be reliably inspected for applicable sources and types of structural flaws using available inspection procedures that meet the minimum probability of detection requirements.

3.20 Maintenance-critical part.

As shown on [figure 1](#), a maintenance-critical part is a structural component whose failure will not cause a safety-of-flight condition but is sized by durability requirements and would not be economical to repair or replace.

3.21 Mission-critical part.

As shown on [figure 1](#), a mission-critical part is a structural component in which damage or failure could result in the inability to meet critical mission requirements or could result in a significant increase in vulnerability.

3.22 Multiple load path.

Multiple load path is structural redundancy in which the applied loads are distributed to other load-carrying members in the event of failure of individual elements.

3.23 Nondestructive inspection (NDI).

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

3.24 Onset of widespread fatigue damage (WFD).

Onset of widespread fatigue damage is the point at which there are cracks at multiple structural details, and these are of sufficient size and density, such that the structure will no longer meet its damage tolerance requirement (e.g., maintaining required residual strength after partial structural failure).

3.25 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.

3.26 Producibility.

Producibility means that materials, processes, and/or joining methods are able to support current and future production rates without adversely affecting costs and/or quality.

3.27 Risk analysis.

Risk analysis is an evaluation of a potential hazard severity and probability of occurrence. For aircraft structural applications, the potential hazards include structural failures that can cause injury or death to personnel, damage to or loss of the aircraft, or reduction of mission readiness/availability.

MIL-STD-1530C(USAF)**3.28 Rotorcraft dynamic component.**

A rotorcraft dynamic component is a structural part of the rotorcraft's drive train or lift system that experiences dynamic loading.

3.29 Safe-life.

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

3.30 Safety-of-flight structure.

Safety-of-flight structure is that structure whose failure could cause loss of the aircraft or aircrew, or cause inadvertent store release. The loss could occur either immediately upon failure or subsequently if the failure remained undetected.

3.31 Single load path.

Single load path is the distribution of applied loads through a single member, the failure of which would result in the loss of the structural capability to carry the applied loads.

3.32 Slow damage growth structure.

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

3.33 Stability.

Stability means that materials, processes, and joining methods have matured to where consistent and repeatable quality, and predictable costs have been achieved to meet system production requirements. Also, process parameters and methods are understood, and robust and documented approaches for control of these factors (i.e., specifications) exist.

3.34 Structural integrity.

Structural integrity is the condition which exists when a structure is sound and unimpaired in providing the desired level of structural safety, performance, durability, and supportability.

3.35 Structural operating mechanisms.

Structural operating mechanisms are those operating, articulating, and control mechanisms which transmit structural forces during actuation and movement of structural surfaces and elements.

3.36 Supportability.

Supportability means that thermal, environmental, and mechanical deterioration of materials and structures fabricated using the selected manufacturing processes and joining methods have been identified and that acceptable quality and cost-effective preventive methods and/or in-service repair methods are either available or can be developed in a timely manner.

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4. GENERAL REQUIREMENTS.

4.1 ASIP goal and objectives.

The effectiveness of any military force depends, in part, on the safety and operational readiness of its weapon systems. One major item of an aircraft system that affects its operational readiness is the condition of the aircraft structure. Its capabilities, condition, and operational limitations must be established to maintain operational readiness. Potential structural or material problems must be identified early in the life-cycle to minimize their impact on the operational force. In addition, a preventive maintenance program must be developed and implemented to provide for the orderly scheduling of inspections and replacement or repair of life-limited elements of the aircraft structure. The overall program to provide USAF aircraft with the required aircraft structural characteristics is referred to as the Aircraft Structural Integrity Program, or "ASIP."

The goal of the ASIP is to ensure the desired level of structural safety, performance, durability, and supportability with the least possible economic burden throughout the aircraft's design service life.

The objectives of the ASIP are to:

- a. define the structural integrity requirements associated with meeting Operational Safety, Suitability and Effectiveness requirements;
- b. establish, evaluate, substantiate, and certify the structural integrity of aircraft structures;
- c. acquire, evaluate, and apply usage and maintenance data to ensure the continued structural integrity of operational aircraft;
- d. provide quantitative information for decisions on force structure planning, inspection, modification priorities, risk management, expected life cycle costs and related operational and support issues; and
- e. provide a basis to improve structural criteria and methods of design, evaluation, and substantiation for future aircraft systems and modifications.

4.2 Primary tasks.

The ASIP consists of the following five, interrelated functional tasks as delineated in [table I](#) and [table II](#), and on [figure 2](#) and [figure 3](#):

- a. Task I (Design Information). Task I is development of those criteria which must be applied during design to ensure the overall program goals will be met.
- b. Task II (Design Analysis and Development Testing). Task II includes the characterization of the environment in which the aircraft must operate, the initial testing of materials, components, and assemblies, and the analysis of the aircraft design.
- c. Task III (Full-Scale Testing). Task III consists of flight and laboratory tests of the aircraft structure to assist in determining the structural adequacy of the analysis and design.
- d. Task IV (Certification & Force Management Development). Task IV consists of the analyses that lead to certification of the aircraft structure as well as the development of the processes and procedures that will be used to manage force operations (inspections, maintenance, modifications, damage assessments, risk analysis, etc.) when the aircraft enters the inventory.
- e. Task V (Force Management Execution). Task V executes the processes and procedures developed under Task IV to ensure structural integrity throughout the life of each individual aircraft. This task may involve revisiting elements of earlier tasks, particularly if the service life requirement is extended or if the aircraft is modified.

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TABLE I. USAF Aircraft Structural Integrity Program Tasks.

Note: Numbers refer and are hyperlinked to sections of this document.

TASK I	TASK II	TASK III	TASK IV	TASK V
DESIGN INFORMATION	DESIGN ANALYSES & DEVELOPMENT TESTING	FULL-SCALE TESTING	CERTIFICATION & FORCE MANAGEMENT DEVELOPMENT	FORCE MANAGEMENT EXECUTION
5.1.1 ASIP Master Plan	5.2.1 Material and Joint Allowables Testing	5.3.1 Static Tests	5.4.1 Certification Analyses	5.5.1 Individual Aircraft Tracking (IAT) Program
5.1.2 Design Service Life & Design Usage	5.2.2 Loads Analysis	5.3.2 First Flight Verification Ground Tests	5.4.2 Strength Summary & Operating Restrictions (SSOR)	5.5.2 Rotorcraft Dynamic Component Tracking (RDCT) Program
5.1.3 Structural Design Criteria	5.2.3 Design Service Loads Spectra	5.3.3 Flight Tests	5.4.3 Force Structural Maintenance Plan (FSMP)	5.5.3 Loads/Environment Spectra Survey (L/ESS)
5.1.4 Durability and Damage Tolerance Control Program	5.2.4 Design Chemical/Thermal Environment Spectra	5.3.4 Durability Tests	5.4.4 Loads/Environment Spectra Survey (L/ESS) Development	5.5.4 ASIP Manual
5.1.5 Corrosion Prevention & Control Program (CPCP)	5.2.5 Stress Analysis	5.3.5 Damage Tolerance Tests	5.4.5 Individual Aircraft Tracking (IAT) Program Development	5.5.5 Aircraft Structural Records
5.1.6 Nondestructive Inspection Program	5.2.6 Damage Tolerance Analysis	5.3.6 Climatic Tests	5.4.6 Rotorcraft Dynamic Component Tracking (RDCT) Program Development	5.5.6 Force Management Updates
5.1.7 Selection of Materials, Processes, Joining Methods, & Structural Concepts	5.2.7 Durability Analysis	5.3.7 Interpretation and Evaluation of Test Results		5.5.7 Recertification
	5.2.8 Corrosion Assessment			
	5.2.9 Sonic Fatigue Analysis			
	5.2.10 Vibration Analysis			
	5.2.11 Aeroelastic and Aeroservoelastic Analysis			
	5.2.12 Mass Properties Analysis			
	5.2.13 Survivability Analysis			
	5.2.14 Design Development Tests			
	5.2.15 Production NDI Capability Assessment			
	5.2.16 Initial Risk Analysis			

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TABLE II. USAF ASIP Tasks and elements aligned with U.S. Department of Defense acquisition events.

MILESTONES >>>		A	B					C		
ACQUISITION PHASES >>>		Tech Development	System Development & Demonstration					Production & Deployment	Operations & Support	
REVIEWS & AUDITS >>> <i>(per MIL-STD-1521: Cancelled; cited for reference)</i>		SRR System Requirements Review	SDR [SFR] System Design Review <small>[a.k.a. System Functional Review]</small>	PDR Preliminary Design Review	CDR Critical Design Review	TRR Test Readiness Review	FCA [SVR] Functional Configuration Audit <small>[a.k.a. System Verification Review]</small>	PRR Production Readiness Review	PCA Physical Configuration Audit	
I - Design Information	5.1.1 ASIP Master Plan	INITIAL	UPDATE	UPDATE	UPDATE	UPDATE	UPDATE	UPDATE	UPDATE	UPDATE
	5.1.2 Design Service Life and Design Usage	FINAL								
	5.1.3 Structural Design Criteria	INITIAL	UPDATE							
	5.1.4 Damage Tolerance & Durability Control Program	INITIAL	UPDATE	UPDATE	UPDATE					
	5.1.5 Corrosion Prevention & Control Program	INITIAL	UPDATE	UPDATE	UPDATE					
	5.1.6 Nondestructive Inspection Program	INITIAL	UPDATE	UPDATE	UPDATE					
	5.1.7 Selection of Materials, Processes, Joining Methods, & Structural Concepts	INITIAL	UPDATE							
II - Design Analyses & Development Testing	5.2.1 Material & Joint Allowables		INITIAL	UPDATE	UPDATE					
	5.2.2 Loads Analysis		INITIAL	UPDATE	UPDATE					
	5.2.3 Design Service Loads Spectra		INITIAL	UPDATE	UPDATE					
	5.2.4 Design Chemical/Thermal Environment Spectra		INITIAL	UPDATE	UPDATE					
	5.2.5 Stress Analysis		INITIAL	UPDATE	UPDATE					
	5.2.6 Damage Tolerance Analysis			INITIAL	UPDATE					
	5.2.7 Durability Analysis			INITIAL	UPDATE					
	5.2.8 Corrosion Assessment				INITIAL					
	5.2.9 Sonic Fatigue Analysis				INITIAL					
	5.2.10 Vibration Analysis				INITIAL					
	5.2.11 Aeroelastic & Aeroservoelastic Analysis			INITIAL	UPDATE					
	5.2.12 Mass Properties Analysis		INITIAL	UPDATE	UPDATE					
	5.2.13 Survivability Analysis				INITIAL					
	5.2.14 Design Development Tests		INITIAL	UPDATE	UPDATE					
	5.2.15 Production NDI Capability Assessment				FINAL					
	5.2.16 Initial Risk Analysis				INITIAL					

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TABLE II. USAF ASIP Tasks and elements aligned with U.S. Department of Defense acquisition events – Continued.

III - Full-Scale Testing	5.3.1 Static Tests					INITIAL	CONTINUE					
	5.3.2. First Flight Verification Ground Tests					FINAL						
	5.3.3 Flight Tests						FINAL					
	5.3.4 Durability Tests						FINAL					
	5.3.5 Damage Tolerance Tests						FINAL					
	5.3.6 Climatic Tests						FINAL					
	5.3.7 Interpretation & Evaluation of Test Results						FINAL					
IV - Certification & Force Management Development	5.4.1 Certification Analyses						FINAL					
	5.4.2 Strength Summary & Operating Restrictions (SSOR)							FINAL				
	5.4.3 Force Structural Maintenance Plan (FSMP)							FINAL				
	5.4.4 Loads/ Environment Spectra Survey (L/ESS) Development							FINAL				
	5.4.5 Individual Aircraft Tracking (IAT) Program Development							FINAL				
	5.4.6 Rotorcraft Dynamic Component Tracking (RDCT) Program Development							FINAL				
V - Force Management Execution	5.5.1 Individual Aircraft Tracking (IAT) Program										EXECUTE	
	5.5.2 Rotorcraft Dynamic Component Tracking (RDCT) Program										EXECUTE	
	5.5.3 Loads/Environment Spectra Survey (L/ESS)										EXECUTE	
	5.5.4 ASIP Manual										CREATE/MAINTAIN	
	5.5.5 Aircraft Structural Records										CREATE/MAINTAIN	
	5.5.6 Force Management Updates										UPDATE	
	5.5.7 Recertification										CREATE/UPDATE	
REVIEWS & AUDITS >>> (per MIL-STD-1521)		SRR	SDR [SFR]	PDR	CDR	TRR	FCA [SVR]	PRR	PCA			
ACQUISITION PHASES >>>		Tech Development	System Development & Demonstration						Production & Deployment	Operations & Support		
MILESTONES >>>		A	B					C				

MIL-STD-1530C(USAF)**5. DETAILED REQUIREMENTS.**

Detailed guidance for the establishment and verification of aircraft structural requirements and for the planning and execution of ASIP tasks is documented in JSSG-2006, Aircraft Structures.

5.1 Design information (Task I).

The design information task encompasses those efforts required to apply the existing theoretical, experimental, applied research, and operational experience to specific criteria for materials selection and structural design for an aircraft. The objective is to ensure appropriate criteria and planned usage characteristics are applied to an aircraft's design to meet specific operational requirements. This task begins as early as possible in the Technology Development phase and is finalized in subsequent phases of the aircraft's life cycle.

5.1.1 ASIP Master Plan.

The ASIP Manager shall translate the requirements defined by this standard and AFI 63-1001 into a program for each aircraft and document these in the ASIP Master Plan. Each aircraft program must have an ASIP Master Plan. This plan shall be integrated into the Integrated Master Plan (IMP) and Integrated Master Schedule (IMS). The purpose of the ASIP Master Plan is to define and document the specific approach to accomplish the various ASIP tasks throughout the life-cycle of each individual aircraft. The plan shall depict the time-phased scheduling and integration of all required ASIP tasks for design, development, certification, damage surveillance, and tracking of the aircraft structure. The plan shall also include discussion of unique features, exceptions to this standard and the associated rationale including risk assessments, and any problems anticipated in the execution of the plan. The development of the schedule shall consider all interfaces, the impact of schedule delays (e.g., delays due to test failure), mechanisms for recovery programming, and other problem areas.

5.1.1.1 Tailoring.

The ASIP Master Plan shall specify how an ASIP is tailored for a specific aircraft program.

5.1.1.2 Approval.

For all acquisition programs, the initial ASIP Master Plan shall be written and approved prior to the System Requirements Review (SRR).

5.1.1.3 Updates.

The ASIP Master Plan shall be updated annually throughout the service life of the aircraft.

5.1.1.4 Responsibility.

Air Force Instruction 63-1001 describes the organizations responsible for the creation, review, and approval of the ASIP Master Plan.

5.1.2 Design service life and design usage.

The USAF shall provide the design service life and design usage/environments as part of the contract. These data shall be used in the initial design and analysis for strength, rigidity, durability, corrosion prevention and control, damage tolerance, etc. The design service life and design usage/environment shall be established through close coordination between the acquisition and operational organizations. Design mission profiles, mission mixes, and environmental exposure mixes which are realistic estimates of expected service usage shall be established based on aircraft requirements.

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5.1.3 Structural design criteria.

Detailed structural design criteria for the specific aircraft shall be established in accordance with the requirements of the applicable contracts. These shall include design criteria for loads, dynamics, strength, durability, damage tolerance, and mass properties.

5.1.3.1 Loads criteria.

Criteria shall be established such that all critical limit load conditions are developed. These limit loads are those which can result from authorized ground and flight usage of the aircraft including maintenance activity, system failures from which recovery is expected, and those that occur within the design service life. Ultimate loads for the aircraft shall be obtained by multiplying the limit loads by the appropriate factor of safety.

5.1.3.2 Dynamics criteria.

Criteria shall be established to ensure the aircraft in all configurations including store carriage is free from flutter, whirl flutter, divergence, and other related aeroelastic or aeroservoelastic instabilities for all combinations of altitude and speed within the approved flight envelope by the required airspeed margin of safety. Criteria shall be established such that the aircraft structure can withstand the aeroacoustic loads and vibrations due to aerodynamic and mechanical excitations throughout the design service life.

5.1.3.3 Strength criteria.

Criteria shall be established to ensure the aircraft structure has adequate strength capability. This capability requires that, for the design environments, no detrimental deformation or damage occurs at 115-percent design limit loads and no structural failure occurs at design ultimate loads.

5.1.3.4 Durability criteria.

Criteria shall be established to ensure the aircraft structure can achieve the design service life and that in-service maintenance is economically viable. In addition, durability criteria shall be established to ensure the aircraft structure can achieve the damage tolerance criteria described in 5.1.3.5. Durability criteria apply to all airframe structural components and shall include criteria that pertain to the onset of WFD as described in 5.1.3.4.1 and economic life as described in 5.1.3.4.2.

5.1.3.4.1 Onset of WFD.

Criteria shall be established to ensure the onset of WFD does not occur within the design service life of the aircraft structure. The onset of WFD is the end of the service life for the affected component. Full-scale durability testing described in 5.3.4 shall demonstrate that the onset of WFD occurs at a time equal to or greater than the design service life by the specified margin.

5.1.3.4.2 Economic life.

Additional criteria shall be established to ensure the aircraft structure's economic life as defined in 3.12 is greater than the design service life by the specified margin. This shall be demonstrated by the full-scale durability test described in 5.3.4.

5.1.3.5 Damage tolerance criteria.

Criteria shall be established to ensure the aircraft structure can safely withstand undetected flaws, corrosion, impact damage, and other types of damage throughout its design service life. The damage tolerance criteria shall be applied to all safety-of-flight structure and other selected structure. Criteria shall consider establishment of a minimum critical flaw size for those locations which are difficult to inspect. The damage tolerance evaluation criteria for rotary-wing aircraft dynamic components are addressed in 5.1.3.5.2.

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5.1.3.5.1 Damage tolerance design concepts.

The aircraft structural damage tolerance design shall be categorized into either of the general design concepts which follow:

- a. fail-safe concepts where the required residual strength of the remaining intact structure shall be maintained for a period of unrepaired usage through the use of multiple load paths or damage arrest features after a failure or partial failure. The period of unrepaired usage necessary to achieve fail-safety must be long enough to ensure the failure or partial failure will be detected visually and repaired prior to the failure of the remaining intact structure.
- b. slow damage growth concepts where flaws, defects, or other damage are not allowed to attain the size required for unstable, rapid propagation failure. This concept must be used in single-load-path and non-fail-safe multiple load path structures. No significant growth which results from manufacturing defects or from damage due to high-energy impact shall be allowed for composite structures.

5.1.3.5.2 Special applications.

The safe-life design methodology may be used on a limited basis. It is expected that it will be used to establish replacement times for some specifically-approved structural components (e.g., landing gear components and rotorcraft dynamic components). Damage tolerance evaluations are required for all safe-life designed components and other selected structure. 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 safety. Such options may include design features, manufacturing processes, or inspections. Additionally, the damage tolerance evaluation shall establish individual aircraft tracking requirements so that the safe-life component replacement times and any scheduled safety inspections can be adjusted based on actual usage. Use of a safe-life approach for a structural component must be identified in the ASIP Master Plan.

5.1.3.6 Mass properties criteria.

Criteria shall be established to ensure the aircraft can accommodate aerodynamic, center of gravity, and inertia changes which result from fuel usage, store expenditure, asymmetric fuel and store loading, fuel migration at high angles of attack and roll rates, and aerial refueling.

5.1.4 Durability and Damage Tolerance Control Program.

A Durability and Damage Tolerance Control Program shall be established for the aircraft structure. This program shall identify and define all the tasks necessary to ensure compliance with the durability requirements as described in 5.1.3.4 and the damage tolerance requirements as described in 5.1.3.5. The disciplines of fracture mechanics, fatigue, materials and processes selection, environmental protection, corrosion prevention and control, design, manufacturing, quality control, nondestructive inspection, and probabilistic methods shall be considered when the durability and damage tolerance control processes are developed. This program shall include the requirement to perform durability and damage tolerance design concept, material, weight, performance, and cost trade studies early during the aircraft's design so as to obtain structurally-efficient and cost-effective designs.

5.1.4.1 Durability and Damage Tolerance Control Plan.

A Durability and Damage Tolerance Control Plan that is consistent with the design service life shall be prepared and executed throughout the System Development & Demonstration and the Production & Deployment phases. The plan shall establish a Durability and Damage Tolerance Control Board (DDTCB) responsible for establishment and oversight of the administration of the specific controls that will be applied in accordance with the plan. The board shall be comprised of representatives from

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engineering, manufacturing, quality assurance, and others involved in the design, engineering development, and production of the aircraft structure. The board's decisions are subject to USAF approval.

5.1.4.2 Critical part/process selection and controls.

Criteria shall be established to select aircraft structural critical parts/processes and the controls for these critical parts/processes. The DDTCB described in 5.1.4.1 shall oversee this selection and control process. The impact on safety-of-flight, mission completion, and production and maintenance costs shall be considered in the selection of critical parts/processes. Figure 1, along with the analyses described in 5.2, shall be part of the selection process and establishment of controls. The DDTCB shall ensure the critical part/process list is updated as the design matures.

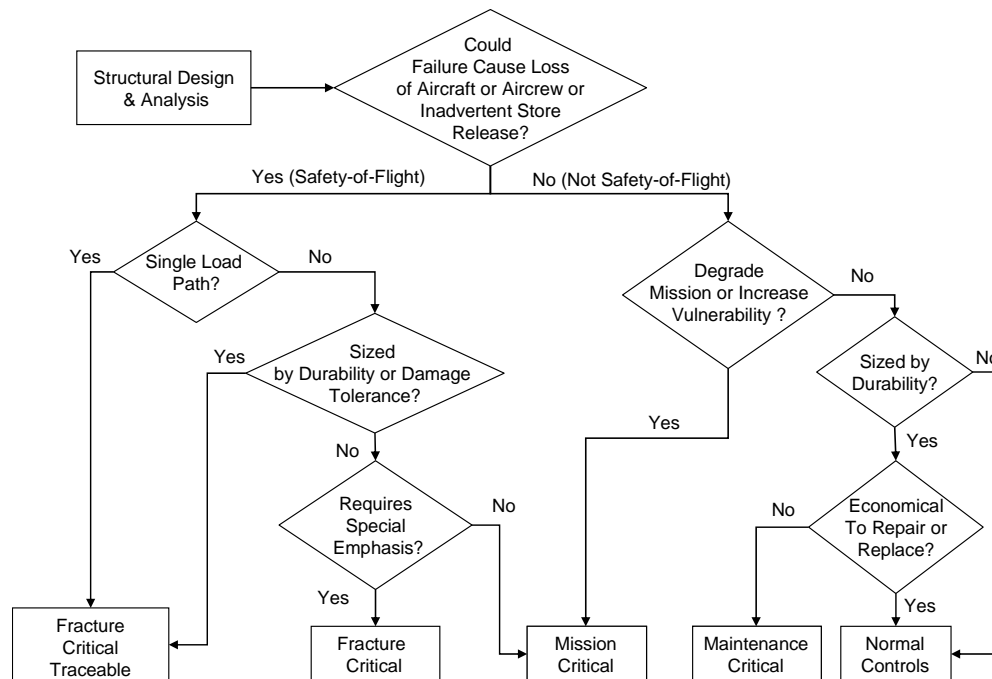


FIGURE 1. Critical part selection flow chart.

5.1.5 Corrosion Prevention and Control Program (CPCP).

A Corrosion Prevention and Control Program shall be established for the aircraft structure. The program shall establish a Corrosion Prevention Advisory Board (CPAB) responsible for establishment and oversight of the execution of the program. The board shall be comprised of representatives from engineering, manufacturing, quality assurance, and others involved in the design, engineering development, and production of the aircraft structure. The board's decisions are subject to USAF approval. Corrosion prevention shall be a primary consideration in the development and implementation of the durability and damage tolerance control process and the force management process. Materials and processes, finishes, coatings, and films which have been proven in service or by comparative testing in the laboratory shall be selected to prevent corrosion as described by the Corrosion Prevention and Control Plan described in 5.1.5.1. Results of the susceptibility to corrosion evaluation described in 5.1.5.2 shall be used to control the impact of corrosion damage. Corrosion prevention and control guidelines are provided in JSSG-2006, the DoD Corrosion Prevention and Control Planning Guidebook (Spiral II), MIL-HDBK-1568, DFARS 207.105(b)(13)(ii) Oct 04, AFPD 21-1, and AFI 21-105.

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5.1.5.1 Corrosion Prevention and Control Plan.

A Corrosion Prevention and Control Plan shall be prepared and corrosion prevention and control processes shall be used in accordance with this standard, MIL-HDBK-1568, and JSSG-2006. The plan shall be consistent with the design service life and shall define corrosion prevention and control requirements and considerations for the System Development & Demonstration and Production & Deployment phases. The plan shall specify actions to delay the onset of corrosion and minimize corrosion maintenance costs through the selection of materials, fabrication techniques, sealants, protective coatings, design features, and other measures that minimize the potential for corrosion throughout the structure.

5.1.5.2 Evaluation of corrosion susceptibility.

An evaluation of the susceptibility of the aircraft structure to corrosion shall be conducted as part of the CPCP. The evaluation shall identify locations where the structure might be susceptible to corrosion and the expected type(s) of corrosion (e.g., exfoliation, uniform, crevice, intergranular, and stress-corrosion cracking, etc.) that could occur at these locations. To identify potential corrosion damage locations, the evaluation shall account for the materials, manufacturing processes, corrosion prevention systems (e.g., coatings, sealants, etc.), preventative maintenance approaches (e.g., hangaring, wash cycles, wash fluids, etc.), the inspectability of the location, and structural fabrication techniques as well as the expected operational environments to which the aircraft are subjected.

5.1.6 Nondestructive Inspection (NDI) Program.

An NDI Program shall be established in accordance with MIL-HDBK-6870 and consistent with direction in AFI 21-105. The NDI Program will consider and implement appropriate nondestructive inspection processes into all phases of the program (design, engineering development, production, and in-service operation). The program shall establish a Nondestructive Inspection Requirements Review Board (NDIRRB) responsible for oversight and execution the program. The NDIRRB shall be formed early in the design phase to review and assess product form concepts for inspectability in terms of production process control and quality monitoring. The NDIRRB shall also be responsible for review and approval of inspection methods and detectability assumptions implemented in the Force Structural Maintenance Plan. The board's decisions are subject to USAF approval.

5.1.7 Selection of materials, processes, joining methods, and structural concepts.

Materials, processes, joining methods, and structural concepts shall be selected to result in a structurally efficient, cost-effective aircraft structure that meets the strength, rigidity, observability, durability, and damage tolerance requirements of the applicable specifications. Prior to a commitment to new materials, processes, joining methods, and/or structural concepts (i.e., those not previously used in the military and/or commercial aviation industry), an evaluation based on their stability, producibility, inspectability, supportability, and mechanical and physical properties shall be performed. The risk associated with the selection of the new materials, processes, joining methods and/or structural concepts shall be estimated and risk mitigation actions defined. The trade studies performed as part of the durability and damage tolerance control described in 5.1.4 shall be a major driver in the final selection of materials, processes, joining methods, and structural concepts. The detailed rationale for the individual selections and any proposed risk mitigation actions shall be submitted in the proposals of prospective contractors. Each rationale and all supporting data shall become part of the design database after contract award and during the design of the aircraft.

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5.1.7.1 Stability.

Maturity of material, process, and joining method choices shall be assessed by determining if these choices result in consistent and repeatable quality and if predictable costs are likely to be achieved to meet production requirements. This can be demonstrated by robust and documented approaches for controlling process parameters/methods, i.e., specifications exist.

5.1.7.2 Producibility.

Quality control shall be ensured through the use of appropriate process control measures employed during the manufacture of the aircraft structure.

5.1.7.3 Mechanical and physical properties.

Mechanical and physical properties include all the key mechanical and physical properties that have been determined in the appropriate environments in the as-fabricated condition using the manufacturing processes and joining methods that will be utilized. Key mechanical properties include but are not limited to: strength, elongation, fracture toughness, damage growth rates, stress corrosion and fatigue crack growth thresholds. Key physical properties include but are not limited to: density, corrosion resistance, defect population, reflectivity, and surface roughness.

5.1.7.4 Supportability.

Legacy experience and health/environmental regulations must be considered when the capability of proposed approaches is evaluated. The selection of preventive and repair methods shall consider the potential for repeated use on individual aircraft. These preventive and repair methods include corrosion preventive coatings, hot bonding of composites, mechanical fastened repairs, field welding and stress relief, grinding, shot peening, etc.

5.1.7.5 Risk mitigation actions.

Risk mitigation actions shall be defined and implemented in the program based on an estimate of the level of risk associated with the selection of the new materials, processes, joining methods, and/or structural concepts. The specific actions required will depend on the classification of the structural component (e.g., safety-of-flight structure), the design concept (i.e., safe-life, fail-safe, or slow damage growth), and the estimated risk level. Possible risk mitigation actions include: using higher factors of safety, fabrication and durability testing of one or more large structural components in the appropriate thermal/chemical environments, special in-service inspections of test and/or operational aircraft, and special in-process testing (such as periodic strength proof testing of bonded joints) conducted throughout the production of the aircraft. In addition, the use of fail-safe design concepts is preferred when flight safety depends on the integrity of the bonded joint.

5.2 Design analyses & development testing (Task II).

The objectives of the design analyses and development tests task are to: 1) determine the environments in which the aircraft structure must operate (load, temperature, chemical, abrasive, and vibratory and aeroacoustic environment), 2) perform preliminary and final analyses and tests based on these environments, and 3) size the aircraft structure to meet the strength, rigidity, damage tolerance, and durability requirements. Test plans, procedures, and schedules shall be approved by the USAF.

5.2.1 Material and joint allowables.

Material and joint allowables data identified in FAA MMPDS-Handbook, Damage Tolerant Design Handbook, CINDAS Aerospace Structural Metals Handbook, and CINDAS Structural Alloys Handbook may be used to support the use of existing materials in design analyses. Other data sources may also be used, but shall first be reviewed by the USAF and the contractor. Experimental programs to obtain the

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data and generate analysis test data shall be formulated and performed for new materials and those existing materials for which there are insufficient data available. The variability in material properties shall be considered when material and joint allowables are established.

5.2.2 Loads analysis.

Loads analysis shall determine the magnitude and distribution of significant static and dynamic loads which the aircraft structure may encounter when operated within the envelope established by the structural design criteria. This analysis consists of a determination of the flight loads, ground loads, powerplant loads, control system loads, and weapon effects. When applicable, this analysis shall include the effects of temperature, aeroelasticity, and dynamic response of the aircraft structure.

5.2.3 Design service loads spectra.

Design service loads spectra shall be developed to establish the distribution, frequency, and sequencing of loadings that the aircraft structure will experience based on the design service life and usage. The design service loads spectra and chemical/thermal environment spectra as defined in 5.2.4 shall be used to develop flight-by-flight stress/environment spectra, as appropriate, to support the analyses and tests described herein.

5.2.4 Design chemical/thermal environment spectra.

Design chemical/thermal environmental spectra shall be developed to establish the intensity, duration, frequency of occurrence, etc., of the environment which the aircraft structure will experience based on the design service life and usage.

5.2.5 Stress analysis.

A stress analysis shall include the analytical determination of the internal loads, stresses, strains, deformations, and margins-of-safety which result from the external loads and environments imposed on the aircraft structure. In addition to verification of strength, the stress analysis shall be used as a basis for durability and damage-tolerance analyses, selection of critical structural components for design development tests, material review actions, and selection of loading conditions to be used in the structural strength tests. The stress analysis shall be used as the basis to determine the adequacy of structural changes throughout the life of the aircraft and to determine the adequacy of the structure for new loading conditions which result from increased performance or new mission requirements. The stress analysis shall be revised to reflect any major changes to the aircraft structure or to the loading conditions applied to the aircraft structure.

5.2.6 Damage tolerance analysis.

Damage tolerance analysis shall be conducted to substantiate the ability of the structural components to comply with the detail requirements for damage tolerance. The design flight-by-flight stress/environment spectra based on the requirements of 5.2.3 and 5.2.4 shall be used in the damage growth analysis and verification tests. The calculations of critical flaw sizes, residual strengths, safe damage growth periods, and inspection intervals shall be based on existing fracture test data and basic fracture allowables data generated as a part of the design development test program.

5.2.7 Durability analysis.

Durability analysis shall be conducted to substantiate the ability of the structure to comply with the detail requirements for durability. The design flight-by-flight stress/environment spectra based on the requirements of 5.2.3 and 5.2.4 shall be used in the durability analysis and verification tests. Durability analysis shall be performed for all airframe structural components and shall include analysis that pertains to the onset of WFD as described in 5.2.7.1 and economic life as described in 5.2.7.2.

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5.2.7.1 Onset of Widespread Fatigue Damage (WFD).

The analysis shall account for those factors which affect the time for typical-quality structure to experience the onset of WFD. These factors shall include initial quality and initial quality variations, chemical/thermal environment, load sequence and environment interaction effects, material property variations, and analytical uncertainties.

5.2.7.2 Economic life.

The analysis shall account for those factors that affect the time for cracks or equivalent damage to reach sizes large enough to necessitate maintenance actions.

5.2.8 Corrosion assessment.

An assessment shall be conducted to identify the failure modes associated with the type(s) of corrosion identified by the CPCP described in 5.1.5 and the structural integrity consequences associated with the failure modes. Special attention should be given to those safety-of-flight and mission-critical aircraft structural locations where corrosion damage could affect the onset of fatigue cracking or lead to stress-corrosion cracking, and especially to those locations where corrosion could accelerate the onset of WFD. Consideration for the results of the assessment shall be utilized to evaluate accessibility for inspection, establish rework limits, and ensure component replaceability (if necessary) in the design of the aircraft structure.

5.2.9 Sonic fatigue analysis.

Sonic fatigue analysis shall be conducted to ensure the aircraft structure is resistant to sonic fatigue cracking throughout the design service life. The analysis shall define the intensity of the aeroacoustic environment from potentially critical sources and shall determine the dynamic response, including significant thermal effects. Potentially critical sources include but are not limited to powerplant noise, aerodynamic noise in regions of turbulent and separated flow, exposed cavity resonance, and localized vibratory forces.

5.2.10 Vibration analysis.

Vibration analysis shall be conducted to predict the resultant environment in terms of vibration levels in various areas of the aircraft such as the crew compartment, cargo areas, equipment bays, etc. The vibration analyses, in conjunction with the durability analyses of 5.2.7, shall show that the structure in each of these areas is resistant to cracking due to vibratory loads throughout the design service life. In addition, the analyses shall show that the vibration levels are acceptable for the reliable performance of personnel and equipment throughout the design service life of the aircraft.

5.2.11 Aeroelastic and aeroservoelastic analysis.

Analysis shall be conducted to determine the characteristics of the aircraft for flutter, divergence, and other related aeroelastic or aeroservoelastic instabilities. The primary objective of the analysis is to evaluate potential aeroelastic and aeroservoelastic instabilities and substantiate the ability of the aircraft structure to meet the specified aeroelastic airspeed margins, damping requirements, and aeroservoelastic stability margins for all design conditions. Analysis for design failure conditions shall also be conducted.

5.2.12 Mass properties analysis.

A mass properties analysis shall be conducted to determine the aircraft weight and balance. This analysis shall be based on estimates of the aircraft's design, construction, and usage at the time of Initial Operational Capability (IOC). In addition, a Mass Properties Control and Management Plan (MPCMP) shall be established and implemented throughout the life of the aircraft. Detailed guidance may be found in the Society of Allied Weight Engineers Recommended Practice Number 7 (SAWE RP No. 7).

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Survivability analysis shall be conducted to ensure the aircraft structure can perform effectively in a combat environment.

5.2.13.1 Vulnerability analysis.

Vulnerability analysis shall be conducted to verify that the aircraft structure can withstand the operational loads after being damaged by specific threats.

5.2.13.2 Weapons effects analysis.

Weapons effects analysis shall be conducted to ensure the aircraft structure can withstand the loads due to thermal transients, overpressure, and gust associated with weapon detonation. Nuclear weapons effects analysis shall be conducted to determine the capability envelope for the aircraft structure and crew radiation protection for the specified range of variations of weapon delivery trajectories, weapon size, aircraft escape maneuvers, and the resulting damage limits.

5.2.14 Design development tests.

Design development tests shall be conducted to establish material, process, and joint allowables; to verify analysis methods and procedures; to obtain early evaluation of allowable stress levels, material selection, fastener systems, and the effect of the design chemical/thermal environment spectra; to establish aeroelastic and loads characteristics through wind tunnel tests; and to obtain early evaluation of the strength, durability, fatigue (sonic and vibratory), and damage tolerance capabilities of critical structural components and assemblies. Examples of design development tests are tests of coupons; small elements; splices and joints; panels; fittings; control system components and structural operating mechanisms; and major components such as wing carry through, horizontal tail spindles, wing pivots, and assemblies thereof. The plans shall consist of information such as rationale for selection of scope of tests; description of test articles, procedures, test loads and test duration; and analysis directed at the establishment of cost and schedule trade-offs used to develop the program.

5.2.14.1 Duration of durability tests.

Durability testing shall determine initial estimates of the onset of WFD and of the equivalent initial flaw size (EIFS) distribution.

5.2.14.2 Corrosion tests.

Corrosion testing shall be conducted to evaluate the effectiveness of the corrosion protection system to meet design service life requirements for the defined service environments. For corrosion protection system effectiveness, comparative tests on representative structure (including fasteners and dissimilar material contacts) shall be used to evaluate corrosion protection system choices. The comparative tests shall include corrosion protection systems used on legacy aircraft to ensure the new corrosion protection system provides adequate corrosion protection and to provide insight into the degree the new systems will protect aircraft.

5.2.15 Production NDI capability assessment.

The capability of nondestructive inspection processes used for production process monitoring and quality control of structural component shall be established to mitigate risk of missing defects. Special emphasis shall be given to fracture- and mission-critical parts. Capability demonstration of production NDI processes shall be addressed within the NDI Program.

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5.2.16 Initial risk analysis.

An initial risk analysis shall be performed using the EIFS distribution developed under 5.2.14.1 and 5.3.4 and combined, when appropriate, with data from similar aircraft. A primary objective of this analysis is to demonstrate a low risk of both WFD and loss of fail-safety during the design service life when the aircraft is flown to the design loads/environment spectrum. Also, the analysis should estimate the time beyond the design service life when the risk of loss of fail-safety will become unacceptable. For non-fail-safe structures, the analysis should estimate the time beyond the design service life when required safety inspections and/or modifications would result in an unacceptably high risk of aircraft unavailability and/or adverse economic consequences. All significant variables impacting risk shall be included in the risk analysis. Examples of such variables include: EIFS distribution, load spectra, chemical and thermal environment, material properties, and the NDI probability of detection.

5.3 Full-scale testing (Task III).

The objective of this task is to assist in the determination of the structural adequacy of the design through a series of ground and flight tests. Test plans, procedures, and schedules shall be approved by the USAF. Test results shall be used to validate analytical design data and to verify requirements are achieved.

5.3.1 Static tests.

A static test program shall be conducted on an instrumented aircraft using simulated loads derived from critical flight and ground handling conditions. Thermal environment effects shall be simulated in addition to the load application on aircraft structures where operational environments impose significant thermal effects. The primary purpose of the static test program is to verify the static strength analyses and the design ultimate strength capabilities of the aircraft structure. Deletion of the full-scale ultimate load static tests is generally unacceptable. However, a separate full-scale static test is not required if any of the following conditions are met and specifically approved by the acquisition authority:

- a. where it is shown that the aircraft structure and its loading are essentially the same as that of a previous aircraft structure which was verified by full-scale tests; or
- b. where it is shown that the strength margins (particularly for stability-critical structures) have been demonstrated by major assembly (i.e., entire wing, fuselage, and/or empennage component) tests; or
- c. strength demonstration proof tests are performed to 115 percent of design limit load on every flight aircraft to be operated. These proof tests shall demonstrate that deformation requirements have been met and shall validate the accuracy of the strength predictive methods.

Major repairs, extensive reworks and refurbishments, and component modifications which alter the structural load paths, or which represent significant changes in structural concept, shall require a static ultimate load test of the affected component.

5.3.1.1 Selection of test article.

The test article shall be an early System Development & Demonstration phase test aircraft structure and shall be representative of the operational configuration (including all significant structural details) and manufacturing processes. If there are significant design, material, or manufacturing changes between the test article and production aircraft, static tests of an additional article or selected components and assemblies thereof shall be required.

5.3.1.2 Schedule requirements.

Full-scale static tests and/or strength demonstration proof tests shall be scheduled such that the tests are completed in sufficient time to support removal of flight restrictions on flight test and operational aircraft in support of program requirements.

MIL-STD-1530C(USAF)**5.3.2 First flight verification ground tests.**

The following verification tests shall be conducted prior to first flight.

5.3.2.1 Mass properties tests.

Mass properties tests shall be conducted to verify the aircraft weight and balance are as predicted and within limits for all design conditions.

5.3.2.2 Functional proof tests.

Functional proof tests shall be conducted to design limit load to demonstrate the functionality of flight-critical structural systems, mechanisms, and components whose correct operation is necessary for safe flight. These tests shall demonstrate the deformation requirements have been met.

5.3.2.3 Pressure proof tests.

Each pressurized compartment of each pressurized flight aircraft shall be pressure proof tested to the maximum pressure limit loads. These proof tests shall demonstrate that deformation requirements have been met and shall validate the accuracy of the strength predictive methods.

5.3.2.4 Strength proof tests.

Strength proof tests of selected aircraft structural components and systems (e.g., flight control surfaces, hydraulic systems, etc.) shall be conducted when the full-scale static test schedule does not allow for adequate testing prior to first flight, when the full-scale test will not adequately demonstrate strength capability, or when flight restrictions to limit these component loads may be difficult to achieve without unreasonably restricting the aircraft.

5.3.2.5 Control surface rigidity and free-play tests.

Control surface rigidity and free-play tests shall be conducted to verify the flutter analysis as well as to ensure safe free-play limits. These tests should be conducted prior to ground vibration tests and should be conducted for both design failure and normal conditions. If mass balancing of controls surfaces is used to prevent any aeroelastic instability, stiffness tests of the mass balance attachments shall be conducted. In addition, the mass and inertia of the control surfaces shall be measured in support of the flutter analysis and to verify the mass property analysis.

5.3.2.6 Ground vibration tests.

Ground vibration tests shall be conducted to verify the natural frequencies, mode shapes, and structural damping of the aircraft. Test results are to be correlated against the structural model used in all aeroelastic analyses. Consideration of the aircraft supporting system is required to ensure rigid body modes of the aircraft do not interfere with the capture of aircraft elastic modes. To allow for changes in the structural models, component ground vibrations tests shall be conducted prior to aircraft assembly and well in advance of full-scale aircraft tests.

5.3.2.7 Aeroservoelastic tests.

Aeroservoelastic ground tests to include open-loop transfer (frequency response) tests and closed-loop coupling (structural resonance) tests shall be conducted to correlate and verify the aeroservoelastic analysis.

MIL-STD-1530C(USAF)**5.3.3 Flight tests.**

Flight tests shall be conducted on a fully-instrumented aircraft. An additional aircraft, sufficiently late in the production program to ensure obtainment of the final configuration, shall be the backup aircraft for these flight tests and shall be instrumented similarly to the primary test aircraft. These tests shall include dynamic response, flutter, and aeroacoustic and vibration tests, as well as a flight and ground loads survey.

5.3.3.1 Flight and ground loads survey.

The flight and ground loads survey program shall consist of an instrumented and calibrated aircraft operated within and to the extremes of its limit structural design envelope to measure the resulting loads and, if appropriate, to also measure pertinent temperature profiles on the aircraft structure. Load measurements shall be made in a build-up fashion by the strain gage or pressure survey methods commensurate with the state-of-the-art, usually installed during production buildup. The objectives of the loads survey are to:

- a. verify the structural loads and thermal analyses used in the design of the aircraft structure;
- b. evaluate loading conditions which produce the critical structural load and temperature distribution; and
- c. determine and define suspected new critical loading conditions which may be indicated by the investigations of structural flight conditions within the design-limit envelope.

5.3.3.2 Dynamic response tests.

The dynamic response tests shall consist of an instrumented and calibrated aircraft operated to measure the structural loads and inputs while flown through atmospheric turbulence; and during taxi, takeoff, towing, landing, refueling, store ejection, etc. The objectives shall be to obtain flight verification and evaluation of the elastic response characteristics of the structure to these dynamic load inputs.

5.3.3.3 Flutter tests.

Flight flutter tests shall be conducted to verify the aircraft structure is free from aeroelastic instabilities and has satisfactory damping throughout the operational flight envelope. Test aircraft should have sufficient instrumentation installed and acceptable methods of in-flight excitation shall be used to determine the frequency and amount of damping of the primary modes of interest at each flight test condition. The tests shall be performed with test data taken at predetermined test points, defined by Mach number and altitude, in a prescribed order of ascending criticality. For aircraft with a flight control augmentation system, flight aeroservoelastic stability tests shall be conducted in conjunction with flight flutter testing.

5.3.3.4 Aeroacoustic tests.

The aeroacoustic environments shall be measured on a full-scale aircraft to verify the acoustic loads/environment used in the sonic fatigue analysis. Measurements of sound pressure levels shall be made of those areas determined to be sonic-fatigue critical. Sufficient instrumentation shall be in place for both flight and ground operations which produce the significant aeroacoustic loads.

5.3.3.5 Vibration tests.

Flight vibration tests shall be conducted to verify and correct analysis of the vibration environment. Measurements shall be made at a sufficient number of locations to define the vibration characteristics of the aircraft structure with the test results being the basis for equipment environmental requirements. In addition, the test results shall be used to demonstrate that vibration control measures are adequate to

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prevent cracking and to provide reliable performance of personnel and equipment throughout the design service life.

5.3.4 Durability tests.

A durability test program shall be conducted on an instrumented aircraft using the repeated application of the flight-by-flight design service loads/environment spectrum. Thermal environment effects shall be simulated, along with the load application on aircraft structures where operational environments impose significant thermal effects. The objectives of the full-scale durability tests are to:

- a. demonstrate that the onset of WFD does not occur within the design service life by the specified margin;
- b. demonstrate that the economic life of the test article is equal to or greater than the design service life by the specified margin;
- c. identify critical areas of the aircraft structure not previously identified by analysis or component testing;
- d. provide a basis for special inspection and modification requirements for force aircraft; and to
- e. obtain crack growth data to validate analysis methods and EIFS distribution data to support risk analyses. If no cracks are detected, or an insufficient number of cracks occur during the full-scale test, the data obtained from the design development testing described in 5.2.14 shall be used for verification.

Major component modifications which alter the structural load paths or which represent significant changes in structural concept shall require a durability test of a full-scale component.

5.3.4.1 Selection of test article.

The test article shall be an early System Development & Demonstration phase test aircraft structure and shall be representative of the operational configuration (including all significant details) and manufacturing processes. It is not required that the test article include systems, but the article must include system attach structures and associated details representative of the operational configuration and manufacturing process. If there are significant design, material, or manufacturing changes between the test article and production aircraft, durability tests of an additional article or selected components and assemblies thereof shall be required.

5.3.4.2 Test scheduling and duration.

One lifetime of durability testing plus an inspection of critical structural areas shall be completed prior to a full production go-ahead decision. Two lifetimes of durability testing plus an inspection of critical structural areas shall be scheduled to be completed prior to delivery of the first production aircraft. If the economic life of the test article is reached prior to two lifetimes of durability testing, sufficient inspection in accordance with the inspection program described in 5.3.4.3 and data evaluation shall be completed prior to delivery of the first production aircraft to estimate the extent of required production changes and retrofit. It may be advantageous to continue testing beyond the minimum requirement to: 1) determine life-extension capabilities, 2) validate design-life capability for usage that is more severe than design usage, 3) validate repairs, modifications, inspection methods, and changes, 4) support damage-tolerance requirements, and 5) determine the onset of WFD. In the event the original schedule for the production decision and production delivery milestones becomes incompatible with the above schedule requirements, a study shall be conducted to assess the technical risk and cost impacts of changing these milestones. An important consideration in the durability test program is that it be completed at the earliest practical time, but after Critical Design Review (CDR).

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5.3.4.3 Inspection program.

An inspection program shall be conducted as an integral part of the full-scale aircraft structure durability test. The inspection program shall be approved by the USAF. The objectives of the inspection program shall be to detect damage as early as possible, to provide crack growth data, and to minimize the risk of a catastrophic failure during testing.

5.3.4.4 Teardown inspection and evaluation.

At the end of the full-scale durability test, including any scheduled damage tolerance tests, a destructive teardown inspection program shall be conducted. This inspection shall include disassembly and laboratory-type inspection of those critical areas identified in design as well as additional critical structure identified during testing and during close visual examination while disassembly is performed. Fractographic examinations shall be conducted to obtain crack growth data and to assist in the assessment of the initial quality of the aircraft structure. The EIFS distribution shall be derived from the damage discovered during testing and the teardown inspection. The methods, procedures, and data used to determine the EIFS shall be documented and delivered to the USAF as part of the acquisition contract to serve as a basis to validate any future changes in analytical methods. Prior to teardown, consideration should be given to evaluation of the effectiveness of the anticipated NDI methods that may be applied to fielded aircraft.

5.3.5 Damage tolerance tests.

A damage tolerance test program shall be conducted using the repeated application of the flight-by-flight design service loads/environment spectrum. Thermal environment effects shall be simulated, along with the load application on aircraft structures where operational environments impose significant thermal effects. The intent shall be to conduct damage tolerance tests on existing test hardware. This may include use of components and assemblies of the design development tests as well as the full-scale static and durability test articles. When necessary, additional structural components and assemblies shall be selected, fabricated, and tested.

5.3.6 Climatic tests.

Full-scale system-level climatic testing shall be conducted to identify potential corrosion problems in the field. Identification of fluid sources, trapped fluid locations, and improper drain paths shall be performed to the maximum extent possible. The results of this testing shall provide initial input for corrosion-related tasks in the Force Structural Maintenance Plan described in [5.4.3](#).

5.3.7 Interpretation and evaluation of test results.

Each structural problem that occurs during the tests described by this standard shall be analyzed to determine the root cause, corrective actions, force implications, and estimated costs. Examples of structural problems include but are not limited to: analytical shortfalls (measured loads, stresses, vibrations, etc., that differ from predictions), failures, cracking, yielding, corrosion, etc. The scope of and interrelation between the various ASIP tasks within the interpretation and evaluation effort are illustrated on [figure 2](#) and [figure 3](#). The results of these evaluations shall define corrective actions required to demonstrate that the strength, rigidity, damage tolerance, and durability design requirements are met and the associated risk reduction is achieved. The cost, schedule, and other impacts which result from correction of structural problems shall be used to make major program decisions such as major redesign, program cancellation, awards or penalties, and production aircraft buys. Structural modifications or changes derived from the results of the full-scale tests to meet the specified strength, rigidity, damage tolerance, and durability design requirements shall be substantiated by subsequent tests of components, assemblies, or full-scale article, as appropriate (see [figure 3](#)).

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5.4 Certification & force management development (Task IV).

Aircraft structural certification is based on the results of Tasks I through III. Certification analyses described in 5.4.1 culminate in structural certification of an aircraft. An ASIP must develop an appropriate force management strategy in preparation for force management that occurs during sustainment under Task V. This strategy depends upon formal documentation of structural capability, creation of maintenance plans, and the development of data acquisition/storage/evaluation systems.

5.4.1 Certification analyses.

The design analyses described in 5.2 shall be revised to account for differences revealed between analysis and test. Selected design development tests described in 5.2, the full-scale tests described in 5.3, and the interpretation and evaluation of test results described in 5.3.7 shall be used in the certification effort. The design analyses correlated to ground and flight testing establish structural certification and are herein referred to as “certification analyses.” The certification analyses provide the engineering source data for the Technical Orders that document the operational limitations/restrictions, procedures, and maintenance requirements to ensure safe operation. Approval of the certification analyses shall constitute aircraft structural certification, a critical step in achievement of airworthiness certification for the aircraft in accordance with procedures outlined in MIL-HDBK-516.

5.4.1.1 Risk analysis.

When tailoring, as described in 1.1.2, has been accomplished, a risk analysis shall be performed and utilized in the initial airworthiness certification. The objective of this analysis is to determine the combined impact of all tailored ASIP tasks and/or elements on aircraft structure reliability and to verify that the allocated aircraft structure reliability requirement has been achieved.

5.4.1.2 Quantifying the accuracy of analyses.

The accuracy of the analyses described in 5.2 shall be probabilistically quantified by direct comparison to the test results described in 5.2.14 and 5.3 and documented to support aircraft structural certification.

5.4.2 Strength Summary & Operating Restrictions (SSOR).

A Strength Summary & Operating Restrictions (SSOR) document shall summarize the final analyses and other pertinent structural data into a format which shall provide rapid visibility of the important structural characteristics, limitations, and capabilities in terms of operational parameters. The SSOR shall be primarily in a diagrammatic form that shows the aircraft structural limitations and capabilities as a function of the important operational parameters such as speed, acceleration, center-of-gravity location, and gross weight. The summary shall include brief descriptions of each major structural assembly, in diagrammatic form, which indicate structural arrangements, materials, critical design conditions, damage tolerance and durability critical areas, and minimum margins of safety. Appropriate references to design drawings, detail analyses, test reports, and other back-up documentation shall be provided.

5.4.3 Force Structural Maintenance Plan (FSMP).

The intent during the design of the aircraft is to achieve robust structures that will require little, if any, maintenance for corrosion, fatigue cracking, stress corrosion cracking, and/or delaminations within the design service life assuming that the aircraft is flown to the design loads/environment spectrum. However, full-scale testing described in Task III and the certification analyses performed as part of Task IV may identify critical areas missed during design that would require additional analysis and in-service inspections and perhaps production and/or in-service modifications. The FSMP shall define when, where, how, and the estimated costs of these inspections and modifications. It shall also describe the recurring structural maintenance program (i.e., periodic, minor and major inspections, program depot maintenance (PDM), the CPCP, etc.) It is intended that the FSMP will be used to establish budgetary

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planning, force structure planning, and maintenance planning. The initial FSMP will generally be based on the design loads/environment spectrum and shall be updated when the data from the Loads/Environment Spectra Survey (L/ESS) (described in 5.4.4) becomes available and a new baseline operational spectrum is developed. Additional updates, as described in 5.5.6, will be required when there are significant changes in operational usage and as dictated by damage discovered during scheduled inspections, surveillance sampling inspections conducted using the Analytical Condition Inspection (ACI) Program and structural teardown inspection programs, and/or normal operational maintenance of the aircraft. The structural maintenance database required to support these updates is described in 5.4.3.1.

5.4.3.1 Structural maintenance database development.

The structural maintenance database shall be developed to capture adequate, detailed information on the aging processes (fatigue, corrosion, delaminations, etc.) which occur in the aircraft and thus support the ongoing evaluation of structural integrity during sustainment. The database shall be developed to record all significant damage findings such as cracks, corrosion, and/or delaminations discovered during program depot maintenance, analytical condition inspections, time compliance technical order (TCTO) structural inspections, teardown inspections, and normal operational maintenance. The database shall also be able to record a description of the damage types, damage sizes, damage locations, inspection techniques (including POD information), aircraft configuration, pertinent aircraft usage history including basing information, and corrosion preventive methods (e.g., wash cycles, coatings, etc.). The database shall also be able to record all significant repairs and/or modifications so as to maintain configuration control. These records shall include a description of the repair/modification and when it was incorporated. Additional considerations for data to be recorded shall facilitate the analysis update described in 5.5.6.

5.4.3.2 Inspections.

Implicit in damage-tolerant structural designs are inspection requirements intended to ensure damage never reaches the sizes that can cause catastrophic failures. Inspections are required initially and at the repeat intervals described in 5.4.3.2.1. Such inspections shall continue to the estimated time, with the appropriate scatter factor, of the onset of WFD. At the onset of WFD, inspections are no longer sufficient to protect safety. The risk analysis of 5.2.16 shall be used to initially establish the time to onset of WFD. Upon their availability, the risk analysis updates of 5.5.6.3 shall be used to update the estimated time to onset of WFD.

5.4.3.2.1 Inspection intervals.

The criteria for the initial and repeat inspection intervals shall be as follow:

- a. The initial inspections for fail-safe design concepts shall be established based on either: 1) fatigue analyses and tests with an appropriate scatter factor, or 2) slow damage growth analyses and tests assuming an appropriate initial flaw size.
- b. The initial inspection for slow damage growth design concepts shall occur at or before one-half the life from the assumed maximum probable initial flaw size to the critical flaw size.
- c. The repeat inspection intervals for both design concepts shall occur at or before one-half the life from the minimum detectable flaw size (based on the probability of detection) to the critical flaw size.
- d. The risk analysis of 5.2.16 and 5.5.6.3 should be used to determine if a reduction in the inspection intervals are required to control the safety risk to an acceptable level or to reduce economic or availability consequences associated with damage repair.

5.4.3.2.2 Inspection methods.

Results from structural analysis shall be used to identify the inspection methods required to detect anticipated damage. Selection of the inspection methods shall consider material, geometry, accessibility,

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human factors, and the resulting assumed detectable flaw size. Alternate inspection capability estimates may be used if demonstrated using the guidance of MIL-HDBK-1823 and as approved by the Nondestructive Inspection Requirements Review Board.

5.4.3.3 Surveillance.

A surveillance program shall be developed to improve estimates of the in-service times when damage requires maintenance actions (inspections, repairs, modifications or retirements, etc.). Two essential components of a surveillance program are an ACI Program and a Structural Teardown Program.

5.4.3.3.1 Analytical Condition Inspection (ACI) Program.

An ACI Program shall be conducted throughout the life of the aircraft per Air Force Materiel Command Instruction (AFMCI) 21-102. Corrosion, fatigue, and other damage scenarios shall be considered in the selection of inspection locations and schedules for the aircraft structure. Aircraft scheduled for the ACI Program based on Individual Aircraft Tracking (IAT) estimates of structural damage shall be referred to as Lead the Fleet (LTF) aircraft. The ACI Program shall be conducted with special emphasis on determination of when and where corrosion occurs and on prototypes of NDI and repair actions.

5.4.3.3.2 Structural Teardown Program.

A Structural Teardown Program may be required if an aircraft is expected to operate beyond its design service life or if there is evidence of extensive damage that may jeopardize the aircraft's structural integrity. The need for and timing of a Structural Teardown Program shall be based on force management updates described in 5.5.6.

5.4.3.4 Repair criteria.

Allowable damage limits and damage growth rates shall be established to develop repair concepts for structural components and assemblies. Structural analyses shall be used to establish repair designs and to identify post-repair inspection requirements.

5.4.4 Loads/Environment Spectra Survey (L/ESS) development.

A system to perform a loads/environment spectra survey (L/ESS) shall be developed to obtain actual usage data that can be used to update or confirm the original design spectrum. A sufficient number of aircraft shall be instrumented to achieve a 20-percent valid data capture rate of the fleet usage data. L/ESS systems shall record time-history data such as vertical and lateral load factors; roll, pitch and yaw rates; roll, pitch, and yaw accelerations; altitude; Mach number; control surface positions; selected strain measurements; ground loads; aerodynamic excitations; etc. Data shall also be collected to characterize the thermal and chemical environments within the aircraft and associated with aircraft basing. If the IAT Program as described in 5.4.5 obtains sufficient data to develop the baseline operational loads/environment spectrum and to detect significant changes in usage and/or environment, a separate L/ESS system as described herein is not required. If instrumentation and/or sensors are part of the L/ESS Program, the instrumentation shall be incorporated into the full-scale static test described in 5.3.1, into the full-scale durability test described in 5.3.4, and into the flight and ground loads survey aircraft described in 5.3.3.1. Data systems should comply with the requirements of AFD 63-14 and AFI 63-1401.

5.4.5 Individual Aircraft Tracking (IAT) Program development.

A program to perform individual aircraft tracking shall be developed to obtain actual usage data that can be used to adjust maintenance intervals on an individual aircraft ("by tail number") basis. All force aircraft shall have systems that record sufficient usage parameters that can be used to determine the damage growth rates throughout the aircraft structure. The systems shall have sufficient capacity and reliability to achieve a 90-percent minimum valid data capture rate of all flight data throughout the service life of the aircraft. The systems shall include serialization of interchangeable/replaceable aircraft

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structural components, as required. The IAT Program shall be ready to acquire data at the beginning of initial flight operations. If instrumentation and/or sensors are part of the IAT Program, the instrumentation shall be incorporated into the full-scale static test described in 5.3.1, into the full-scale durability test described in 5.3.4, and into the flight and ground loads survey aircraft described in 5.3.3.1. Data systems should comply with the requirements of AFD 63-14 and AFI 63-1401.

5.4.5.1 Tracking analysis methods.

Analysis methods shall be developed which adjust the inspection and modification times based on the actual measured usage of the individual aircraft. These methods shall have the ability to predict damage growth in all critical locations and in the appropriate environment as a function of the total measured usage, and to recognize changes in operational mission usage. The methods shall also provide the ability to determine the equivalent flight hours. The analysis methods and accompanying computer programs shall be provided to the USAF.

5.4.6 Rotorcraft Dynamic Component Tracking (RDCT) Program development.

A program to perform rotorcraft dynamic component tracking (RDCT) shall be developed to provide data to support condition-based maintenance. One hundred percent of the rotorcraft shall be instrumented with systems that measure component responses to operations and that anticipate impending failures. The systems shall provide sufficient warning of impending failure to allow safe flight and landing. The RDCT Program shall be ready to acquire data at the beginning of initial flight operations.

5.5 Force management execution (Task V).

Task V describes the execution of the force management strategy described in Task IV. Task V will be primarily the responsibility of the USAF. Force management shall be conducted by executing the FSMP. The maintenance schedule directed by the FSMP shall be adjusted for each aircraft by data received from the IAT Program described in 5.5.1 or by the RDCT system described in 5.5.2. The FSMP shall be updated periodically to ensure it accurately and efficiently protects against structural failures. Updates to the FSMP shall be based on evaluations of changes in operational usage described in 5.5.3 as well as assessments of new damage findings documented within the structural maintenance database described in 5.5.5.1. Periodic action shall be taken to ensure the reliability of the on-board usage data-gathering equipment is sufficient to achieve the required data capture rates. Any changes to the force management strategy shall be documented in the ASIP Master Plan described in 5.1.1.

5.5.1 Individual Aircraft Tracking (IAT) Program.

The IAT Program shall be used to adjust the inspection, modification, overhaul, and replacement times based on the actual, measured usage of the individual aircraft. The IAT Program shall be used to determine damage growth in the appropriate environment as a function of the total measured usage and to quantify changes in operational mission usage. The IAT Program shall also determine the equivalent flight hours (or other appropriate measures of damage such as landings, pressure cycles, etc.) and adjust the required maintenance schedule for all critical locations on each individual aircraft. The IAT Program shall forecast when aircraft structural component life limits will be reached. Data systems should comply with the requirements of AFD 63-14 and AFI 63-1401.

5.5.2 Rotorcraft Dynamic Component Tracking (RDCT) Program.

The RDCT Program shall measure rotorcraft dynamic component responses to operations and provide data to support condition-based maintenance and to anticipate impending failures. The systems shall provide sufficient warning of impending failure to allow safe flight and landing.

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5.5.3 Loads/Environment Spectra Survey (L/ESS).

The loads/environment spectra survey shall be conducted to obtain actual usage data that can be used to update the original design spectrum. A new baseline operational loads spectrum shall be developed from the in-flight measurements and the predicted operational environment updated as necessary. Significant changes to the baseline operational loads spectrum shall be used to update the analyses described in 5.5.5. Data systems should comply with the requirements of AFPD 63-14 and AFI 63-1401.

5.5.3.1 Initial Loads/Environment Spectra Survey.

The initial survey period shall last for at least 3 years after Initial Operating Capability (IOC). The length of the initial survey period shall be based on evaluations of the mission types, mission mix, and quantity of aircraft in service.

5.5.3.2 Loads/Environment Spectra Survey updates.

The stability of mission types, mixes, and severity shall be evaluated to determine the need for periodic survey updates. The ASIP Manager shall review the need for L/ESS updates annually.

5.5.4 ASIP Manual.

An Aircraft Structural Integrity Program Technical Order (T.O. X-YY-38) is required for each aircraft per MIL-DTL-87929; Appendix G of the specification provides format and content for an Aircraft Structural Integrity Program Technical Manual. The intent of a T.O. X-YY-38 is to provide the flight-line maintainer basic information on the ASIP and to define actions (if any) that maintainers must perform to support the ASIP. Periodic updates of this technical order are required as the ASIP changes.

5.5.5 Aircraft structural records.

Records which pertain to aircraft structures shall be retained to provide a historical basis for evaluation of continued airworthiness.

5.5.5.1 Structural maintenance records.

The structural maintenance database shall be used to capture detailed information on the aging processes occurring in the aircraft and support the ongoing evaluation of structural integrity during sustainment. The database shall record all significant damage findings such as cracks, corrosion, and/or delaminations discovered during PDM, analytical condition inspections, TCTO structural inspections, teardown inspections, and normal operational maintenance. The database shall also record a description of the damage types, damage sizes, damage locations, inspection techniques (including POD information), aircraft configuration, pertinent aircraft usage history including basing information, and corrosion preventative methods (e.g., wash cycles, coatings, etc.). The database shall also record all significant repairs and/or modifications so as to maintain configuration control. These records shall include a description of the repair/modification and when it was incorporated.

5.5.5.2 Weight and balance records.

Weight and balance records shall be maintained to ensure the aircraft remains within its approved limitations. Guidance may be found in SAWE RP No. 7 and T.O. 1-1B-50.

5.5.6 Force management updates.

Mission and usage changes, major modifications, as well as aircraft inspection findings shall be evaluated by analysis and/or testing (to include a possible additional full-scale static and/or durability test) to determine the need for and timing of periodic updates to the force management strategy. It is envisioned that updates will be required every 5 years or as dictated by the requirements defined in the subparagraphs below. Information which results from the updates described below shall be documented in the FSMP.

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5.5.6.1 Durability and Damage Tolerance Analysis (DADTA) and IAT Program updates.

The IAT data described in 5.5.1, L/ESS data described in 5.5.3, and the aircraft structural records described in 5.5.5 shall be used to determine when Durability and Damage Tolerance Analysis (DADTA) and IAT Program updates should be conducted. Variations in the average usage from the analysis baseline and usage variation extremes from the analysis baseline shall be considered when the need for an update is determined. In addition, an update to the DADTA and IAT Program shall be conducted when aircraft damage findings indicate the accuracy of the analyses are less than expected per the results of 5.4.1.2.

5.5.6.2 Corrosion assessment updates.

Information obtained from the ACI Program and new corrosion findings documented in the structural maintenance database shall be reviewed annually. The occurrences of corrosion shall be evaluated with regard to the effectiveness of the preventive procedures (e.g., frequency of wash cycles, coatings, corrosion prevention compounds, etc.) used and, if possible, corrosion findings shall be correlated to the aircraft basing and the results of Task II and Task III environmental testing. The results of these evaluations and any observed trends will be used to develop improved maintenance procedures and adjust the corrosion inspection requirements in the FSMP.

5.5.6.3 Risk analysis updates.

The risk analyses described in 5.2.16 and 5.4.1.1 shall be updated and the results shall be reported for formal acceptance using MIL-STD-882 direction. The EIFS distribution developed under 5.3.4 shall be updated to include aircraft inspection results (e.g., sizes of cracks found and number of locations inspected) which account for the IAT data described in 5.5.1 to determine the probability of failure of the aircraft structure. Validation of the EIFS distribution by teardown inspection of aircraft and/or components with high levels of predicted damage shall be considered. The primary reasons to update the risk analyses are to:

- a. evaluate detected and anticipated aircraft structural damage. The results shall be used in conjunction with IAT data described in 5.5.1 to establish the individual aircraft maintenance times.
- b. Evaluate economic and/or availability impacts associated with maintenance options such as inspection and repair/replacement as needed versus modification.
- c. Determine the structural integrity risk associated with operating the aircraft beyond the design service life.

These updates shall be used to compare the predicted probability of catastrophic failure of the aircraft structure to the following limits. A probability of catastrophic failure at or below 10^{-7} per flight for the aircraft structure is considered adequate to ensure safety for long-term military operations. Probabilities of catastrophic failure exceeding 10^{-5} per flight for the aircraft structure should be considered unacceptable. When the probability of failure is between these two limits, consideration should be given to mitigation of risk through inspection, repair, operational restrictions, modification, or replacement.

5.5.7 Recertification.

Recertification of the aircraft structure shall be performed if significant deviations from the certification baseline occur. Such deviations may include changes to usage, damage, and/or service life expectancy. The recertification analyses shall provide the engineering source data for revision of Technical Orders which document the operational limitations/restrictions, procedures, and maintenance requirements to ensure continuing safe operation. Recertification efforts should consider all ASIP tasks and elements and may require an additional full-scale static and/or durability test.

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

6.1 Intended use.

This standard is intended as a foundation to establish and conduct an ASIP for all USAF aircraft developed to perform combat and support missions in environments unique to military weapons systems, and may be used by other agencies at their discretion. Contractual documents may contain tailored requirements for each program, based on the content herein.

6.2 Acquisition requirements.

Acquisition documents should specify the following:

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

6.3 Data requirements.

The long-term operation and maintenance of USAF aircraft and equipment is directly dependent on the availability of certain structural data developed during an ASIP. These data are used to establish, assess, and support inspections; maintenance activities; repairs; modification tasks; and replacement actions for the life of the aircraft structure. Contractual provisions must ensure these data are available to the USAF and to relevant contractors and subcontractors throughout the operational life of the system. The following list is provided as a general guide to the necessary data. This list may be tailored based on system operational requirements, the support concept/strategy, AFPD 63-14, AFI 63-1401, the requirements contained in this standard, and guidance in JSSG-2006.

- a. ASIP Master Plan and integration with the IMP and IMS (See [5.1.1.](#))
- b. Design service life and design usage (See [5.1.2.](#))
- c. Structural design criteria (See [5.1.3.](#))
- d. Durability and Damage Tolerance Control Program (See [5.1.4.](#))
- e. Corrosion Prevention and Control Program (See [5.1.5.](#))
- f. Nondestructive Inspection Program (See [5.1.6.](#))
- g. Selection of materials, processes, joining methods, and structural concepts (See [5.1.7.](#))
- h. Material and joint allowables (See [5.2.1.](#))
- i. Loads analysis (See [5.2.2.](#))
- j. Design service loads spectra (See [5.2.3.](#))
- k. Design chemical/thermal environment spectra (See [5.2.4.](#))
- l. Stress analysis (See [5.2.5.](#))
- m. Damage tolerance analysis (See [5.2.6.](#))
- n. Durability analysis (See [5.2.7.](#))
- o. Corrosion assessment (See [5.2.8.](#))
- p. Sonic fatigue analysis (See [5.2.9.](#))
- q. Vibration analysis (See [5.2.10.](#))
- r. Aeroelastic and aeroservoelastic analysis (See [5.2.11.](#))
- s. Mass properties analysis (See [5.2.12.](#))
- t. Survivability analysis (See [5.2.13.](#))
- u. Design development tests (See [5.2.14.](#))
- v. Production NDI capability assessment (See [5.2.15.](#))
- w. Initial risk analysis (See [5.2.16.](#))
- x. Static tests (See [5.3.1.](#))

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- y. First flight verification ground tests (See 5.3.2.)
- z. Flight tests (See 5.3.3.)
- aa. Durability tests (See 5.3.4.)
- bb. Damage tolerance tests (See 5.3.5.)
- cc. Climatic tests (See 5.3.6.)
- dd. Interpretation and evaluation of test results (See 5.3.7.)
- ee. Certification analyses (See 5.4.1.)
- ff. Strength Summary & Operating Restrictions (SSOR) (See 5.4.2.)
- gg. Force Structural Maintenance Plan (FSMP) (See 5.4.3 and 5.5.6.)
- hh. Loads/Environment Spectra Survey (L/ESS) (See 5.4.4 and 5.5.3.)
- ii. Individual Aircraft Tracking (IAT) Program (See 5.4.5 and 5.5.1.)
- jj. Rotorcraft Dynamic Component Tracking (RDCT) Program (See 5.4.6 and 5.5.2.)
- kk. Aircraft structural records (See 5.5.5.)
- ll. ASIP Manual (See 5.5.4.)
- mm. Probability of failure limits (See 5.5.6.3.)
- nn. Recertification (See 5.5.7.)

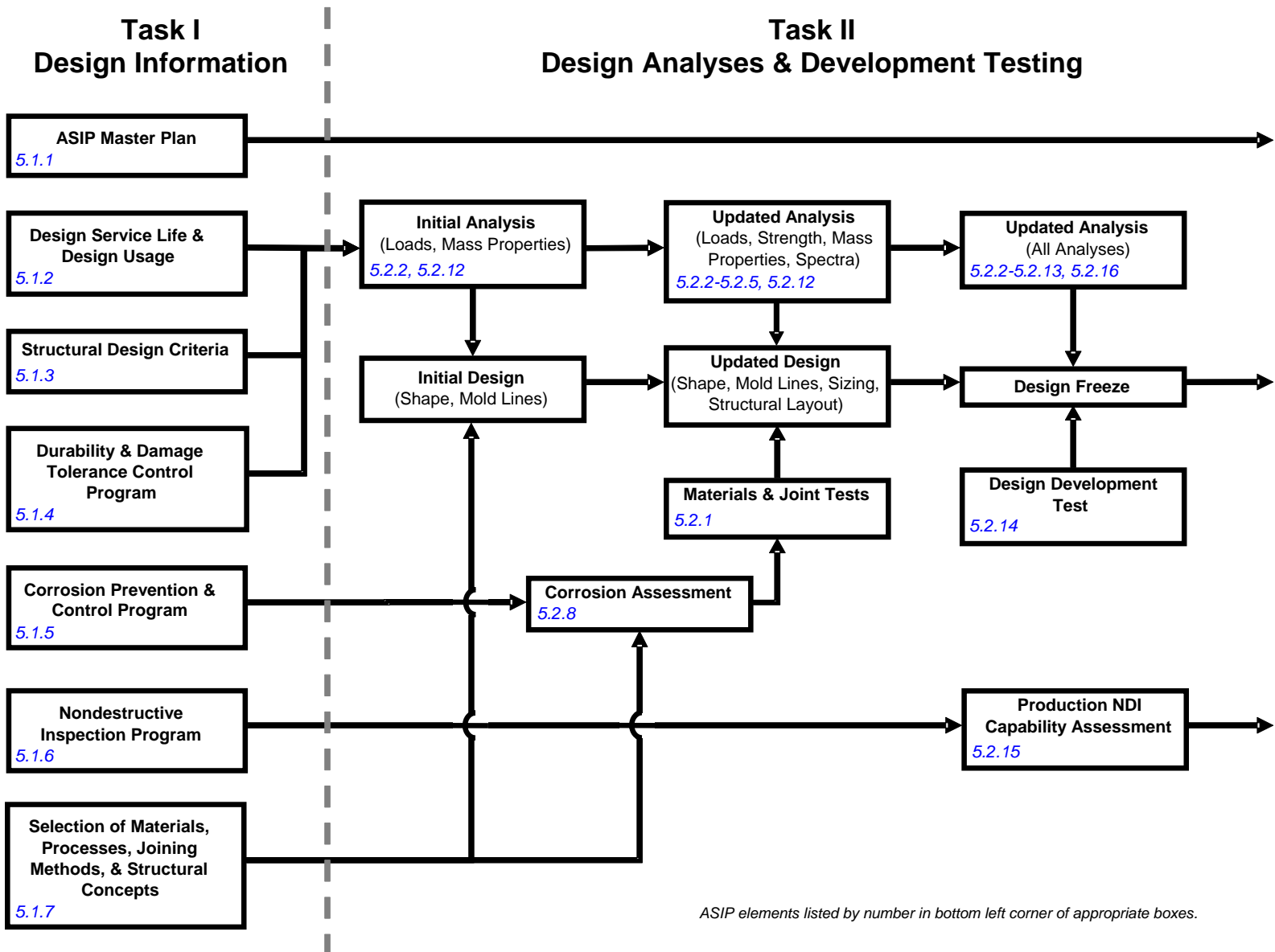
6.4 Subject term (key word) listing.

aeroacoustics
aircraft structure
corrosion
cracking
damage tolerance
durability
economic life
fatigue
flight test
flutter
force management
ground test
loads
mass
nondestructive inspection (NDI)
probability of failure
proof test
risk
service life
static test
strength
sustainment
vibration
weight and balance
widespread fatigue damage

6.5 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.

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ASIP elements listed by number in bottom left corner of appropriate boxes.

FIGURE 2. Aircraft Structural Integrity Program – Tasks I and II.

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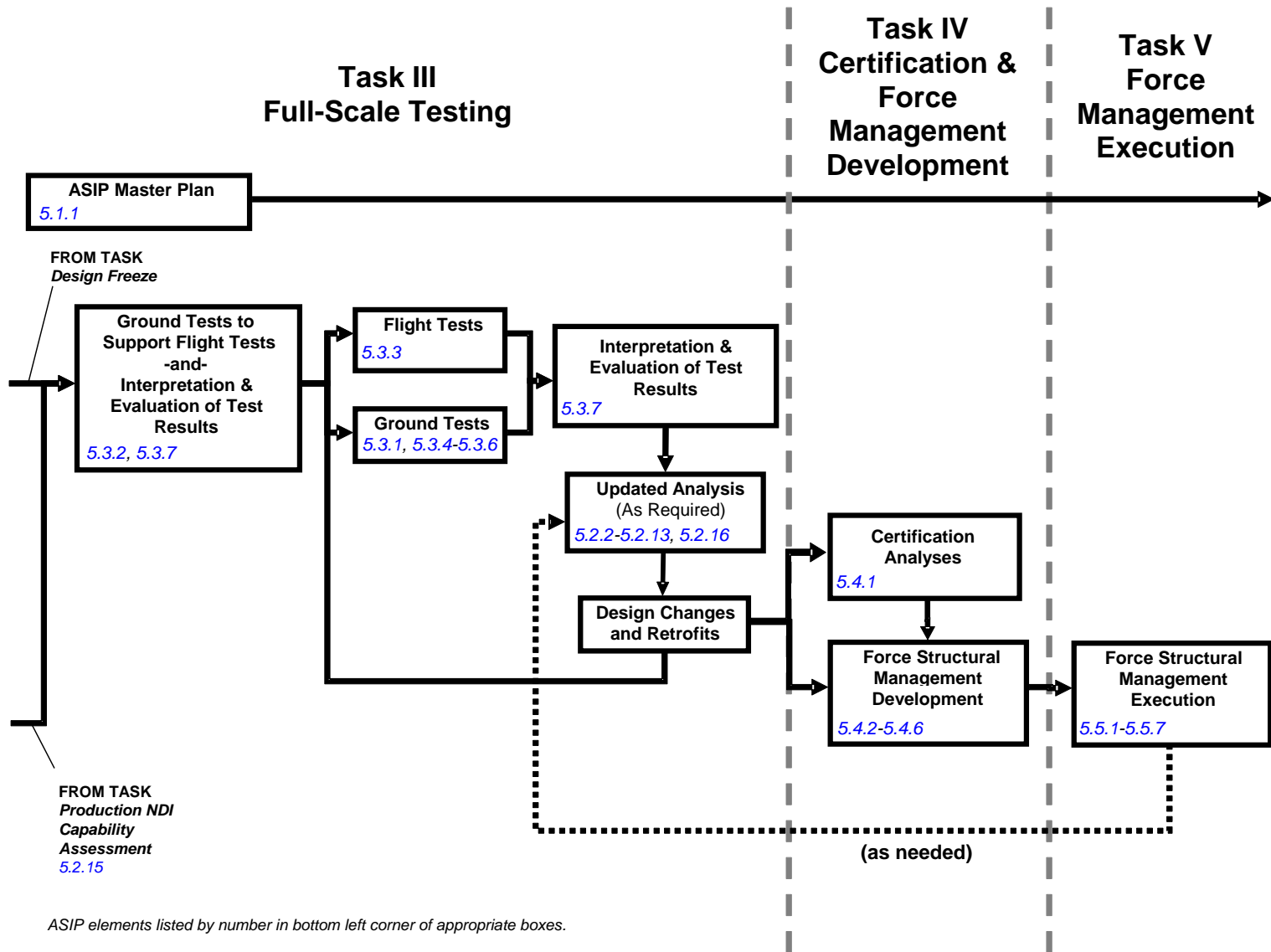


FIGURE 3. Aircraft Structural Integrity Program – Tasks III through V.

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Custodian:
Air Force – 11

Preparing activity:
Air Force – 11
(Project 15GP-2005-009)

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