U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Development of a Nondestructive Inspection Program/Organization

Date: 9/20/13 **AC No:** 25-29

Initiated by: AFS-300 **Change:**

1. PURPOSE. This advisory circular (AC) provides guidance for the development of organizations and facilities performing nondestructive inspections (NDI). This material is neither mandatory nor regulatory in nature and does not constitute a regulation. It describes an acceptable means, but not the only means, for developing NDI facilities, as well as organizational and quality manuals. We, the Federal Aviation Administration (FAA), will consider other methods of demonstrating compliance that you may elect to present. We use the terms "must" and "will" in this AC only to ensure you correctly apply the recommendations of this particular method of compliance, if you choose to do so.

2. RELATED CFR REGULATIONS AND REFERENCES. See Appendix 1.

3. DEFINITIONS.

a. Certification. Written testimony of qualification. The employer issues a certification as a written statement (which may be in an electronic format) that an individual has met the requirements of an accepted standard.

b. Documentation. Written or printed record furnishing information or evidence; a legal or official record in paper or electronic form.

c. Experience. Actual performance or observation conducted in the work environment that results in acquiring knowledge and skills. Although experience is not obtained during classroom or laboratory training, it does include on-the-job training (OJT).

d. Method. One of the disciplines of NDIs or testing (e.g., radiography, ultrasonic, etc.). Each method consists of its own different techniques.

e. On-the-Job Training (OJT). Training, during work time, in learning instrument setup, equipment operation, recognition of indications, and interactions under the technical guidance of an experienced Level II, Level III, or other designated individual.

f. Organization. A corporation or other similar entity established to provide or receive NDI services.

g. Procedure. A detailed, written instruction for conducting NDIs or to qualify personnel.

h. Qualification. Demonstrated skill, training, knowledge, and experience required for personnel to perform the duties of a specific job.

i. Qualified Personnel. Personnel qualified to perform NDIs in accordance with, and covered by, provisions of industry-accepted standards.

j. Recertification/Recurrent Training. Scheduled, periodic classroom training, OJT, or a combination of both, with the intent of refreshing knowledge in a specific method. Requalification should occur, at a minimum, every 3 years. A qualified instructor (Level II, Level III, or other designated individual) should document and provide this type of training.

k. Training. An organized and documented program of activities designed to impart the knowledge and skills necessary for qualification. Training may be a mix of classroom training, laboratory training, programmed self-teaching, and OJT.

4. BACKGROUND.

a. Characteristics of NDI. NDIs are defined as inspections, tests, or evaluations that may be applied to a structure or component to determine its integrity, composition, electrical or thermal properties, or dimensions without changing any of these characteristics. Both manufacturing and maintenance require NDIs. Both the performance of tests and the interpretation of results require a quality organization, appropriate manuals, and trained and qualified individuals.

b. Elements of an NDI Organization. An NDI organization comprises five major elements: the organization, documentation, environment (which includes the facility), calibration, and training/qualification. A satisfactory NDI organization should have these elements represented in its underlying system. This AC also provides the minimum recommendations for the six primary NDI methods.

5. FIVE GENERAL ELEMENTS OF AN NDI ORGANIZATION.

a. Documentation. Documentation is a critical element in any organization that performs NDIs. Documentation includes such items as an organization's NDI manual, industry specifications (if referenced), a quality manual, and product-specific NDI manuals and procedures. Documentation also includes official records for training/qualification of NDI personnel, calibration records, and accomplishment of specific tasks.

b. Organization. The certificate holder should document the NDI organization in its manual, which should include an organizational chart that specifies qualifications of management personnel, as well as those of NDI personnel. The individual in charge of the NDI organization should, at a minimum, meet the requirements for Level II qualification in the methods used, per an industry-accepted standard. The NDI organization should include the following additional items in the organization-level manual:

(1) Procedures for shift changes to ensure communication of individual inspection item status. This, in turn, ensures completion of all steps and proper documentation.

(2) Procedures to identify when, what, how, and by whom specific tasks have been performed in a register, including:

(a) The date of the inspection.

(b) The identification of the inspected aircraft or component with associated task card reference.

(c) The inspection method carried out and the reference of the tool used.

(d) The identification of the person who performed the inspection.

(e) The result of the inspection or a reference to the inspection report.

(3) Procedures for inspection override authority, which includes qualifications of individuals who exercise this authority. These individuals should have qualifications that meet or exceed those of the original NDI inspector.

(4) Procedures detailing when, how, and by whom required vision examinations will be accomplished.

(5) Procedures for ensuring that outsourced vendors accomplish inspections in accordance with the certificate holder's program.

c. Environment. The environment in which NDI is performed can play a critical role in successfully accomplishing NDI tasks, encompassing human factors, and detecting defects. You should take into consideration the following environmental factors:

(1) The size of the NDI work area should be sufficient to perform required NDI tasks.

(2) There should be enough space to separate and store NDI equipment, standards, chemicals, and supplies. This would include an area for controlling and segregating nonconforming NDI equipment and materials.

(3) Appropriate manual procedures and other documentation should be readily accessible.

(4) Parts handling equipment should be adequate for the task and should be well maintained.

(5) Protection of parts should be a concern during handling and routing.

(6) Prevent metal-to-metal contact for critical parts.

(7) Procedures should be in place for controlling materials with expiration dates.

d. Calibration. You should document in your written program the procedures for calibrating tools, measuring devices, and testing equipment. The procedures should show how you ensure that NDI personnel only use calibrated tools when performing maintenance. This

written program should also define what equipment requires calibration, the specific interval and need for calibration, and the methods used for calibration. You should base this program on manufacturers' recommendations or engineering data justifying different intervals or methods. We would find this type of program acceptable.

e. Training. Qualified personnel are required to reliably perform NDIs.

(1) Both the performance of tests and the interpretation of results require skill and must be accomplished by trained personnel. They must know the applications and limitations of the various NDI methods used to locate defects in aircraft structure and components. Individuals who perform NDIs should be qualified in accordance with industry-accepted standards for qualification, certification, and training of NDI personnel. You may use other qualification documents when they are included in your NDI organization's approved manual. The applicable revision of the approved manual should be the latest, unless otherwise specified.

(2) You should base NDI qualification on an examination and/or other demonstration of proficiency, competence, and experience, as established in the relevant documents. The training program may be a mix of classroom training, laboratory training, programmed self-teaching, and OJT. The qualification program should also include a process for recertification/recurrent training to ensure continued qualification.

6. RECOMMENDATIONS PERTAINING TO THE SIX MOST COMMON NDI METHODS.

a. Visual Inspections. A visual inspection is the process of using the eye, either alone or with the help of various aids, as the sensing mechanism to determine the condition of a unit under inspection. A visual inspection may be a standalone inspection, but it is always an integral part of any NDI procedure. You should consider the following recommendations when developing and implementing a visual inspection program:

> **NOTE: While visual inspection is the most common inspection method, industry standards currently do not contain certification requirements for visual inspectors.**

(1) Human factors studies have proven that the successful completion of a visual inspection process depends on well-defined inspection procedures, including specific targets.

(2) Take precautionary steps to ensure that procedures that can adversely affect visual inspection (e.g., cleaning, painting, and disassembly) are not performed prior to the inspection process.

(3) Adequate lighting should be available for performing the detailed inspection.

(4) An NDI organization should define and utilize a training program for visual inspections.

(5) An NDI organization should require vision testing to ensure that NDI inspectors possess vision in at least one eye with good visual acuity.

(6) Job procedure task cards should specify the use of visual tools (e.g., flashlights, videoscopes/borescopes, calipers, micrometers, rulers, and magnifying devices) when required.

b. Liquid Penetrant Inspections. A liquid penetrant inspection is used to reveal surface-breaking cracks in solid, nonporous materials. While both fluorescent and nonfluorescent techniques are available, most aviation applications involve the use of fluorescent penetrants in a bulk process. A liquid penetrant inspection requires a series of steps involving precleaning, application of the penetrant, removal of excess penetrant, application of developer, examination under appropriate light, and postcleaning, if needed. You should consider the following recommendations when developing and implementing a program for a liquid penetrant inspection:

(1) Written procedures should define the liquid penetrant inspection process, including specific targets.

(2) Visible dye penetrant is not allowed on primary structures (i.e., transport category aircraft), nor on critical, rotating engine parts. Inspection of these parts uses a fluorescent penetrant and requires the use of an ultraviolet (UV)-A light of specific intensity.

(3) Gauges, thermometers, and timers used to control the process should be adequate, easily accessible, and utilized. This is critical from a human factors perspective in complying with calibration requirements.

(4) Follow proper dwell times, dry times, and temperatures per standard practices detailed in process specifications.

(5) The examining area should be free of interfering debris and stray fluorescent materials and white light reflectors.

(6) You should protect tanks from possible contamination.

(7) Procedures should be in place to ensure proper performance of precleaning and postcleaning. Also, cleaners who conduct this task should be trained in proper cleaning techniques.

(8) Use test panels to verify system performance. Clean and check the test panels for contamination.

(9) Process controls need to be in place for each step of the procedure. Check these process controls at regular intervals. Records of all process control checks must be retained.

c. Magnetic Particle Inspections. A magnetic particle inspection is used to find surface and near-surface defects in ferromagnetic materials. Fluorescent and nonfluorescent, wet and dry methods are available. However, most aviation applications involve using the wet fluorescent method in a batch processing system, which is the most sensitive. Parts are usually magnetized in at least two directions at right angles to each other, and demagnetization of the part is required. You should consider the following recommendations when developing and implementing a program for a magnetic particle inspection:

(1) Use the correct light type (visible or UV-A light) with intensity values checked and recorded per standard practices.

(2) Reference standards need to be available and used to measure magnetic field strength.

(3) Procedures should specify demagnetization of the part; check the parts for residual magnetization with a field meter indicator.

(4) Appropriate maintenance procedures for the inspection equipment should match the recommended maintenance procedures described in the equipment manuals or those required by the facility's calibration program.

(5) Measure bath concentration using established procedures and document the results. Check the suspension for contamination at established intervals per referenced specifications.

(6) There should be a documented cleaning process to follow during the preinspection and postinspection cleaning process. Records of all process control checks must be retained.

d. Eddy Current Inspections. An eddy current inspection is used to find surface and near-surface defects in electrically conductive materials. The aviation industry uses these inspections to detect certain defects (e.g., cracks and corrosion damage), verify thickness, and determine material characterization, such as metal sorting and heat treatment verification. The range of applications includes fuselage and structural inspection, engines, landing gear, and wheels. An eddy current inspection, which is the technique most often used after a visual inspection, involves intensive setup and calibration procedures with known reference standards of the same material as the part. Use probes of appropriate design and frequency. You should consider the following recommendations when developing and implementing a program for an eddy current inspection:

(1) Appropriate probes and instrumentation should be specified and used per the written procedure.

(2) Written procedures should specify how to set up the instrument using reference standards for calibration/standardization.

(3) The written procedure should specify the recommended templates and guides, if required.

(4) When using protective tape during the inspection to protect probes, also use it during setup and calibration.

(5) Qualified personnel should have proper training for the instruments/equipment (e.g., phased array and scanners) that they use.

(6) Written procedures should spell out frequency, probe type, scanning speed, and scanning directions.

(7) Written procedures should specify accept/reject criteria as well as calibration criteria for reference standard calibration.

(8) All reference standards should be traceable to required blueprints and specifications per the NDI organization's calibration program.

e. Ultrasonic Inspections. An ultrasonic inspection involves high-frequency sound waves from a transmitting transducer (single or multiple elements) being transmitted into or onto the surface of a part to interrogate the material. The sound waves travel on or through the material, then return to either the same transducer or a different transducer. An ultrasonic instrument displays the input and return signals. Differences between the input and output signals are analyzed to determine the flaws, defects, changes in thickness, and other material characteristics. Inspectors compare the received signals to the signals of a reference standard. Usually a couplant is used between the transducer and material. You should consider the following recommendations when developing and implementing a program for an ultrasonic inspection:

(1) Written procedures should specify appropriate transducers and couplants, both of which are essential elements to successful ultrasonic inspections.

(2) You must document and follow specific maintenance and instrument calibration procedures.

(3) Procedures need to ensure glycerin is not used on aluminum materials, as it may cause corrosion.

(4) Qualified personnel must have proper training for the instrument/equipment (e.g., phased array and scanners) that they use.

(5) Written procedures must spell out frequency/transducer type, scanning speed, and scanning direction, along with specific accept/reject criteria.

(6) All reference standards must be traceable to required blueprints and specifications.

f. Radiographic Inspections. A radiographic inspection uses radiation energy to detect variations in x-ray attenuation in the object under inspection and can detect inclusions, voids, cracks, and changes in geometry or material properties. The aviation industry typically uses two types of radiation energy: x-rays and gamma rays. X-rays are produced by electronic generators, while gamma rays are produced by isotope sources. A radiographic inspection can be used to inspect most materials for both surface and internal flaws, but the orientation of the flaw and source is critical. You should consider the following recommendations when developing and implementing a program for a radiographic inspection:

(1) Written procedures should define the x-ray inspection process, including specific equipment, recommended exposure times, spot focal distances, and accept/reject criteria.

(2) Required film types and other detectors should be available and properly handled/stored. Store film and film-processing chemicals in a climate-controlled environment, and procedures to store film should include a system to control expiration dates.

(3) Adequate darkroom facilities/equipment should be available, properly maintained, and cleaned.

(4) There should be a program in place to monitor radiation exposure (film badges, dosimeters, survey meters, etc.). State and Federal requirements control this program.

7. NDI ORGANIZATION POLICY AND PROCEDURES. A maintenance organization wishing to perform NDIs should document all policies and procedures pertaining to NDIs as part of its required manual system. These policies and procedures should include, at a minimum, the general elements of an organization outlined in paragraph 5 as well as any additional information specific to individual NDI methods.

8. REQUEST FOR INFORMATION. The Aircraft Maintenance Division (AFS-300) developed this AC. For information concerning this document, contact AFS-300 at 202-385-6399. Direct comments regarding this AC to:

Aircraft Maintenance Division, AFS-300
Federal Aviation Administration
950 L'Enfant Plaza, S.W., 5th Floor
Washington, DC 20024.

/s/
John S. Duncan
Director, Flight Standards Service

APPENDIX 1. RELATED CFR REGULATIONS AND REFERENCES

a. Title 14 of the Code of Federal Regulations (14 CFR).

(1) Part 23, § 23.621, Casting Factors.

(2) Part 25.

- Section 25.611, Accessibility Provisions.
- Section 25.621, Casting Factors.

(3) Part 27, § 27.621, Casting Factors.

(4) Part 29, § 29.621, Casting Factors.

(5) Part 121.

- Section 121.363, Responsibility for Airworthiness.
- Section 121.367, Maintenance, Preventive Maintenance, and Alteration Programs.
- Section 121.369, Manual Requirements.

(6) Part 135.

- Section 135.413, Responsibility for Airworthiness.
- Section 135.423, Maintenance, Preventive Maintenance, and Alteration Organization.
- Section 135.425, Maintenance, Preventive Maintenance, and Alteration Organization.
- Section 135.427, Manual Requirements.

(7) Part 145. § 145.61, Limited Ratings.

b. Federal Aviation Administration (FAA) Documents. Advisory Circular (AC) 65-31, Training, Qualification, and Certification of Nondestructive Inspection (NDI) Personnel.

c. Industry Documents.

- Recommended Practice SNT-TC-1A, Personnel Qualification and Certification in Nondestructive Testing.
- Airlines for America (A4A) Specification 105, Training and Qualifying Personnel in Nondestructive Testing Methods.
- AIA-NAS-410, Aerospace Industries Association, National Aerospace Standard, NAS Certification & Qualification of Nondestructive Test Personnel.

- prEN 4179, Aerospace Series, Qualification And Approval of Personnel for Non-destructive Testing.
- Canadian General Standards Board (CAN/CGSB)-48.9712, Non-destructive (NDT) Testing—Qualification and Certification of Personnel.

NOTE: Internationally, standards generated by other regulatory agencies and national certification programs have been and are considered acceptable to the FAA.