INCH-POUND

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DEPARTMENT OF DEFENSE

HANDBOOK

INSPECTION PROGRAM REQUIREMENTS

NONDESTRUCTIVE FOR AIRCRAFT AND

MISSILE MATERIALS AND PARTS

THIS HANDBOOK IS FOR GUIDANCE ONLY, DO NOT CITE THIS DOCUMENT AS A REQUIREMENT

AMSC N/A

AREA NDTI

FORWARD

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

2. This handbook is for guidance only. This handbook cannot be cited as a requirement. If it is, the contractor does not have to comply.

3. This handbook covers acceptable requirements for establishing the nondestructive inspection (NDI) program for the procurement of all supplies and products when directly referenced in the item specification contract or order.

4. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to the Air Force Research Laboratories, MLSA, Wright-Patterson Air Force Base, Ohio 45433 by. Using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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1 SCOPE

1.1 Scope.

This handbook is for guidance only. This handbook cannot be cited by the government as a requirement. If it is, the contractor does not have to comply. This handbook covers requirements for establishing the nondestructive inspection (NDI) program for the procurement of all supplies and products when directly referenced in the item specification contract or order.

1.2 Applicability.

This handbook should apply to new structural components for aircraft and missiles and their propulsion systems when the design activity or system specification requires nondestructive inspection for acceptance.

2 APPLICABLE DOCUMENTS

2.1 General.

The documents listed below are not necessarily all of the documents referenced herein, but are the ones needed to fully 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. Unless otherwise specified, the issues of these documents are those listed in the latest issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto:

SPECIFICATIONS

JSSG 2006	Aircraft Structures

STANDARDS

MIL-STD-867	Temper Etch Inspection
MIL-STD-1537	Electrical Conductivity Test for Verification of Heat Treatment of Aluminum Alloys Eddy Current Method
MIL-STD-2154	Process for Ultrasonic Inspection of Wrought Metals

HANDBOOKS

MIL-HDBK-1530	General Guidelines for Aircraft Structural Integrity Program
MIL-HDBK-1783	Engine Structural Integrity Program (ENSIP)
MIL-HDBK-1823	Nondestructive Evaluation System Reliability Assessment

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Document Order Desk 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094)

2.3 Non-Government publications.

The following document(s) form a part of this document to the extent specified herein. Unless otherwise indicated, the issues of the documents which the DoD adopted of related publications which may be obtained from a common source:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B244	Standard Test Method for Measurement of Thickness of Anodic Coatings on Aluminum and of other Nonconductive Coatings on Nonmagnetic Basis Materials with Eddy Current Instruments
ASTM E164	Standard Practice for Ultrasonic Contact Examination of Weldments
ASTM E215	Standard Practice for Standardizing Equipment for Electromagnetic Examination of Seamless Aluminum Alloy Tubes Electromagnetic Testing of Seamless Aluminum Alloy Tubing
ASTM E309	Standard Practice for Eddy Current Examination of Steel Tubular Products Using Magnetic Saturation
ASTM E376	Standard Practice for Measuring Coating Thickness by Magnetic Field or Eddy Current (Electromagnetic) Test Method
ASTM E426	Standard Practice for Electromagnetic (Eddy Current) Examination of Seamless and Welded Tubular Products, Austenitic Stainless Steel and Similar Alloys
ASTM E427	Standard Practice for Testing for Leaks Using the Halogen Detector (Alkali-Ion Diode)
ASTM E498	Standard Test Method for Leaks Using the Mass Spectrometer Leak Detector or Residual Gas Analyzer in Tracer Probe Mode
ASTM E1004	Standard Practice for Determining Electrical Conductivity Using the Electromagnetic (Eddy Current Method)
ASTM E1444	Standard Practice for Magnetic Particle Examination
ASTM E1417	Standard Practice for Liquid Penetrant Examination
ASTM E1742	Standard Practice for Radiographic Examination

(Application for copies should be addressed to American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103).

NATIONAL AEROSPACE STANDARDS (NAS)

AIA/NAS410	Certification and Qualification of Nondestructive Test Personnel

(Application for copies of NAS publications should be addressed to the Aerospace Industries Association of America, 1250 I Street NW, Suite 1100, Washington DC 20005-3924.)

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 Certification.

Written testimony of qualification. The certifying agency may be the employer of the inspection personnel.

3.2 Class.

Class refers to functional reliability requirements of the material or part and implies a confidence level requirement for NDI. A high-reliability class may require redundant testing to assure adequate NDI confidence level.

3.3 Contracting agency.

A contractor, subcontractor, or Government agency procuring parts or services.

3.4 Contractor.

Organization having contractual responsibility to the Government.

3.5 Final inspection.

The last inspection of a part or component, usually just prior to final acceptance. This may occur during manufacturing if the component becomes uninspectable at some later stage in fabrication or if it is inspected just after some processing step and is not subject to reinspection after further processing.

3.6 Fracture or fatigue critical component.

Components, which are susceptible to crack initiation and propagation mechanism such as, established in MIL-STD-1530/JSSG-2006.

3.7 General NDI procedure.

An NDI procedure applicable to a general category of product such as plate, bar stock, etc.

3.8 Materials Review Board.

A government approved review of discrepant materials by authorized contractor Engineering and Quality Assurance personnel to determine whether materials can be returned to an acceptable state.

3.9 NDI procedure.

A procedure providing detail information on "how-to" perform a particular NDI technique (see 5.2.4).

3.10 NDI facility.

Organization responsible to the contractor and the subcontractor for nondestructive inspection services.

3.11 NDI process specification.

A specification defining the nondestructive testing requirements for equipment, materials, personnel, etc., for a particular NDI technique or for the testing of a particular product.

3.12 Nondestructive inspection.

Inspection processes or techniques intended to reveal conditions at or beneath the external surface of a part or material, which cannot be evaluated solely by visual examination with or without magnification or by dimensional measurement.

3.13 Special NDI procedures.

An NDI procedure to inspect designated components, which incorporates all processing criteria and may be used in lieu of company process specifications.

3.14 Subcontractors.

Organization responsible to the contractor for a portion of the contracted product.

3.15 Supplier.

The organization directly responsible for delivering a material, part or service to the Government, a contractor, or a subcontractor.

3.16 Qualification.

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

4 GENERAL REQUIREMENTS

4.1 Preparation of NDI plan.

The prime contractor should establish in writing an overall systems plan to assure adequate nondestructive inspection of structural components for which the prime contractor determines NDI acceptance is necessary in an aircraft or missile system.

4.1.1 Objective.

NDI detection capability and requirements should be considered by the prime contractor during system design as indicated in applicable design specifications. The objective of the NDI plan is to assure a level of nondestructive inspection capability and confidence consistent with the prime contractor’s design requirements.

4.1.2 Applicability.

This plan should include and be applicable to structural components as specified in the system specification and produced by the contractor, subcontractors, and suppliers under government contract.

4.1.3 Elements.

This plan should present the scheme for establishing the NDI requirements and implementing procedures to meet these requirements. It should include the means of:

a. Conducting a materials and parts classification.

b. Coordination of design requirements and NDI procedures.

c. Preparing new NDI procedures, as applicable.

d. Implementing NDI procedures.

4.1.4 Coordination.

This plan should be coordinated with the Aircraft Structural Integrity Plan (ASIP) when MIL-STD-1530 is used.

4.2 Materials and parts classification.

The contractor should classify all structural components according to the structural integrity requirements of applicable specifications. 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. Components should be classified as follows:

Class 1 - Components which are fracture or fatigue critical or components the single failure of which would cause significant danger to operating personnel or would result in an operational penalty. This includes loss of major components, loss of control, unintentional release, inability to release armament stores, or failure of weapon installation components.

Subclass 1A - A safety-of-flight component, the single failure of which would result in the loss of an aircraft or missile system.

Subclass 1B - Components subject to fracture and fatigue but not included in Subclass 1A.

Class 2 - All components not classified as Class 1 or its subclasses.

4.3 NDI Technical Requirements Review Board.

The contractor should utilize appropriate competent technical personnel to develop and implement the nondestructive inspection plan required to assure product design integrity. The government should retain the right of disapproval of the NDI requirements review system.

4.3.1 Purpose.

The NDI Requirements Review Board should determine the nondestructive inspection requirements for those components identified in accordance with (see 4.2) to assure that the most appropriate inspection technique(s) have been selected for the components being tested, and that the level of inspection is commensurate with the quality required.

5 DETAILED REQUIREMENTS

5.1 Documentation of the review.

Notation indicating NDI Board review and approval should be documented on the appropriate drawing for each Class 1 and designated Class 2 component identified in (see 4.2). Acceptable defect size, critical location and orientations should be referenced on the drawings or other released engineering specifications as appropriate. In all cases, the notation should consist of the signature of the contractor's authorized NDI Review Board representative.

5.1.1 Drawings.

The NDI Board review should be the basis for specification of NDI requirements on engineering production drawings. The NDI procedure number, process specification, or coding, thereto, will be referenced on the drawing.

5.2 Preparation of NDI procedures and process specifications.

5.2.1 Use of general NDI process specifications.

The use of process specifications such as those listed in (see 2.2.1 and 2.3) as sole controlling specifications is not permitted. These specifications reflect minimum quality requirements and, of necessity, are broad in scope.

5.2.2 Company NDI process specifications.

Company process specifications should be prepared incorporating the requirements of the referenced Government and Non-Government process specifications. In addition the company process 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.

5.2.2.1 Special NDI procedures.

Special procedures to inspect designated components may be used to supplement company process specifications. A contractor may elect to incorporate all processing criteria into each NDI procedure in lieu of generating process specifications.

5.2.2.2 NDI Standardization.

The company process specification should reflect procedures, acceptance criteria and records requirements to assure adequate quality assurance measures are being enforced to keep the NDI process in control. Basic process, equipment, materials, and technique variables as applicable should be monitored to assure adequate control of the inspection process.

5.2.2.3 Approval.

Company process specifications to be applied on aircraft and missile components will be coordinated with an authorized representative of the contractor and be subject to review by the Government as specified by the contract.

5.2.3 NDI Processes.

The following methods of nondestructive inspection are acceptable. Company process specifications may be used to supplement if needed.

a. Magnetic particle, in accordance with ASTM E1444.

b. Penetrant, in accordance with ASTM E1417.

c. Radiographic, in accordance with ASTM E1742 for Air Force applications.

d. Ultrasonic, in accordance with MIL-STD-2154 and ASTM E113 or E164, as applicable.

e. Eddy current, in accordance with MIL-STD-1537 and ASTM B244, E215, E309, E376, E426, or E1004, as applicable.

f. Thermal, in accordance with an approved company process specification.

g. Magnetic rubber in accordance with SAE-AMS-I-83387/AMS-2308.

h. Leak testing in accordance with ASTM E498 and ASTM E427, as applicable.

i. Temper etch inspection in accordance with MIL-STD-867.

j. Other methods, in accordance with an approved company process specification or other industry document.

5.2.4 NDI procedures.
NDI procedures will be provided for inspection of each part requiring NDI (see 5.1), except when special procedures are utilized (see 5.2.2.1). These procedures should be in accordance with the requirements of the component drawing, the company process specification, or other engineering requirements, and should contain the information listed below:

a. Specific part or drawing reference.

b. Specific part material; surface finish and part preparation, as applicable.

c. Manufacturer and model number of all instrumentation to be used, indicating optional equivalents, if desired.

d. Fixturing requirements, as applicable.

e. Manufacturer and identification of required inspection materials.

f. Reference to company process specification procedure if applicable.

g. Calibration/standardization procedure and reference standard identity as applicable.

h. Identification of areas to be inspected, detailed steps and level of inspector qualification required, an; acceptable defect criteria including location and fist critical orientation (based upon primary stress condition and direction) or equivalent drawing or specification reference for these criteria.

i. Identifiable precautions in use of the inspection procedure.

5.2.5 General NDI procedures.
General procedures or company process documents are acceptable for common product forms such as plate, bar stock, fasteners and tubular products.

5.3 Implementation of NDI procedures.

5.3.1 Personnel.
The contractor should have available records of certification for personnel conducting and interpreting nondestructive inspections in accordance with the applicable sections of NAS 410 - or other methods in accordance with the contract.

5.3.2 NDI reports.

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.

5.3.3 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.

5.3.4 NDI procedure verification.

All procedures and procedure families should be verified to assure repeatable defect sensitivity 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 sensitivity and confidence level. Redundant inspections may be utilized.

5.3.5 Removal of discontinuities.

When nondestructive inspection reveals discontinuities in excess of the level permitted by applicable drawings or documents, such discontinuities may be removed if permitted by applicable drawings and documents or authorized by Material Review Board action. Evidence of removal should be shown by reinspection.

5.3.5.1 Reinspection.

Reinspection for removal of discontinuities should be conducted using the same procedure. If a new procedure is still necessary to be used an addendum or temporary change to the original procedure as approved by Materials Review Board action should be prepared showing the essential features of the repair test.

5.3.6 Inspection scheduling.

5.3.6.1 Receiving inspections.

Incoming materials, parts or assemblies will meet the applicable engineering requirements.

5.3.6.2 Manufacturing and assembly.

Inspection should be performed as necessary during manufacture and assembly of components to assure acceptable final parts or assemblies.

a. When processing operations are involved which may adversely affect the quality of material or part, such as heat treating, forging, or cold forcing, NDI should be performed subsequent to such operations.

b. When processing operations are involved which may interfere with the kind(s) of inspection to be used, inspection should be performed prior to such operations.

5.3.7 Data and documentation.

Requirements expressed or implied herein concerning preparation, submittal, approval, availability, retention, or delivery of data or documentation should be applicable only to the extent provided in the contract.

5.4 Responsibility for NDI.

Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified in the NDI program. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements unless disapproved by the Government,

6 NOTES

6.1 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 production of aircraft and missile materials and parts.

6.2 Subject term (key word) listings.

a. Eddy Current
b. Magnetic Particle
c. Penetrant
d. Radiographic
e. Thermal
f. Ultrasonic

6.3 Changes from previous issues.

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

Custodians:
Army – MR
Navy – AS
Air Force – 11

Preparing Activity:
Air Force – 11

Project No. NDTI-0280

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies f documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waiver any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER	2. DOCUMENT DATE (YYMMDD)
3. DOCUMENT TITLE INSPECTION PROGRAM REQUIREMENTS, NONDESTRUCTIVE FOR AIRCRAFT AND MISSILE MATERIALS AND PARTS		
4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)		
5. REASON FOR RECOMMENDATION		
6. SUBMITTER		
a. NAME (Last, Middle Initial)	b. ORGANIZATION	
c. ADDRESS (include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) DSN *(If applicable)*	e. DATE SUBMITTED *(YYMMDD)*
8. PREPARING ACTIVITY		
a. NAME ASC/ENOI (AF-11)	b. TELEPHONE (Include Area Code) (1) Commercial (937)255-6281	(2) DSN 785-6281
c. ADDRESS *(Include Zip Code)* ASC/ENOI BLDG 560 2530 LOOP ROAD W WRIGHT-PATTERSON AFB OH 45433-7101	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Program Office (DLSC-LM) 8725 John J. Kingman Road, Suite 2533 Fort Belvoir, VA 22060-6221 Telephone (703) 767-6888 DSN 427-6888	

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