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DEPARTMENT OF DEFENSE

HANDBOOK

NONDESTRUCTIVE INSPECTION PROGRAM REQUIREMENTS FOR AIRCRAFT AND MISSILE MATERIALS AND PARTS



This handbook is for guidance only.
Do not cite this document as a requirement.

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FOREWORD

1. This handbook is approved for use by all Departments and Agencies of the Department of Defense (DoD).
2. This handbook provides guidance for establishing a nondestructive inspection (NDI) program for evaluation of structural components in development, production or sustainment of aircraft and missiles systems. This document is directly applicable when referenced in the item specification contract or order.
3. Comments, suggestions, or questions on this document should be addressed to AFRL/RXSA, 2179 12th St., Wright-Patterson AFB, OH 45433-7717 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 <https://assist.dla.mil>.

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1. SCOPE

1.1 Scope.

This handbook details guidance to Government personnel and contractors for defining the requirements for establishing an acceptable Nondestructive Inspection (NDI) program for DoD aircraft structure, aircraft stores (external structures such as antennas, pods, fuel tanks, weapons, radomes, etc.) and missile structural components when an NDI Program Plan is required in the contract or order. NDI Programs are essential to ensuring NDI processes are implemented to support the lifecycle design requirements of the system and its components. NDI Programs are applicable to all phases of the system life cycle, including acquisition, modification, and sustainment. This handbook may also be applicable to mechanical equipment, subsystems and propulsion systems, but the requirements defined by the NDI Program Plan should be tailored by the contracting agency for such use. An NDI Program Plan should be developed at the beginning of the technology development phase, and should define all NDI requirements to be adhered to throughout the system life cycle. This handbook is for guidance only and cannot be cited as a requirement.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed below are not necessarily all of the documents referenced herein, but are those needed to understand the information provided by this handbook.

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.

DEPARTMENT OF DEFENSE SPECIFICATIONS

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

DEPARTMENT OF DEFENSE STANDARDS

| | | |
|--------------|---|---|
| MIL-STD-867 | – | Temper Etch Inspection |
| MIL-STD-1530 | – | Aircraft Structural Integrity Program (ASIP) |
| MIL-STD-1537 | – | Test Method Standard for Electrical Conductivity Test for Verification of heat Treatment of Aluminum Alloys Eddy Current Method |
| MIL-STD-1798 | – | Mechanical Equipment and Subsystems Integrity Program |
| MIL-STD-1907 | – | Inspection, Liquid Penetrant and Magnetic Particle, Soundness Requirements for Materials, Parts, and Weldments |
| MIL-STD-3024 | – | Propulsion System Integrity Program (PSIP) |
| MIL-STD-3048 | - | Air Force Business Rules for Implementation of |

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MIL-STD-40051 – Preparation of Digital Technical Information for IETMs

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-516 – Airworthiness Certification Criteria

MIL-HDBK-1823 – Nondestructive Evaluation System Reliability Assessment

(Copies of these documents are available online at <https://assist.dla.mil>)

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.

JOINT AIR FORCE-NAVY-ARMY TECHNICAL MANUAL

TO 33B-1-2 – Nondestructive Inspection General
 TM 1-1500-366-23 Procedures and Process Controls
 NAVAIR 01-1A-16-2

(Copies of this documents are available thru ETIMS online at <https://etims.cce.af.mil/ETIMS/index.jsp>)

AIR FORCE SERVICE BULLETINS

EN-SB-008-011 – Nondestructive Inspection of Safety-of-Flight Structures
 EN-SB-008-012 – In-Service Flaw Assumptions for Metallic Structures
 EZ-SB-13-003 – Revised Initial Flaw Size Assumptions for Slow Crack Growth (SCG) Metallic Structures
 EZ-SB-15-001 – Aircraft Structures Teardown Inspection and Evaluation Program Protocols
 EZ-SB-15-002 – Requirements for NDI Procedure Development, Validation and Verification for Aircraft Inspection During Operations and Support Phase

(Copies of these document are available from EngineeringStandards@wpafb.af.mil)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein.

AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA (AIA)

NAS410 – NAS Certification & Qualification of Nondestructive Test Personnel (DoD Adopted)

(Copies of this document are available online from www.aia-aerospace.org.)

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ASTM INTERNATIONAL

| | | |
|------------------------|---|--|
| ASTM B244 | – | Standard Test Method for Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments (DoD Adopted) |
| ASTM E164 | – | Standard Practice for Contact Ultrasonic Testing of Weldments (DoD Adopted) |
| ASTM E213 | – | Standard Practice for Ultrasonic Testing of Metal Pipe and Tubing |
| ASTM E215 | – | Standard Practice for Standardizing Equipment and Electromagnetic Examination of Seamless Aluminum-Alloy Tube (DoD Adopted) |
| ASTM E2375 | – | Standard Practice for Ultrasonic Testing of Wrought Products |
| ASTM E2445/E2445M | – | Standard Practice for Performance Evaluation and Long-Term Stability of Computed Radiography Systems |
| ASTM E309 | – | Standard Practice for Eddy Current Examination of Steel Tubular Products Using Magnetic Saturation (DoD Adopted) |
| ASTM E376 | – | Standard Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Testing Methods (DoD Adopted) |
| ASTM E426 | – | Standard Practice for Electromagnetic (Eddy Current) Examination of Seamless and Welded Tubular Products, Titanium, Austenitic Stainless Steel and Similar Alloys (DoD Adopted) |
| ASTM E498/E498M | – | Standard Practice for Leaks Using the Mass Spectrometer Leak Detector or Residual Gas Analyzer in the Tracer Probe Mode (DoD Adopted) |
| ASTM E1004 | – | Standard Test Method for Determining Electrical Conductivity Using the Electromagnetic (Eddy -Current) Method (DoD Adopted) |
| ASTM E1417/ E1417M | – | Standard Practice for Liquid Penetrant Testing (DoD Adopted) |
| ASTM E1444/ E1444/M | – | Standard Practice for Magnetic Particle Testing (DoD Adopted) |
| ASTM E1742/ E1742M | – | Standard Practice for Radiographic Examination (DoD Adopted) |

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| ASTM E2033 | – | Standard Practice for Computed Radiology (Photostimulable Luminescence Method) |
| ASTM E2339 | - | Standard Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE) |
| ASTM E2580 | – | Standard Practice for Ultrasonic Testing of Flat Panel Composites and Sandwich Core Materials Used in Aerospace Applications (DoD Adopted) |
| ASTM E2581 | – | Standard Practice for Shearography of Polymer Matrix Composites, and Sandwich Core Materials and Filament-Wound Pressure Vessels in Aerospace Applications (DoD Adopted) |
| ASTM E2582 | – | Standard Practice for Infrared Flash Thermography of Composite Panels and Repair Patches Used in Aerospace Applications (DoD Adopted) |
| ASTM E2662 | – | Standard Practice for Radiologic Examination of Flat Panel Composites and Sandwich Core Materials Used in Aerospace Applications (DoD Adopted) |
| ASTM E2663 | – | Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE) for Ultrasonic Test Methods |
| ASTM E2698 | – | Standard Practice for Radiological Examination Using Digital Detector Arrays |
| ASTM E2736 | – | Standard Guide for Digital Detector Array Radiology |
| ASTM E2737 | – | Standard Practice for Digital Detector Array Performance Evaluation and Long-Term Stability |

(Copies of these documents are available from www.astm.org.)

SAE INTERNATIONAL

| | | |
|--------------|---|--|
| AMS-I-83387 | – | Inspection Process, Magnetic Rubber |
| AMS-STD-2154 | – | Inspection, Ultrasonic, Wrought Metals, Process for |
| AMS 2644 | | Inspection Material Penetrant |
| AMS 2647 | – | Fluorescent Penetrant Inspection Aircraft and Engine Component Maintenance |
| ARP4402 | | Eddy Current Inspection of Open Fastener Holes in Aluminum Aircraft Structures |
| AS4787 | – | Eddy Current Inspection of Circular Holes in NonFerrous Metallic Engine Hardware |

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ARP4462 – Barkhausen Noise Inspection for Detecting Grinding Burns in High Strength Steel Parts

(Copies of these documents are available online at www.sae.org.)

2.4 Order of precedence.

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

3 DEFINITIONS

3.1 Inspector certification.

A written statement from the certifying agency verifying that an individual inspector has met applicable requirements. The certifying agency may be the employer of the inspection personnel.

3.2 Classification.

Classification refers to functional reliability requirements of the part and implies a confidence level requirement for NDI. A high-reliability class (i.e. fracture-critical and fracture-critical traceable) may require NDI capability demonstrations to assure the capability and confidence level of the NDI process; applied to that component to meet the intended design requirement. Complex components may also be divided into zones with separate classifications.

3.3 Contracting agency.

A contractor, subcontractor or government agency procuring product or services.

3.4 Contractor.

An organization having contractual responsibility to the government.

3.5 Durability-critical part.

A non-safety-of-flight structural component that is judged to require additional controls beyond those for normal-control parts.

3.6 Final inspection.

The last inspection of a part or component usually just prior to final acceptance. This inspection may occur during manufacturing and also before a component is built into an assembly and will become uninspectable. The final inspection may also be an inspection just after some processing step and is not subject to reinspection by the manufacturer after further processing. Final inspection may also occur in maintenance activities just before the component is built into an assembly where subsequent inspection is not possible.

3.7 Fracture-critical part.

A safety-of-flight, structural component that is not single load path nor judged to require serialization and traceability (reference MIL-STD-1530, MIL-STD-3024, MIL-HDBK-516 and JSSG-2006).

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3.8 Fracture-critical traceable part.

A safety-of-flight structural that is either single load path or judged to require serialization and traceability (reference MIL-STD-1530, MIL-STD-3024, MIL-HDBK-516 and JSSG-2006).

3.9 Life Cycle.

The entire life of a program or system, including design, development, testing, production, sustainment, modification, and disposal.

3.10 Maintenance-critical part.

A structural component whose failure will not cause a safety-of-flight condition but the failure of which would not be economical to repair or replace.

3.11 Mission-critical part.

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.

3.12 Material Review Board (MRB).

A government approved review of discrepant materials by authorized contractor engineering and quality assurance personnel to determine whether material or component can be returned to an acceptable state.

3.13 Nondestructive inspection (NDI).

The inspection of a structure or component in any manner that will not impair its future usefulness. The purpose of NDI may be to detect flaws at or beneath the external surface of a part, measure geometric characteristics, determine material structure or composition, or it may characterize physical, electrical, or thermal properties without causing changes in the part. The five primary methods of NDI are liquid penetrant, magnetic particle, eddy current, ultrasonic and radiography. Other methods include but are not limited to computed tomography, shearography and thermography.

3.14 Nondestructive inspection (NDI) procedure.

Step-by-step instructions for performing a particular NDI method on a specific part or family of parts (see [5.3.4](#)).

3.15 General NDI procedure.

Non-part specific, Step-by-step NDI instructions applicable to common product forms such as plates, composite laminates and bonded assemblies, bar stock, fasteners and tubular products, etc. General NDI procedures may also include those that describe standardization and inspection processes, for common inspection methods.

3.16 Part specific NDI procedures.

Step-by-step instructions for inspection of a designated part or component, which incorporates all processing criteria. The contractor's or customer's general procedures may be used to form part of specific NDI procedures when supplemented by part specific information, permitted by contract

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and approved by the customer. With approval from the contracting agency, part specific NDI procedures may be used in lieu of company process specifications.

3.17 NDI facility.

Organizations responsible for providing NDI services in support of the program in any phase of the system life cycle.

3.18 NDI Program Plan.

Document that defines the approach for implementing NDI processes throughout the system life cycle.

3.19 NDI process specification.

NDI process specifications define the requirements for equipment, reference standards, materials, personnel, etc., for a particular NDI method or for the testing of a particular product.

3.20 NDI Requirements Review Board (NDIRRB).

An advisory team (also known as an NDI Advisory Board) comprised of NDI, durability and damage tolerance, design, materials and processes (M&P), subject matter experts (SMEs) representing the prime, major subcontractors, and government/customer. The NDIRRB should be formed early in the conceptual phase of a weapons system to provide guidance to the prime contractor, major sub-contractors, System Program Office (SPO), and subsequently to the System Program Manager (SPM), on all technical matters necessary to establish, implement and maintain an effective life cycle NDI Program responsive to the quality assurance, structural integrity and sustainment requirements of the program. The NDIRRB should review and assess inspection requirements and processes during all phases of the program from initial design development through production and in-service operation.

3.21 Probability of detection (POD).

A statistical measurement of the likelihood, with a specified confidence level, of finding a flaw of a defined size using a specific inspection process.

3.22 Qualification.

The verified ability of personnel or products to meet the minimum capability, technical or performance requirements for a specified level of capability.

3.23 Safety-of-flight structure.

Structures whose single failure could cause loss of the weapon system, aircrew, or cause inadvertent store release. The loss could occur either immediately upon failure or subsequently if the failure remained undetected.

3.24 Subcontractors.

Organizations responsible to the contractor for a portion of the overall government contracted product.

3.25 Supplier.

Organizations directly responsible for delivering a material, part or service to the government, a contractor, or a subcontractor.

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3.26 Validation.

The process of demonstrating the applicability of a proposed inspection process (equipment and procedures) to meet a specified requirement.

3.27 Verification.

The process of certifying the efficacy of an inspection process (equipment, reference standards and written procedures) through a demonstration, on a representative structure, in a representative environment, and by representative inspection personnel.

4 REQUIREMENTS

4.1 General Requirements.

The acquisition or modification of aircraft, aircraft stores, missiles and their propulsion systems should stress the inclusion and use of NDI throughout the system life cycle. A detailed life cycle NDI Program Plan is an integral component of the structural maintenance plans required by MIL-STD-1530.

4.2 Preparation of the NDI Program Plan.

The prime contractor should establish in writing an overall systems plan to assure adequate NDI of structural components. This systems plan should include provisions for conducting NDI throughout all phases of the program life cycle. This systems plan is referred to herein as the NDI Program Plan. The NDI Program Plan should be subject to review by the NDIRRB and approval by the government. It is paramount that the NDIRRB program plan be frequently updated to include evolving program requirements as each new phase of the program is implemented. The NDI program should consider and implement appropriate NDI processes into all phases of the program life cycle. [Appendix A](#) provides a NDI Program Plan template.

4.3 Responsibility for NDI.

Unless otherwise specified in the contract, the contractor is responsible for the performance of all production inspection requirements as specified in the NDI Program Plan. Except as otherwise specified in the contract, the contractor may use their own or any other facilities suitable for the performance of the inspection requirements unless disapproved by the government. The contractor will be responsible for NDI sustainment tasks as specified in the contract.

4.3.1 Objective.

The objective of the NDI Program Plan is to assure a level of NDI capability, for both production and sustainment inspections, consistent with the prime contractor's design requirements.

4.3.2 Applicability.

The NDI Program Plan should be applicable to structural components produced under the program contract. It is the prime contractor's responsibility to flow down the NDI Program Plan requirements to all subcontractors and suppliers supporting the Program.

4.3.3 Elements.

The NDI Program Plan should present the scheme for establishing the NDI requirements and implementing processes and procedures to meet these requirements. The NDI Program Plan documents how NDI processes will be implemented, executed, controlled and monitored for compliance across the supplier base throughout the system life cycle. It should include descriptions

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of processes and requirements that will be used to accomplish the following tasks:

- a. Inspect parts in accordance with part classification requirements.
- b. Coordination of design requirements and production NDI procedures.
- c. Establishment, review and concurrence of NDI drawing notes by the contractor's NDI Level III representative to the NDIRRB prior to drawing release.
- d. Preparation, review, and approval of production NDI process specifications and written inspection procedures.
- e. Demonstration of production NDI capability.
- f. Qualification of prime contractor, sub-contractor, and supplier facilities where NDI will be conducted.
- g. Obtaining and maintaining qualified NDI staff and an accredited NDI training/certification program.
- h. Implementation of production NDI procedures.
- i. Storage and retention of production NDI records and digital records (e.g., digital radiographs, ultrasonic C-scans).
- j. Coordination and documentation of inspection requirements to support long-term sustainment including structural repairs.
- k. Preparation of NDI technical data for long term sustainment.
- l. Validation and verification of inspection technical data for sustainment.
- m. Assessment and documentation of sustainment NDI capability.
- n. Coordination of NDI requirements for test articles (coupon, component, destruct, full-scale static and fatigue) and development of NDI methods and procedures to support test articles.
- o. Development of NDI training and supporting materials for sustainment inspections that have elements or requirements unique to the system (e.g., NDI methods, NDI equipment, materials, and/or manufacturing processes requiring procedures that sustainment personnel supporting the system do not have experience with).
- p. Qualification of new technologies for use during any phase of the system life cycle.
- q. Qualification of NDI methods adapted for the purpose of in-situ structural damage sensing.

4.3.4 Coordination.

For DoD programs the NDI Program Plan will be delivered to the government for review and approval per contract requirements. This plan should be coordinated with the contractor, the integrity program managers (*ASIP / PSIP / MECSIP*) as applicable, and the NDI Requirements Review Board (NDIRRB). When MIL-STD-1530 is a contractual requirement the Aircraft Structural Integrity Plan (ASIP) manager is responsible for review and approval. When MIL-STD-3024 is invoked, the customer Propulsion Integrity Plan (PSIP) manager is responsible for review and approval. When MIL-STD-1798 is a contractual requirement the Mechanical Equipment and Subsystems Integrity Program (MECSIP) manager is responsible for review and approval.

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4.4 Parts classification.

4.4.1 Structural parts classification.

The contractor should classify all structural components according to the structural integrity requirements of MIL-STD-1530, MIL or other contractual requirements. Complex components may be divided into zones and a separate classification or quality grade assigned to each zone in accordance with the reliability requirements. Classification should be noted on the drawing of the component or other released engineering data. NDI requirements may vary with part classification. Part classification categories include (see 3.0 for definitions):

Fracture-critical.

Fracture-critical traceable.

Durability-critical.

Mission-critical.

Maintenance-critical.

Normal controls (all parts not included in the above categories).

4.4.2 Propulsion systems parts classification.

When this handbook is used to establish an NDI Program Plan for propulsion system components the parts classification requirements of MIL-STD-3024 should be used.

4.4.3 Mechanical equipment and subsystem parts classification.

When this handbook is used to establish an NDI Program Plan for mechanical equipment or subsystem components, the parts classification requirements of MIL-STD-1798 should be used.

4.5 NDI Requirements Review Board (NDIRRB).

The contractor should establish and maintain a Nondestructive Inspection Requirements Review Board (NDIRRB) (also known as an NDI Advisory Board (NDIAB)) for oversight and execution of the NDI Program Plan. The NDIRRB should be formed early in the design phase to review and assess product form concepts for inspectability in terms of process control and quality monitoring. The NDIRRB should also be responsible for review and approval of inspection methods and detectability assumptions implemented in the Force Structures Maintenance Plan. The board's decisions are subject to government approval. The government should retain the right of disapproval of NDIRRB decisions. [Appendix B](#) provides a NDIRRB Charter template.

4.5.1 Purpose.

The NDIRRB should:

- a. Review and approve changes to the NDI Program Plan over the life cycle of the system.
- b. Production Inspections: determine the NDI requirements for those components identified in accordance with paragraph 4.4, and assure that the most appropriate inspection methods(s) have been selected for the components being tested, and that the level of inspection is commensurate with the quality required. Assure NDI requirements are adhered to and are consistent across the NDI supplier base for the system.
- c. Sustainment Inspections: Determine the NDI processes, procedures, technologies and

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support equipment required to maintain the integrity of components throughout their service life.

- d. Determine the requirements for demonstration of NDI capability (e.g., MIL-HDBK-1823) for inspection processes implemented in all phases of the program.

4.5.2 NDI Requirements Review Board (NDIRRB) Membership.

The NDIRRB should be comprised of the prime contractor, major subcontractor and government NDI, design and materials and processes (M&P) experts. The government program office should designate an independent government team to participate as representatives to the NDIRRB. The government representatives should also include subject matter experts (SMEs) from the respective service's NDI program office, research laboratories, depot maintenance facilities, and using commands. The NDIRRB may be augmented with independent Non-Governmental SMEs as required. The NDIRRB functions as an advisory panel to the prime contractor, major subcontractors, System Program office and/or System Program manager and assures NDI Program Plan and contractual NDI requirements are met. NDIRRB should have the authority to review/recommend/approve technical issues/solutions related to NDI within the confines of the contract and NDI Program Plan; however, the NDIRRB cannot make contractual changes or direct a contractor, subcontractor, or Government agency to take any action outside the scope of the contract.

5 DETAILED REQUIREMENTS FOR PRODUCTION

5.1 Documentation of the review.

Drawings for each fracture-critical, fracture-critical traceable and mission-critical structural component, if applicable, (see 4.3) should be reviewed and approved by the contractor's authorized NDI Level III representative to the NDIRRB. The drawing should include the signature of the contractor's authorized NDI Level III as documented evidence of the review.

5.2 Drawings.

The NDIRRB review should provide guidance to the contractor's responsible NDI Level III for defining NDI requirements on engineering production drawings or other released engineering specifications addressing part manufacturing requirements. The drawing should reference all NDI procedures, process specifications, acceptance criteria and/or class/grade requirements that are relevant to the manufacture of the part. If the inspection requirements are zonal, the zones and associated inspection requirements should be referenced on the drawings or other released engineering specifications as appropriate. Drawings should specify raw material and finished part inspection requirements.

5.3 Preparation of NDI process specifications and procedures.

5.3.1 Use of general NDI process specifications.

The use of process specifications, such as those listed in section 2.2 and 2.3, as sole controlling specifications, is not permitted. These specifications reflect minimum quality requirements and are broad in scope.

5.3.2 Company NDI process specifications.

Company process specifications should be prepared incorporating the requirements of the referenced government and non-government process specifications. The company process

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specifications should meet or exceed the requirements of the referenced process specifications using the particular equipment, personnel and test facilities required to meet the reliability requirements of the product. If no general process specification exists for a particular method a company process specification or general NDI procedure should be generated and should incorporate sufficient information and criteria to adequately describe the NDI method and control the process.

5.3.2.1 Special NDI procedures.

Special procedures to inspect designated components may be used in lieu of or to supplement company process specifications. A contractor may elect to incorporate all processing criteria into each NDI procedure in lieu of generating process specifications. Special procedures should require the same approval processes as both process specifications and part specific NDI procedures. When special procedures are used to implement new technology or to deviate from accepted practices with common NDI technology (e.g. reduced flaw size assumptions), NDIRRB approval is also required.

5.3.2.2 NDI standardization.

The company process specification should reflect procedures, acceptance criteria, personnel qualification requirements, certification requirements, and records requirements to assure adequate quality assurance measures are being enforced to keep the NDI process in control. Basic processes, equipment, reference standards, materials, and method specific variables, as applicable, should be monitored to assure adequate control of the inspection process. For sustainment inspections, attempts should be made to use standard DoD NDI equipment and procedures (e.g., TO 33B-1-2/TM 1-1500-366-23/NAVAIR 01-1A-16-2) wherever possible to streamline the development and transition of field and depot level inspection solutions.

5.3.2.3 Approval.

Company process specifications and special procedures will be coordinated with an authorized representative of the contractor and should be subject to review and approval by the NDIRRB and the government prior to use on components. Deviations from or revisions to company process specifications or special procedures throughout the system life cycle should also be submitted to the NDIRRB and the Government for review and approval prior to implementation.

5.3.3 NDI processes.

Company process specifications should comply to the minimum requirement of industry standards as specified by contract and/or the NDI Program Plan. Company process specifications should be subjected to the review and approval of the NDIRRB. The following nondestructive inspection methods and the associated specifications are acceptable and are recommended as the base requirements for the associated company process specifications:

- a. Magnetic particle, in accordance with ASTM E1444/E1444M, MIL-STD-1530 and MIL-STD-1907, as applicable.
- b. Penetrant, in accordance with ASTM E1417, MIL-STD-1530, MIL-STD-1907, SAE AMS 2644, and SAE AMS 2647, as applicable.
- c. Film Radiography, in accordance with ASTM E1742/E1742M.
- d. Digital or Computed Radiography, in accordance with ASTM E2033, E2662, E2698,

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- E2736, or E2737, and E2445/E2445M as applicable.
- e. Ultrasonic, in accordance with SAE AMS-STD-2154, ASTM E213, E164 or E2580, and ASTM E2375, as applicable.
 - f. Eddy current, in accordance with MIL-STD-1537 and ASTM B244, E215, E309, E376, E426 or E1004, SAE AS4787 and ARP4402 as applicable.
 - g. Thermography, in accordance with ASTM E2582.
 - h. Magnetic rubber, in accordance with SAE-AMS-I-83387.
 - i. Leak testing, in accordance with ASTM E498.
 - j. Temper etch, inspection in accordance with MIL-STD-867.
 - k. Shearography, in accordance with ASTM E2581.
 - l. Barkhausen Noise Inspection, in accordance with ARP4462.

5.3.4 NDI procedures.

Written inspection procedures should be developed for inspection of each part requiring NDI. These procedures should be in accordance with the requirements of the component drawing, the company process specification and other engineering requirements if applicable. Written inspection procedures should contain the information listed below at a minimum:

- a. Specific part or drawing reference.
- b. Specific part material; surface finish and part preparation, as applicable.
- c. Consumable Materials.
- d. Warnings, Cautions, and Notes, as applicable. For Cautions related to inspection of safety-of-flight structures refer to EN-SB-008-011.
- e. Manufacturer and model number of all instrumentation to be used, indicating optional equivalents, if desired.
- f. Fixturing requirements, as applicable.
- g. Manufacturer and identification of required inspection materials.
- h. Reference to applicable company process specification.
- i. Level of inspector qualification required.
- j. Calibration/standardization procedure and reference standard identification as applicable, including requirements for re-checking the calibration/standardization and a requirement to re-inspect all parts since the last satisfactory calibration/standardization if the re-check fails.
- k. Identification of areas to be inspected, detailed inspection steps including indexing and scan direction if applicable.
- l. Defect sizing, locating and marking requirements.
- m. Acceptable defect criteria including location and critical orientation (based upon primary stress condition and direction) or equivalent drawing or specification reference

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for these criteria.

- n. Post inspection and reporting requirements.

5.3.5 General NDI procedures.

General procedures or company process documents are acceptable for common product forms such as metallic plate, bar stock, fasteners, tubular products, as well as composite and hybrid material product forms when approved by the NDIRRB.

5.4 Reference Standards.

Reference standards should be used in support of raw material and component inspections. Reference standards should represent the materials and components being inspected. Permanent markings should be applied that note: the reference standard part number or identifier; key features of the reference standard such as edges of steps; location, depth, and size of reference defects; and reference defect identifiers. Prior to their use, reference standards should be certified to be within drawing tolerances and specification requirements. Reference defect dimensions should be verified by physical measurements when feasible, or by nondestructive evaluation when reference defects cannot be physically measured. Composite reference standards for critical components should be ultrasonic C-scan inspected and the digital C-scan record should be maintained for the life of the standard. Porosity content should be determined, documented, and within acceptable limits for composite reference standards use on inspections where porosity evaluation is performed. Documentation substantiating reference standard certification, including reference defect measurements, should be maintained for the life of the reference standard and be available to the government upon request. Any deviations from drawing or specification requirements should be documented and approved by the Responsible Level III and should not inhibit the use of any reference defects within the standard unless redundant reference defects exist. Additionally, the NDIRRB should review and concur with deviations to reference standards when they are being used for inspection of fracture-critical, fracture-critical traceable, and mission-critical components. Reference standards should be recertified whenever damage to the reference standard is suspected.

5.5 Implementation of NDI procedures.

5.5.1 Personnel.

The contractor should have available records of certification for personnel conducting and interpreting nondestructive inspections in accordance with the applicable sections of NAS410 or other alternate specifications in accordance with the contract requirements.

5.5.2 NDI reports and records.

The contractor's NDI reports and data records should be kept on file for the minimum amount of time as required by the contract. Reports should be signed or stamp identified by an authorized representative of the inspection facility. NDI procedures and equipment that produce digital records should be utilized on fracture-critical and fracture-critical traceable parts and assemblies. In instances where it is not technically feasible to obtain digital records, substantiation should be provided to the government for concurrence or rejection. Digital NDI records (e.g., ultrasonic C-scans, radiographs, shearography images, etc.) used for final acceptance of fracture-critical traceable parts (including assembly bond lines) should be delivered with each aircraft and should be in a DICONDE compliant format (ASTM E2339, ASTM E2663) electronic format as specified by the contract. Ultrasonic scan data should include full-waveform captures to facilitate

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reprocessing the scan images at some future date, should the need arise. When full waveform data is captured, it should be retained. Digital NDI records for fracture-critical traceable parts should be traceable to aircraft number, part/assembly number, and part serial number, as applicable. Records should include NDI of repairs performed to achieve part conformance to requirements.

5.5.3 Equipment and materials.

The equipment and materials used for inspection should be in accordance with the applicable company process specification. Specified equipment should have adequate maintenance to assure that it is fully operational when used to conduct inspections. When being used on critical components, equipment and material compliance should be verified by the contractor and the government should be given the opportunity to be present. Any data generated during equipment qualification should be submitted to the appropriate NDIRRB members and the government.

5.5.4 NDI procedure validation.

All procedures and procedure families should be validated by the responsible NDI Level III to assure repeatable defect detectability sufficient for the classification of the part. Procedures should be validated on parts, or on test pieces simulating the actual part, and which provide the essential features of the part with regard to the important application variables which may affect defect sensitivity and confidence level. Redundant inspections may be utilized. Procedures for critical components and raw material to be used for fracture-critical components should be submitted to the NDIRRB for review and concurrence prior to use, although formal approval of the procedures still resides with the contractor's responsible NDI level III.

5.5.5 Removal of discontinuities.

When NDI reveals discontinuities in excess of the level permitted by applicable drawings or documents, such discontinuities may be removed or repaired if permitted by applicable drawings and documents or authorized by Materials Review Board action. Evidence of removal or successful repair should be confirmed by reinspection.

5.5.5.1 Reinspection.

Reinspection for removal of discontinuities should be conducted using the same procedure used during the initial inspection that detected the discontinuities. If a modified or different procedure is necessary, an addendum or temporary change to the original procedure action should be prepared and approved by the responsible NDI Level III and Materials Review Board showing the essential features of the repair test. If the original procedure was reviewed by the NDIRRB, any proposed modifications should be submitted to the NDIRRB for review and concurrence.

5.5.6 Inspection stages.

5.5.6.1 First article destruct inspections.

Inspections of all first article components should be conducted as part of manufacturing qualification and to assure the components meet the applicable engineering requirements. The requirements for first article inspections should be defined and may exceed requirements for subsequent receiving inspections. The effectiveness of the NDI processes performed on the first article component should be evaluated and any necessary revisions to written procedures should be made and implemented prior to inspection of the next production representative component.

5.5.6.2 Receiving inspections.

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Incoming materials, parts or assemblies should be inspected in accordance with the contractor's quality assurance requirements to assure they meet the applicable engineering requirements.

5.5.6.3 Manufacturing and assembly.

Inspections should be performed during manufacture and assembly of components to assure the quality of final parts or assemblies is commensurate with the part or assembly classification and the criticality of the manufacturing processes. These inspections should be approved by the contractor's designated NDI Level III.

- a. NDI should be performed subsequent to operations which may adversely affect the quality of material or part, such as heat treating, forging, cold working and autoclave curing. When processing operations may interfere with or be detrimental to the capability of the required inspection, inspections should be performed prior to such operations or actions should be taken to eliminate the condition interfering with inspection (e.g. potential for smeared metal from a machining operation requiring pre-penetrant acid etch).
- b. NDI should be also performed when composite parts may be damaged as a result of machining operations or final assembly.
- c. NDI procedures for composite parts should demonstrate the capability of detecting foreign material that may inadvertently be left in the material stack-up during the layup process, typically including any material in the clean room. The contractor's process for demonstrating foreign material detection should be detailed in the NDI Program Plan. Successful demonstration is required for each inspection procedure on each piece of equipment used in a facility, therefore multiple demonstrations may be required at a single facility. Requests for waiving a demonstration based on similarity may be proposed and substantiated to the NDIRRB for consideration. In cases where materials cannot be detected by NDI, those material types should be documented and reported to the government for awareness such that additional material controls can be implemented by Materials and Processes Engineering as necessary.

5.5.7 Vendor qualification.

All facilities, including sub-tier suppliers, performing inspection of fracture-critical, fracture-critical traceable and mission-critical structural components, should be qualified by the contractor to assure their NDI processes and procedures meet design requirements. The NDI Program Plan should address the criteria for qualification, including facility and personnel capability demonstrations, required for each inspection method employed. The vendor's NDI process specifications and fracture-critical, fracture-critical traceable and mission-critical part specific procedures should be reviewed and approved by the contractor's Level III prior to the initial vendor qualification audit. The qualification process should include initial and periodic audits of the vendor's facility. The audits should be performed by personnel knowledgeable in the NDI methods being qualified, using a Level III approved checklist as a framework for conducting the audit. The auditor should witness the vendor performing sample fracture-critical, fracture-critical traceable and mission-critical part specific procedures as part of the audit. The initial audits of vendors manufacturing fracture-critical, fracture-critical traceable and mission-critical parts should be performed by an NDI Level III in that method. The recurring audits frequency may be dependent on past performance and audit results, but should not exceed two years for vendors of fracture-

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critical, fracture-critical traceable and mission-critical parts. Government NDI representatives should be given at least 14 calendar days' advance notice of audits and be given the opportunity to be present.

5.5.8 Capability demonstration.

The capability of nondestructive inspection processes used for production process monitoring and quality control of components should be established, as required by MIL-STD-1530, to mitigate risk of missing defects. Special emphasis should be given to inspection processes applied to fracture-critical, fracture-critical traceable and mission-critical parts. If a procedure is required to detect flaws smaller than the accepted capability for the particular method, a capability demonstration should be performed to prove that the technique can reliably detect flaws of that size. For acceptable detection capability values for establishing initial flaw sizes, refer to JSSG 2006 and Structures Bulletin EZ-SB-13-003. Capability demonstrations should also be required for qualification of new inspection processes or technologies prior to implementation. The requirement and approach for conducting capability studies should be addressed within the NDI Program Plan.

6 DETAILED REQUIREMENTS FOR TEST ARTICLES

NDI requirements for and procedures used on test articles should be submitted to the NDIRRB for review and approval prior to use.

6.1 First article testing.

Structural components undergoing first article testing should receive, as a minimum, production representative NDI. Additional NDI may be utilized to further quantify the component as part of the first article evaluation.

6.2 Static test articles.

Static test articles should receive, as a minimum, production representative NDI prior to testing. Additional NDI may be utilized to further quantify the component during or after the completion of the static test. The NDI requirements for static test articles should be detailed in a Static Test Plan and submitted for review and approval prior to the commencement of the test.

6.3 Component, full-scale durability test articles.

Structural components undergoing full-scale durability test should receive a production representative NDI prior to test. NDI should be utilized during component and full-scale durability testing. These tests provide a valuable opportunity to verify NDI procedures that may be required to sustain the aircraft. Additionally, the application of NDI during durability tests provides early detection of impending failures which facilitates more accurate determination of the onset of cracking, the opportunity to monitor crack growth rates, the development and demonstration of repair concepts and the extension of the test by preventing premature catastrophic failure of the test article. Durability test articles provide an excellent opportunity to evaluate standard and emerging NDI technologies and embedded structural damage sensing (structural health monitoring) systems for use as sustainment tools once the system is fielded. The NDI requirements for full-scale durability test articles should be detailed in a Full-Scale Durability (Fatigue) Test Plan and submitted for review and approval prior to the commencement of the test.

6.4 Teardown inspections.

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NDI should be performed on component and full-scale test durability articles during the teardown inspections that are performed after cyclic testing. Fatigue test inspections require special part preparation and inspection techniques. Part disassembly, paint stripping, sealant removal, and cleaning processes should be carefully performed to avoid damaging any fatigue crack fracture surfaces. Crack detection sensitivity is also heightened to make sure even the smallest cracks are detected with lessened concern for false positive calls. Additionally, crack orientation information is paramount to any break-open and fractography efforts. The teardown NDI requirements for static and full-scale durability test articles should be detailed in the Static Test Plan and Full-Scale Durability (Fatigue) Test Plan and submitted for review and approval prior to the commencement of the tests. If teardown inspections are performed at subcontractor facilities, the facilities should be audited by a contractor NDI Level III in the method(s) used prior to the commencement of the teardown effort to ensure compliance with NDI requirements. For best practices for conducting teardown program refer to Structures Bulletin EZ-SB-15-001.

6.5 Flight testing.

NDI should be utilized as required during flight testing to monitor fracture-critical, fracture-critical traceable and mission critical structures where durability and damage tolerance analysis identifies a shortfall. These tests also provide a valuable opportunity to verify NDI procedures and reference standards that may be required to sustain the aircraft. The NDI procedures that support flight test should be developed considering their eventual inclusion into the sustainment requirements for the system. Inspection procedures developed to support flight test should reference the equipment available to the flight test maintenance organization and be written in accordance with paragraph 7.3.1.

6.6 Test support monitoring inspections.

NDI should be utilized as necessary to assess the onset of damage other than fatigue, including corrosion, thermal, and impact damage to components and structures. The test support NDI procedures should also be developed considering their eventual inclusion in the sustainment requirements for the system.

7 DETAILED REQUIREMENTS FOR SUSTAINMENT

7.1 Defining sustainment inspection requirements.

The initial and recurring inspections should be identified and inspection solutions should be implemented to maintain the safety of the structure throughout the intended design life. These inspections should be established in accordance with MIL-STD-1530, MIL-STD-3024 or MIL-STD-1789 or other contractual requirements for structural integrity. Sustainment requirements should be considered throughout the design, development and pre-production phases. Inspection requirements for component, full-scale and flight test articles should be leveraged as opportunities to develop and validate sustainment inspection procedures.

7.2 Sustainment inspection requirements review.

The NDIRRB will:

- a. Review the requirements and proposed inspection processes for initial and recurring in-service inspections and determine whether the proposed methods and the associated detection capabilities are sufficient to address the inspection requirements.

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- b. Review plans for conducting probability of detection (PoD) and/or proficiency studies to quantify detection capability used to establish realistic reinspection intervals.
- c. Review and approve the capability assumptions used to establish inspection intervals for recurring inspections.
- d. Assess the need for system specific NDI equipment and propose a plan to address any deficiencies that were identified.
- e. Assess the need for system specific NDI training and propose a plan to address any deficiencies that were identified.
- f. Provide recommendations and guidance directly to the prime contractor, major subcontractors and SPO/SPM/PMA for decision making regarding all aspects of the NDI Program.
- g. Recommend technology development or demonstration programs to identify and transition inspection solutions as required to address commercial-off-the-shelf capability shortfalls.

7.3 Preparation of NDI procedures.

The NDI Program should consider and implement appropriate NDI processes to address sustainment requirements. Inspection procedures should be written to utilize existing standard-issue NDI methods and equipment to the greatest extent possible. Any proposed use of non-standard NDI methods/equipment should be technically justified to the government including evidence to document its capability to meet the specific inspection requirements. Justification should address capability as well as costs for procurement, training and sustainment of the non-standard support equipment. Inspection procedures should use the detailed guidance and requirements of MIL-DTL-87929 and MIL-STD-3048 for procedure content and format. Procedures should also be supplemented with pictures, graphics and videos to ensure the procedure details are clearly conveyed to the inspector. MIL-DTL-87929 also provides detailed guidance for graphics, pictures, and multimedia content inclusion in procedures.

7.3.1 Sustainment NDI procedure content.

NDI procedures should be provided for inspection of each part requiring inspection. Each procedure should contain the following information:

- a. Inspection purpose or intent.
- b. Specific part or drawing reference. When appropriate for the inspection, detailed information about part constructions such as cross sectional views, thicknesses and fabrication features should also be included in the part description and associated figures.
- c. Applicable weapon system configuration.
- d. Specific part material; surface finish and part preparation, as applicable.
- e. Inspector training and qualification requirements.
- f. Manufacturer and model number of all equipment to be used, indicating optional equivalents, if desired.

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- g. Fixturing requirements including figures, as applicable.
- h. Manufacturer and identification of required inspection materials.
- i. Reference to inspection standard practices as applicable.
- j. Identification of reference standards required for calibration/standardization and figures detailing relevant features of the reference standard construction (e.g., material type(s), material thickness (es), simulated defect types and locations). If this information is available in a drawing or document that is readily available to the inspector when performing the inspection, then that drawing or document may be referenced in the procedure. If custom reference standards are designed, customer concurrence with the reference standard design is required.
- k. Calibration/standardization procedure, including initial equipment settings and screen shots showing the signals that should be achieved at each step of the calibration/standardization process as well as process control enhancements such as QCI placement.
- l. Inspection access including overall system figures leading to detailed access figures (overall systems view, compartment views, unobstructed compartment views and detailed views of the inspection zone(s)).
- m. Inspection frequency (at what flight hours to initiate – and frequency thereafter).
- n. Identification of expected damage type (fatigue crack, SCC, impact damage, corrosion, etc.), location and orientation.
- o. Identification of required scan direction and coverage.
- p. Evaluation criteria.
- q. Acceptance criteria (including repair criteria where applicable).
- r. Component disposition.
- s. Cautions and warnings in use of the inspection procedure.
- t. Part marking (to designate/document if part has passed or failed inspection).
- u. Post-test requirements (including calibration/standardization verification, cleaning, preservation, demagnetization, etc.).
- v. Contractor NDI Level III approval.
- w. Document Release date/Revision number.

7.3.2 Sustainment NDI procedure format.

NDI procedures should be written in accordance with MIL-DTL-87929 for work package format maintenance manuals and MIL-STD-3048 and MIL-STD-40051 for integrated electronic maintenance manual systems to the appropriate inspector training level or as stipulated by the contract. The format should be reviewed and approved by the NDIRRB.

7.4 Sustainment Reference Standards.

Reference standards used for sustainment inspections should meet the requirements of Paragraph 5.4. Additionally, reference standard designs should be submitted to the NDIRRB for review and

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concurrence prior to fabrication. The design should take into account the need for the reference standards to be portable. Reference defects should be constructed in such a way that their signal responses are consistent with that of actual defects when using the specific inspection technique(s) applicable to that reference standard. Coating systems and filler materials consistent with what is applied to the components being inspected should be reflected in the reference standard design when it impacts the inspection technique(s) being used. An evaluation procedure that defines what constitutes an acceptable reference standard should be submitted to the NDIRRB for review and approval prior to fabrication of reference standards. This evaluation procedure should be used to accept or reject reference standards upon completion of fabrication. Reference standards should be stored in portable casing that provides protection from damage.

7.5 Inspection capability demonstration.

The capability of nondestructive inspection processes to be used for long term sustainment should be established. Special emphasis should be given to fracture or fatigue and mission- critical parts. Capability demonstrations should also be performed when new materials, fabrications techniques, specialty coatings and repairs processes are implemented that may affect the efficacy of the selected inspection processes. The methodology for establishing capability should be addressed within the NDI Program Plan. Capability assumptions used to establish reoccurring inspection intervals should be approved by the NDIRRB and documented in accordance with the MIL-STD-1530, MIL-STD-3024 or MIL-STD-1789. Use of pre-established capability assumptions for established inspection methodologies (i.e., Structures Bulletin EN-SB-008-012) should be approved by the NDIRRB. The methodology for establishing probability of detection should be in accordance with MIL-HDBK-1823.

7.6 NDI procedure validation and verification.

The NDI Program Plan should address the process for validation and verification of all inspection procedures. All procedures and procedure families should be verified to assure repeatable damage detection capability sufficient for the classification of the part. Procedures may be verified on parts or on test pieces simulating the actual part and which provide the essential features of the part with regard to the important application variables which may affect defect detection sensitivity, signal-to-noise and confidence level. Use of substitute test pieces should be approved by the NDIRRB. If the NDIRRB deems it necessary, a POD study should be conducted to verify the detection capability of the NDI processes. Further guidance on POD studies can be found in MIL-HDBK-1823. For execution of validation and verification activities refer to Structures Bulletin EZ-15-002.

7.6.1 Procedure validation.

Procedure validation should be the responsibility of the authoring agency or as designated by the responsible Government NDI Level III.

Procedure verification should as a minimum accomplish the following objectives and be documented using a Verification Checklist approved by the responsible Government NDI Level III (see Structures Bulletin EZ-SB-15-002):

- a. Collect and analyze supporting data.
- b. Establish appropriate method, equipment and procedure parameters.
- c. Establish requirements for unique reference standards to effectively control set-up

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variability.

- d. Establish appropriate technician skill-level for reliable procedure performance.
- e. Establish appropriate component removal and surface preparation requirements necessary for adequate access.
- f. Design/manufacture test specimens containing actual or simulated discontinuities.
- g. Design/manufacture prototype support equipment.
- h. Produce a draft technical procedure.
- i. Demonstrate procedure feasibility to responsible NDI Level III or designee (reference NAS410).
- j. Approval of the procedure by the responsible NDI Level III or designee (reference NAS410).

7.6.2 Procedure verification.

Procedure verification should be performed after successful procedure validation. The verification process should prove the suitability of an NDI procedure to perform its intended purpose to the satisfaction of the end user, the responsible Government NDI Level III or designee, the depot NDI program manager and the responsible program engineer. Verification should be performed on an aircraft or on an individual assembly or component in the exact configuration in which the procedure should be performed (i.e. on-aircraft, painted, etc.). Verification will also be conducted within a representative environment by inspectors that represent the lowest level of certification expected to perform the inspection.

Procedure verification should as a minimum accomplish the following objectives and be documented using a Verification Checklist approved by the responsible Government NDI Level III (see Structures Bulletin EZ-SB-15-002):

Ensure the procedure is thorough, understandable, and logically written.

- a. Ensure the procedure is understood and executable by the lowest skill level expected to perform the procedure.
- b. Ensure the specified equipment performs as expected and is readily available to the intended end-user.
- c. Ensure the specified part preparation procedures are logical and can be accomplished as written.
- d. Demonstrate the procedure meets expectations for detection capability and false call propensity.
- e. Ensure the inspection results are properly documented and communicated to the appropriate engineering, maintenance, and other NDI functions.
- f. Determine the need for specialized personnel training or certification.
- g. Determine the estimated inspection process man-hours.
- h. Account for human factor and environmental variables as necessary.
- i. Document verification per the appropriate Verification Checklist (see Structures

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Bulletin EZ-SB-15-002).

- j. Approve the procedure for publication, distribution and use.

Any documented shortcomings should be corrected prior to releasing the inspection as verified. Substantial changes resulting from failed procedure verification require the procedure to be corrected and re-verified.

8 NOTES

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

8.1 Intended use.

This document is intended to be used by the applicable organization(s) in setting forth specific policy as to the required nondestructive inspection program to be conducted in the production and sustainment of aircraft, missiles and their propulsion systems.

8.2 Acquisition requirements.

Acquisition documents should specify the title, number, and date of this standard.

8.3 Subject term (key word) listing.

Calibration.

Eddy Current.

Magnetic Particle.

Penetrant.

Radiographic.

Shearography.

Temper etch.

Thermography.

Ultrasonic.

8.4 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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APPENDIX A

NDI PROGRAM PLAN TEMPLATE

A.1 SCOPE

A.1.1 Scope.

The appendix provides instructions to the users of this template. This template addresses NDI requirement in all phases of the system life cycle. The system specific NDI plan should be tailored to address requirements specific to the current system lifecycle. In cases where phases are concurrent, all relevant sections should be included. The text without brackets can be used as is for programs requiring compliance to MIL-STD-1530. The text in brackets should be replaced with program specific information. The applicable life cycle stages (Development, Production, and Sustainment.) are annotated in the header of each section. If a particular section does not apply, either omit the section or place an N/A after the heading.

A.1.2 [Insert aircraft designation.] NDI Program Plan.

A.1.3 Introduction (Development, Production and Sustainment).

This document defines the nondestructive inspection (NDI) plan for the [insert aircraft designation] aircraft during the sustainment phase. This NDI plan is based on the requirements established in the Aircraft Structural Integrity Program (ASIP) MIL-STD-1530 and guidance contained in the Department of Defense Handbook Nondestructive Inspection Program Requirements for Aircraft and Missile Materials and Parts MIL-HDBK-6870.

A.1.4 The NDI Plan.

Task I in MIL-STD-1530 states “An NDI plan shall be developed and executed in accordance with MIL-HDBK-6870. The NDI plan shall establish the NDI requirements for the aircraft structure and all tasks necessary to ensure compliance with the durability requirements as described in damage tolerance criteria and the damage tolerance requirements...” Task V in MIL-STD-1530 states “The NDI plan described in (Task I) shall be updated as necessary during the sustainment phase and document the process for determining when NDI equipment is obsolete and the procedures for ensuring replacement NDI equipment is selected, qualified, procured and provided to all units in a timely manner.”

A.1.5 General Requirements.

The general requirements section of MIL-HDBK-6870 describes the elements of the NDI Plans, covering all program phases. The NDI Program Plan documents the NDI requirements and implementing procedures to meet these requirements. The plan should address the means for:

- a. Conducting parts classification.
- b. Coordination of design requirements and production NDI procedures.
- c. Preparation and approval of production NDI procedures.
- d. Demonstration of production NDI capability.
- e. Qualification of NDI vendors to meet production capability requirements.
- f. Obtaining and maintaining qualified NDI staff and an accredited NDI training/certification program.
- g. Implementation of production NDI procedures.
- h. Coordination and documentation of inspection requirements to support long-term sustainment including structural repairs.
- i. Preparation of NDI technical data for long term sustainment.
- j. Validation and verification of inspection technical data for sustainment.

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- k. Assessment and documentation of sustainment NDI capability.
- l. Development of NDI methods and procedures to support test articles.
- m. Qualification of new technologies for use during production or component/aircraft testing or during the service life of the system.
- n. Qualification of NDI methods adapted for the purpose of in situ structural damage sensing.

A.2 Applicable Documents (Development, Production and Sustainment).

A.2.1 General.

The documents listed below are not necessarily all of the documents referenced herein, but are those needed to understand the information provided by this handbook.

[This section should list the specifications, standards, technical orders, handbooks and structures bulletins considered requirements for the aircraft ASIP. The following are considered a minimum list. Original Equipment Manufacturer (OEM) (contractor specific) and applicable Non-Government Standards (NGS) should also be listed where applicable.]

A.2.2 Government documents.

A.2.2.1 Specifications, standards, and handbooks.

The following specifications, standards, and handbooks form a part of this document to the extent specified herein.

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

DEPARTMENT OF DEFENSE STANDARDS

| | | |
|---------------|---|--|
| MIL-STD-1530 | – | Aircraft Structural Integrity Program. |
| MIL-STD-1798 | – | Mechanical Systems Integrity Program [if applicable]. |
| MIL-STD-3024 | – | Propulsion Structural Integrity Program [if applicable]. |
| MIL-STD-3048 | - | Air Force Business Rules for Implementation of S1000D. |
| MIL-STD-40051 | – | Preparation of Digital Technical Information for IETMs. |

DEPARTMENT OF DEFENSE TECHNICAL ORDERS

| | | |
|-------------------|---|------------------------------------|
| TO 33B-1-2 | – | Nondestructive Inspection General. |
| TM 1-1500-366-23 | | Procedures and Process Controls. |
| NAVAIR 01-1A-16-2 | | |

DEPARTMENT OF DEFENSE HANDBOOKS

| | | |
|---------------|---|--|
| MIL-HDBK-6870 | – | Nondestructive Inspection Program Requirements for Aircraft and Missile Materials and Parts. |
|---------------|---|--|

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A.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.

UNITED STATES AIR FORCE STRUCTURES BULLETINS

| | | |
|---------------|---|---|
| EN-SB-008-010 | – | Criteria for Establishing Repeated/Independent Inspection Requirements for Fatigue Cracks in Safety of Flight Structure. |
| EN-SB-008-011 | – | Nondestructive Inspections of Safety-of-Flight Structure. |
| EN-SB-008-012 | – | In-Service Inspection Flaw Assumptions for Metallic Structures. |
| EN-SB-012-001 | – | Requirements for Evaluation and Authorization of Digital Radiography for Inspection of Aerospace Castings. |
| EZ-SB-13-003 | – | Revised Initial Flaw Size Assumptions for Slow Crack Growth (SCG) Metallic Structures. |
| EZ-SB-15-001 | – | Aircraft Structure Teardown Inspection and Evaluation Program Protocols. |
| EZ-SB-15-002 | – | Requirements for NDI Procedure Development, Validation, and Verification for Aircraft Structural Inspections During Operations and Support Phase. |

A.2.3 Non-Government publications.

The following documents form a part of this document to the extent specified herein.

OEM specifications.

[Insert applicable OEM specifications/standard here]

NON-Government Standards.

[Insert applicable NGS Standards here (ASTM, SAE, NAS, etc.) See Section 2.3 of MIL-HDBK-6870 for the lists of accepted NGS standards.]

A.3 NDI Advisory Board (Development, Production and Sustainment).

MIL-STD-1530 states “The PM (or their delegate) shall establish a NDI Team (NDIT) with authority and responsibility to evaluate and implement appropriate NDI processes into all phases of the program. The NDIT shall be comprised of representatives from engineering, manufacturing, NDI, quality assurance, maintenance, and others involved in the design, engineering development, production, certification, and force management of the aircraft structure where NDI is relied upon for DADTC (Durability and Damage Tolerance Control).” MIL-STD-1530 establishes specific requirements of the NDIT throughout the document.

[The NDI Team is also known as the NDI Requirements Review Board (NDIRRB) or NDI Advisory Board (NDIAB). For the purposes of this template NDIRRB is used. This section of the NDI Plan should describe the NDIRRB members (e.g. ASIP Manager, Air Logistics Complex (ALC) NDI Program Manager, AF NDI Program Office, AFRL/RXSA, and

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contractors), roles, responsibilities, and procedures for executing various tasks.]

The NDIRRB will ensure that the requirements established in MIL-STD-1530 and any structures bulletin related to NDI are executed as intended. In addition, the NDIRRB shall ensure the execution of the NDI Plan unless specific tasks are unfunded. For any unresolved NDI issues related to ASIP, the NDIRRB and ASIP Manager will report them to the AF ASIP Technical Advisor for evaluation in accordance with MIL-STD-1530.

[The NDIRRB Charter should also be developed and provided as an appendix to this document (see MIL-HDBK-6870, [Appendix B](#) for a charter template that must be tailored for the sustainment phase.)

A.4 Production inspection requirements (Development and Production).

A.4.1 Parts classification.

[This section should describe the methodology for establishing part criticality classification used in the system design. At minimum the following categories should be used; fracture-critical, fracture-critical traceable, normal controls (Reference MIL-STD-1530). Additional categories such as mission-critical and maintenance-critical may be used.]

A.4.2 Defining production inspection requirements.

[This section should describe the methodology for establishing NDI inspection requirements, processes and procedures for manufacture of production and spare parts in accordance with the part classification and inspection requirements established during program development. The method for establishing inspection capability for part manufacturing to support damage tolerance requirements relative to part criticality should be defined. JSSG 2006 Table XXX, EN-SB-13-03 and or capability demonstration results, should be referenced. The guidelines of MIL-HDBK-1823 should be referenced. This section should define the organization and NDI Level 3 oversight responsible for establishing, reviewing and approving these requirements.]

A.4.3 Requirements documentation and transmission.

[The section should define how these requirements are documented and communicated to the manufacturing organizations.]

A.4.4 Procedure Development and approval.

[This section should also define how manufacturing inspection requirements are documented and how procedures are developed and approved for inspection of production parts and spares. The section should define the process for approval and the organization responsible for approving prime and subcontractor processes and procedures. The review should include concurrence of NDI drawing notes by the contractor's NDI Level III representative to the NDIRRB prior to drawing release.]

A.4.5 Inspector qualification and certification requirements.

[This section should define the facility and inspector qualification and certification requirements for performing inspections on production and spare replacement parts. This section should also describe how inspection requirements, to include NDI facility and inspector qualifications and capability demonstrations, etc., are established for each of the part criticality categories.]

A.4.6 NDI surveillance.

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[This section should define the process for surveying/auditing NDI the production processes of the prime and subcontractors. This section should also identify the government organization and NDI Level 3 responsible for supporting/conducting reviews and process audits to ensure compliance of prime and subcontractor inspection processes and procedures to the contract requirements.]

A.4.7 Capability demonstrations.

[This section should define prime and subcontractor process qualification requirements including defining requirements and methodology for capability demonstrations commensurate with the part classification level. The guidelines of MIL-HDBK-1823 should be referenced.]

A.4.8 Inspection records retention.

[This section should define the storage and retention requirements for inspection of production and spare parts to include paper and digital documentation and all inspection results (e.g., digital radiographs, ultrasonic C-scans, Computed Tomography data sets, etc.).]

A.5 Sustainment inspection requirements (Sustainment).

A.5.1 Sustainment inspection development process.

[This section should define the process for developing, documenting and communicating sustainment inspection requirements. Inspection types should be defined and could include recurring sustainment inspections defined by the Force Structural Maintenance Plan, conditional event inspections (impact damage, hard landings, etc.) repair inspections, analytical condition inspections (ACI), Time Compliance Technical Orders (TCTOs), etc.). Inspection processes could include NDI methods adapted for the purpose of in situ structural damage sensing.]

A.5.2 Sustainment inspection approval process and authority.

[This section should define the organization and ALC NDI Program Manager or designated NDI Level 3 oversight responsible for developing and approving these sustainment inspection requirements and how these inspection requirements will be communicated to the user.]

A.6 Sustainment NDI procedure validation and verification (Sustainment).

A.6.1 NDI procedure validation and verification process.

[This section should describe the process for executing validation and verification of all new or revised inspection processes (equipment, kits, procedures, capability demonstration and training) and documentation of the results. Inspection processes could include NDI methods adapted for the purpose of in situ structural damage sensing.]

A.6.2 NDI procedure validation and verification authority.

[This section should also define the organization and ALC NDI Program Manager or designated NDI Level 3 oversight required to execute this process. The requirement of EN-SB-0015-002 should be specified for validation and verification of inspection processes.]

A.7 NDI technical data (Sustainment).

A.7.1 NDI technical data development process.

[This section should describe the process for ensuring NDI technical data is current such as the -36 TO, other TOs that contain NDI requirements (e.g. commodity TOs), work control documents, and process orders. To the extent possible, common NDI procedures of TO 33B-1-2 should be utilized and referenced and justification provided if TO 33B-1-2 procedures are not

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used. This section should also address technical data format requirements and reference MIL-DTL-87929, MIL-STD-40051 and MIL-STD-3048 as applicable.]

A.7.2 Identifying safety-of-flight inspections.

[Inspections identified as safety-of-flight should be identified per the aircraft TOs. The location (i.e. -36 or other) of all safety-of-flight inspection procedures should be defined. The format requirements of MIL-DTL-87929 should be specified. If electronic technical data is to be implemented, the format and management process for this data should be described.]

A.7.3 Technical data management.

[This section should also define the organization responsible for managing program technical data and ensuring its currency.]

A.8 Sustainment NDI capability (Sustainment).

[This section should describe how capability estimates (e.g. a_{90/95} PoD values, PoD functions) are defined for recurring sustainment inspections and the organization and ALC NDI Program Manager or designated NDI Level 3 oversight required for approval. This section should state that EN-SB-08-12 will be used when applicable, and specify the approach for executing capability demonstrations when necessary. MIL-HDBK-1823 should be referenced.]

A.9 NDI equipment (Sustainment).

A.9.1 NDI equipment requirements.

[This section should define the standard and program specific inspection equipment required to execute sustainment inspections. This section should also describe the process for performing qualification and approval of new NDI equipment and technologies to include capability demonstration requirements, validation and verification activities, and establishing training requirements.]

A.9.2 NDI equipment authorization authority.

[This section should also define the organization and ALC NDI Program Manager or designated ALC NDI Program Manager or designated NDI Level 3 oversight responsible for establishing and approving these requirements.]

A.9.3 In-Situ structural damage sensing.

[This section should describe methods of in-situ damage sensing (if used). The methodology for qualifying these processes should be defined.]

1. NDI equipment procurement (Sustainment).

[This section should describe the process for procuring and transitioning new NDI equipment at all field and depot locations as required. Common NDI equipment defined by T.O. 33B-1-2 should be used unless a unique requirements is defined and approved by the ALC NDI Program Manager or designated NDI Level 3.]

2. NDI technician training (Sustainment).

[This section should describe the training requirements for system unique inspection techniques, methods, equipment and procedures. The section should also define the organization and ALC Program Manager or designated Level 3 oversight required to establish new and recurring training

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requirements. The process for establishing and implementing these requirements should be defined to include the approach for and the responsible organization tasked to execute the training, the scope of the training (reference the training plan or include the syllabus in an appendix), proficiency testing requirements and requirements for recurring training.]

3. NDI requirements for teardown programs and test articles (Development and Sustainment).

[This section should describe how inspection requirements will be established for structural teardown programs in support of full scale fatigue test articles and lead-the-fleet aircraft structural teardowns. This section should also define the organization, ALC Program Manager or designated Level 3 oversight and subject matter expertise responsible for establishing and approving these requirements and executing the program. EN-SB-15-001 should be referenced for execution of structural teardowns. The section should also include inspection requirements for subcomponent testing that may be conducted in support of system development and/or sustainment.]

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NONDESTRUCTIVE INSPECTION REQUIREMENTS REVIEW BOARD (NDIRRB)
CHARTER TEMPLATE

B.1 SCOPE

B.1.1 Scope.

This appendix provides the guidance for preparing a Charter for a system specific Nondestructive Inspection Requirements Review Board (NDIRRB) also known as the Nondestructive Inspection Advisory Board (NDIAB). The following example charter defines the typical mandatory responsibilities and requirements of an NDIRRB as indicated by the verb “shall”. This text is provided as guidance only and should be tailored based on program contractual requirements. The NDIRRB is comprised of a Government NDI, durability and damage tolerance, design, M&P SMEs representing the interests of the Government/customer. The NDIRRB should be formed early in the conceptual phase of a weapons system to provide guidance to the System Program Office (SPO) and subsequently to the System Program Manager (SPM) on all technical matters necessary to establish, implement, and maintain an effective life cycle NDI Program responsive to the quality assurance, structural integrity and sustainment requirements of the program.

CHARTER FOR
(Enter system designation.)

Nondestructive Inspection Requirements Review Board (NDIRRB)

Introduction.

The appropriate application of Nondestructive Inspection (NDI) to aerospace systems helps achieve system safety and structural integrity requirements. To ensure appropriate NDI is implemented, a Nondestructive Inspection Advisory Board shall be established as a means of achieving this goal. The intent is to bring together engineer, maintainer and user so that they may all contribute in formulating and implementing an effective, continuing system NDI plan. This charter establishes the NDIRRB for the system designation.

Purpose.

The system designation NDIRRB shall be the authorized body for NDI policy and implementation. The purpose of the NDIRRB is to provide assistance and guidance to the (ASIP / MECSIP / PSIP) manager, System Program Manager (SPM), the Prime Contractor and suppliers on all technical matters necessary to establish, implement, and maintain an effective sustainment NDI Program responsive to the structural integrity and in-service maintenance requirements of the system designation. Each NDIRRB team member is responsible to be cognizant of the system designation NDI requirements and processes and bring any NDI program considerations/problems to the review board for resolution.

Membership.

The NDIRRB shall be comprised of the (ASIP / MECSIP / PSIP) manager, prime contractor, ALC NDI program manager or designated NDI Level 3, prime contractor structures engineering representatives, NDI and materials and process (M&P) subject matter experts. The system designation Program shall also designate independent representatives to the NDIRRB as required. The government representatives shall include subject matter experts (SMEs) from the Air Logistic Complex (ALC) NDI Program Office, research laboratories, depot maintenance

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facilities, Air System Group, and using commands as required. The NDIRRB may be augmented with independent Non-Governmental SMEs as required.

The system designation NDIRRB is chaired by the (*ASIP / MECSIP / PSIP*) manager with membership defined as follows:

Member/Alternate.

- (Enter name) _____ (*ASIP / MECSIP / PSIP*) Manager, (OEM) _____.
- (Enter name) _____ (*ASIP / MECSIP / PSIP*) Engineering, (OEM) _____.
- (Enter name) _____ (*ASIP / MECSIP / PSIP*) Manager, (Govt. organization) _____.
- (Enter name) _____ (*ASIP / MECSIP / PSIP*) Engineering, (Govt. organization) _____.
- (Enter name) _____ Depot/Complex NDI Program Manager (or Designated NDI Level III), Govt. organization) _____.
- (Enter name) _____ Depot Production NDI Representative, (Govt. organization) _____.
- (Enter name) _____ Major Command NDI Functional Manager, (Govt. organization) _____.
- (Enter name) _____ Da/DT Engineering, (Govt. organization) _____.
- (Enter name) _____ Da/Dt Engineering, (OEM) _____.

Responsibilities.

The mission of this board is advisory and thus has no authority to direct a contractor, subcontractor, to take any action as a result of its findings. Rather, the Board shall make recommendations directly to the system designation (*ASIP / MECSIP / PSIP*) manager and system program manager. The NDIRRB shall present its recommendations in written form coordinated through all board members. The responsibilities of the NDIRRB are summarized as follows:

Convene as required at the request of the (*ASIP / MECSIP / PSIP*) manager. The minimum interval shall be annually.

The system designation NDIRRB review all new inspection requirements and shall advise the ASIP program manager, system program office, and prime contractor on the following:

- a. Adequacy of existing NDI technologies (methods and equipment) and the use of new technologies.
- b. Ensure the NDI equipment, procedures and processes are consistent with inspection requirements.
- c. Report status to the program management and DoD NDI representatives on NDI issues when significant changes occur.
- d. Ensure compliance of the NDI program with applicable standards, specifications, design handbooks, and related documentation.
- e. Review requirements for all new sustainment NDI requirements, including time compliance technical orders (TCTOs), conditional event inspection, scheduled inspections and analytical condition inspections (ACIs) and make recommendations to address these requirements.
- f. Recommend initial flaw size and NDI capability assumptions used to establish initial and reoccurring inspections, etc.

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- g. Review and define inspection requirements for repairs, modifications, new and spare parts, etc.
- h. Review requirements for new equipment and kits and develop/execute qualification of such equipment.
- i. Participation in validation and verification of NDI technical orders.
- j. Review requirements for and define requirements for NDI training related to task specific NDI, new equipment, new inspection procedures, etc. to ensure inspector competency to achieve required inspection capability.
- k. Review and establish requirements for capability demonstrations for all new inspection requirements and address concerns regarding inspection capability for all existing NDI equipment and procedures.
- l. Maintain a continuing record of all board meetings, trips and actions, to include but not limited to:
 - 1. Specific area(s) reviews.
 - 2. Technical discussions.
 - 3. Board recommendations.
 - 4. Individual or agency responsibility.
 - 5. Final disposition of board recommendations.

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CONCLUDING MATERIAL

Custodians:
Air Force – 20

Preparing Activity:
Air Force – 20

Review activities:
Army – MR
Navy – AS
Air Force – 11

Agent:
Air Force – 110

(Project NDTI-2020-006)

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 <https://assist.dla.mil>.