



Does ‘Visual Inspection’ and ‘Structural Health Monitoring’ Belong in NDT?

David Piotrowski– Senior Principal Engineer, Technology Development Engineering

Does Visual inspection and SHM belong in NDT?

- Depends who you ask!
 - Management
 - Engineering
 - Vendors
 - Regulators
 - OEMs
 - QA/QC



~40% of 2025 NDT Forum Agenda would be classified as 'not applicable to us'!

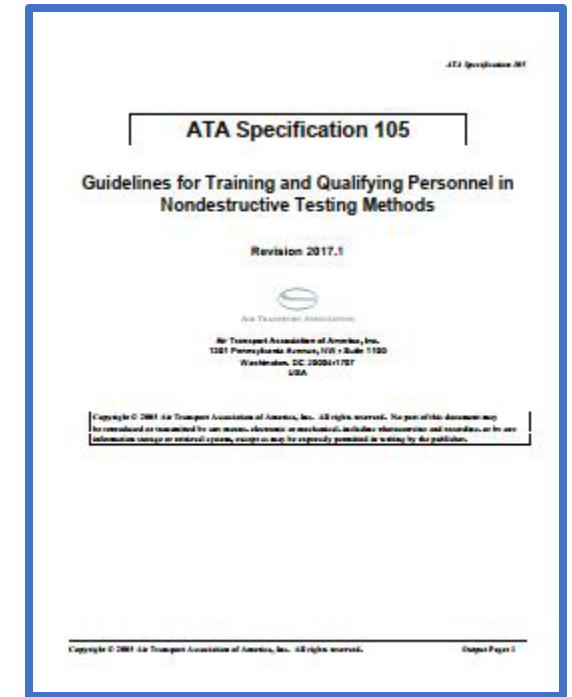
Outline

- NDT today => Qualified and Certified
- What do the documents say?
 - Why does ATA 105 even exist?
 - Conflicting guidance in Advisory Circulars?
 - Definitions
- Mic drop – 14CFR 25.571, POD & more
- Intrusion examples: Cameras(drone); Boros
 - Training and Qualifications
- Structural Health Monitoring (in-situ NDT)
 - Application hurdles – Training & Quals
 - NDT Manual incorporation



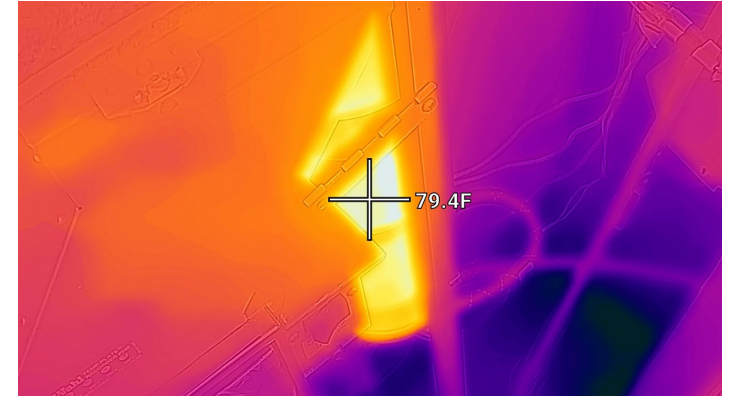
NDT Today (Civil Aviation)

- Big 5: PT, MT, UT, ET, RT
 - Honorable mentions: IR, Acoustic Emission, Shearography
- ATA 105 'Guidelines for Training and Qualifying Personnel in Nondestructive Testing Methods' is our governing document
 - No visual (because anyone can do visual!)
 - NDT is an instrumented, subjective/interpretive inspection
 - Specialized tasking with required training
- ATA 105 has some language around 'Emerging NDT' – but aimed at Level III qual
- Direct Reading instruments, ATA 105 exception
- NAS 410 has clear 'Direct read guidance', but written in the context of 'traditional methods' (BIG 5) with simplified instruments in mind (no interpretation)



NDT Today (Civil Aviation)

- Some Techniques used by 'non-NDT' personnel
 - Hardness
 - Some thickness measurements
- Fleet AMMs = Thermography for wiring, bleed leaks; Acoustic ultrasound for duct leaks
- Dent scanners (similar to Ramp Damage Checker i.e., NDT not called unless result is unacceptable)
- 'Remote' inspections



Challenges at Delta (from Alex)

1. Inspection personnel duties in Line and Check environment cover more than just NDT. *Shop inspection personnel tend to have greater NDT specialization dependent on shop throughputs.
2. Aircraft inspectors are required to do many tasks: e.g.: Visual Inspection, RII, Run/Taxi & Preflight after engine changes as well as certain levels of airframe block visits
3. These job duties all have their own training requirements that vie for resources and time spent on NDT
 - In some areas (line stations in particular) NDI activity and variety can be a challenge
4. Many inspectors are qualified in multiple NDT methods. Enormous variety of NDT tasks due to diverse airline fleet and large MRO.
5. Growing number of NDT tasks requiring very specialized equipment and training e.g. Ultrasonic Phased Array, Enhanced ET & UT

NDT Documents

- **Aerospace Sector**

Major
differences
in OJT
hours

- ATA Spec 105 (Recommended Practice) Airline Oriented
- NAS 410 / EN 4179 (Standard) Aerospace Industries Association

Primarily 'Big 5' methods

- **General Industry**

- ASNT SNT-TC-1A (Recommended Practice)
- ISO 9712 (Standard)

Include Visual Inspection

- **Civil Aviation Regulatory Advisory Material with NDT**

- AC 65-31, AC 25-29

Why does ATA 105 exist?

Existing standards, such the **American Society for Nondestructive Testing (ASNT)** Recommended Practice No. [SNT-TC-1A], National Aerospace Standard [NAS-410], and EN 4179, directly respond to the training and qualification of NDT personnel. In fact, the curriculum of individual member programs upon which this guideline was developed was primarily derived from such standards. However, **ATA NDT-specialists required a training guideline that was specifically tailored for airplane inspection.** A guideline that could be adopted among ATA-member training programs was needed.

The first draft of ATA Spec 105 was developed by NDT representatives from American Airlines, Eastern Airlines, Trans World Airlines, United Airlines and US Air. This draft was distributed among the other ATA members for comment and, following minor changes, was adopted in January 1990 by the ATA Engineering, Maintenance and Materiel Council (EMMC). Also approved by the EMMC was the formation of the ATA NDT Panel, which is responsible for review and approval of subsequent changes to this specification.

- Heartburn with OEMs that specify NAS410 Level II or III
- NADCAP => NAS410

} Regulatory pressures

AC 65-31, AC 25-29 Revisions



U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Training, Qualification, and
Certification of Nondestructive
Inspection Personnel

Date: 2/24/14

Initiated by: AFS-300

AC No: 65-31B

Change:

1. **PURPOSE.** This advisory circular (AC) contains recommendations for the experience, training, qualification, examination, and certification of nondestructive inspection (NDI) personnel for the inspection of aircraft, engines, propellers, accessories, and other aviation components. It recommends criteria for the qualification of personnel requiring appropriate knowledge of the technical principles underlying the nondestructive tests they perform. This document applies to those individuals directly responsible for technical adequacy of the NDI

AC 65-31: Training, Qualification, and Certification of Nondestructive Testing Personnel

AC 25-29: Development of a Nondestructive Inspection Program/Organization

certification of nondestructive personnel performing nondestructive testing (NDT) and NDI. Qualified personnel are required for reliable performance of NDT. 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 NDT methods used to locate defects in aircraft structure and components. Persons performing NDT, NDI, or nondestructive evaluations may be qualified in accordance with one or more of the standards listed in paragraph 6. Other qualification documents may be used when they are included in the approved manual for the organization specified in the contractual document between the user of the NDI services and their provider. The applicable revision should be the latest unless otherwise specified. Qualification should be based on an examination and/or other demonstration of proficiency, competence, and experience, as set forth in the relevant documents.

b. **Records and Documentation of Administrative Practices.** An organization's records should include a description of the details to be recorded for each qualified individual and



U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Development of a Nondestructive
Inspection Program/Organization

Date: 9/20/13

Initiated by: AFS-300

AC No: 25-29

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

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.

AC 65-31 vs AC 25-29

- AC 65-31 = 5 NDI Methods; AC 25-29 = 6 NDI Methods

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.

(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.

AC 65-31 vs AC 25-29

- We often do an *unwritten* visual inspection within each NDT procedure
 - Surface condition (cleaning)
 - Probe position
 - Fingernail
- UT doesn't include PAUT
- RT only includes film/darkroom; no DR/CT
- Desire to make both ACs consistent with NDT definitions
- AC 25-29 draft revision downgrades visual; clarifies 'NDT'
- Vision test is logical requirement



Federal Aviation
Administration

DOT/FAA/AM-05/21
Office of Aerospace Medicine
Washington, DC 20591

Medical Surveillance Programs for Aircraft Maintenance Personnel Performing Nondestructive Inspection and Testing

Van B. Nakagawara
Ronald W. Montgomery
Civil Aerospace Medical Institute
Federal Aviation Administration
Oklahoma City, OK 73125
Gregory W. Good
College of Optometry
The Ohio State University
Columbus, OH 43210

November 2005

Final Report

Visual Inspection Standards

- AC 43-204 Visual Inspection of Aircraft
 - No NDT
 - Cancelled 1997
 - Included borescope



U.S. Department
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Advisory Circular

TITLE 14 OF THE CODE OF FEDERAL REGULATIONS (14 CFR) GUIDANCE MATERIAL

Subject: ACCEPTABLE METHODS,
TECHNIQUES, AND PRACTICES—AIRCRAFT
INSPECTION AND REPAIR

Date: 9/8/98
Initiated by: AFS-640

AC No: 43.13-1B
Change: 1

5-15. GENERAL. (extract) *“Visual inspection is the oldest and most common form of NDI for aircraft. [...] This inspection procedure may be greatly enhanced by the use of appropriate combinations of magnifying instruments, borescopes, light sources, video scanners, and other devices discussed in this AC.”*

“The use of optical aids for visual inspections is beneficial and recommended. Optical aids magnify defects that cannot be seen by the unaided eye and also permit visual inspection in inaccessible areas”

AC 43-13-1B

CHAPTER 5. NONDESTRUCTIVE INSPECTION (NDI)

SECTION 1. GENERAL

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SECTION 2. VISUAL INSPECTION

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- a. Visual inspection
- b. Magnetic particle
- c. Penetrants
- d. Eddy current
- e. Radiography
- f. Ultrasonic
- g. Acoustic emission
- h. Thermography
- i. Holography
- j. Shearography
- k. Tap testing

- 3rd Advisory Circular with inconsistent guidance on NDT/Visual
 - Last revision 1998

MSG3 Definitions

A. GENERAL VISUAL INSPECTION (GVI)

A visual examination of an interior or exterior area, installation or assembly to detect obvious damage, failure or irregularity. This level of inspection is made from within touching distance, unless otherwise specified.

A mirror may be necessary to enhance visual access to all exposed surfaces in the inspection area.

This level of inspection is made under normally available lighting conditions such as daylight, hangar lighting, flashlight or drop-light and may require removal or opening of access panels or doors. Stands, ladders or platforms may be required to gain proximity to the area being checked.

Basic cleaning may be required to ensure appropriate visibility.

Zonal Inspection Program - General Visual Inspection - This inspection includes the GVI requirements as well as also assuring security of attachment and general condition of any system. This will include checking for evidence of degradation, such as corrosion, chafing of tubing, loose duct support, damage to wiring and connected EWIS, cable and pulley wear, fluid leaks, inadequate drainage, condition of panels and doors, and for other conditions which could lead to corrosion/damage. The extent of a zonal inspection is defined by the area listed, access required and the instructions provided with the task.



MSG3 Definitions

B. DETAILED INSPECTION (DET)

An intensive examination of a specific item, installation or assembly to detect damage, failure or irregularity. This could include tactile assessment in which a component or assembly can be checked for tightness/security.

Available lighting is normally supplemented with a direct source of good lighting at an intensity deemed appropriate.

Inspection aids such as mirrors and magnifying lenses, may be necessary.

Surface cleaning and elaborate access procedures may be required.

IP 122
removes
'visual' in
2012

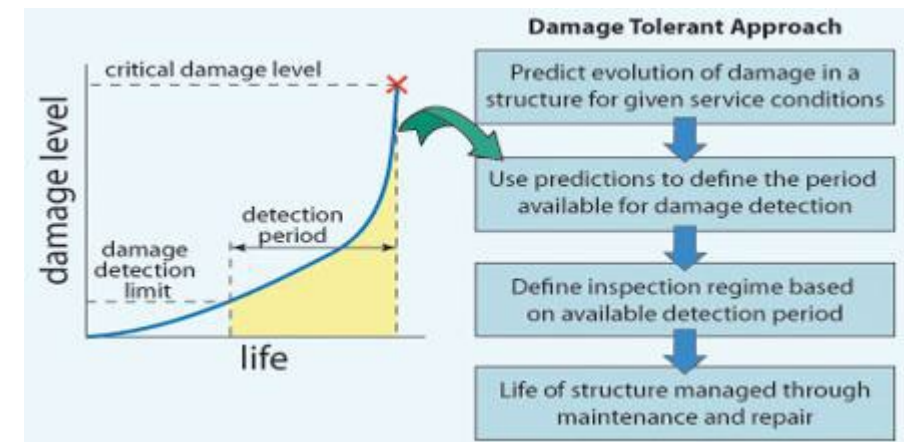
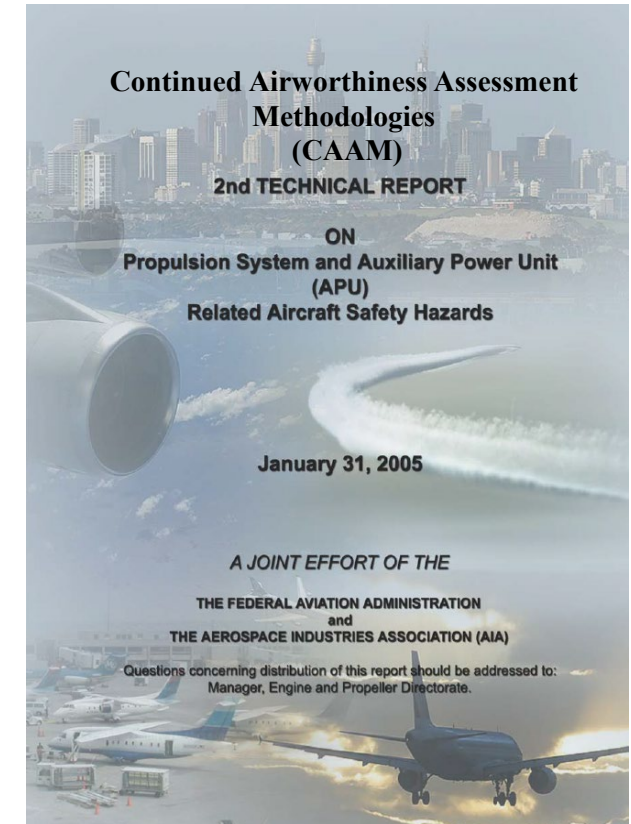
C. SPECIAL DETAILED INSPECTION (SDI)

An examination of a specific item, installation, or assembly making use of specialized inspection techniques such as Non Destructive Testing (NDT) and/or equipment (e.g. boroscope, videoscope, tap test) to detect damage, failure or irregularity. Intricate cleaning and substantial access or disassembly procedures may be required.

Classification of a task as an SDI does not define the required qualifications for the person performing the task.

Mic Drop!

- 25.571 implications (Fatigue & Damage Tolerance)
 - Criticality
 - Risk Management
 - Flaw sizes, Crack growth
 - Probability of Detection (POD) required
 - Specialized processes need to achieve POD
 - Training (Qualified and Certified) to ensure quality, confidence
 - Job Codes/classifications (Maintenance vs Inspection)
- Engines managed via CAAM Levels
 - Dictate level of inspection required



Intrusion example: Camera Based Inspections

- ‘Drone’ program accepted, incorporated into Delta Maintenance Program
 - Conditional GVI only (Lightning strikes)
- “As a certificate holder with a CAMP operating under 14 CFR Part 121 or 135, certificate holders can change their methods, techniques, and practices for maintenance if the changes are acceptable to the Administrator, reference 14 CFR part 43.13(c). The methods, techniques and practices used by an operator with a CAMP can be different than what is prescribed in a maintenance manual by an original equipment manufacturer. Certificate holders are responsible for their maintenance program, CAMP, in its entirety.”
- Equivalency? POD, Gage R&R
- Training & Qualifications – who signs off?
- Regulatory ‘Misalignment’ (RVI, GVR)
 - IMRBPB feedback – Zonal Inspections



**Federal Aviation
Administration**

- **Dated:** December 15, 2023
- **From:** AFS-300 to all Flight Standard Offices assigned safety oversight of certificate holders with a Continuous Airworthiness Maintenance Program (CAMP)
- **Subject:** FAA acceptance of Unmanned Aircraft System(s) (UAS) procedures for general visual inspections (GVI) of aircraft in accordance with 14 CFR Part 43.13(c)
- **Details:** “As a certificate holder with a CAMP operating under 14 CFR Part 121 or 135, certificate holders can change their methods, techniques, and practices for maintenance if the changes are acceptable to the Administrator, reference 14 CFR part 43.13(c). The methods, techniques and practices used by an operator with a CAMP can be different than what is prescribed in a maintenance manual by an original equipment manufacturer. Certificate holders are responsible for their maintenance program, CAMP, in its entirety.”

New Industry Committee – SAE G-38

- SAE G-38 Exterior Aircraft Inspection created
 - Does not 'fit' anywhere
 - Committee K – NDT Processes/Materials => Visual is not NDT
 - A4A NDT Network => Visual is not NDT
 - ASTM E07 – Emerging NDT = Visual is easy, doesn't need specification
- Already have existing guidance
 - Inconsistencies across industries
 - Inconsistencies across Advisory Circulars
 - Compliance trap



Intrusion example: Borescope

- Borescope is SDI
- Borescope is separate from NDT at most operators/MROs
 - Visual
- Engine OEM Quality Alert in 2025 - Borescope Inspector Qualification & Training
 - Did not inspect all areas
 - Incorrect BSI probe routings used
 - Misunderstood score marks versus spalling
 - Misunderstanding the applicable Tables of conditions
 - Not identifying corrosion properly
 - Incorrect focus tip used on new BSI equipment
- Work to develop a formal BSI inspection qualification program
 - Specific areas now recorded; videos/pictures sent to OEM (part of 'source qualification')
 - The OEM Expert will provide training to additional identified BSI inspection staff
 - The facility is responsible for monitoring ongoing proficiency and 'skill drift' on a documented periodic basis and takes appropriate actions when the proficiency level changes or drift occurs.
 - Audit from OEM

Other intrusion examples

- Etch Inspection (Visual, not NDT)

- ARP1923 Qualification and Certification of Etch Inspectors
 - AMS B Committee (Finishes, Processes & Fluids)

- Radiography

- ASTM E3168-20a Standard Practice for Determining Low-Contrast Visual Acuity of Radiographic Interpreters

FEATURE | **NDTTUTORIAL**

A NEW STANDARD FOR VISUAL ACUITY
TESTING OF RADIOGRAPHIC INTERPRETERS:
ASTM E3168

BY DAVID A. FRY, UWE ZSCHERPEL, AND THOMAS S. JONES

- ASTM E3327 Standard Guide for the Qualification and Control of the Assisted Defect Recognition of Digital Radiographic Data

What about SHM? NDT or not?

- B737 APB Y-chord AMOC almost complete
 - SB and B737 NDT Manual
- Many technologies flying as demo programs:
 - Comparative Vacuum Monitoring
 - PZT – Piezoelectric (Guided Ultrasonic Waves)
 - Eddy current array SHM
 - Phased Array UT SHM
 - Carbon nanotubes
 - Optical Fibers
 - Strain gages/Accelerometers
- Additional Boeing applications: B737 Pickle fork; Chem-mills
- Airbus proposed application: A320FAM FR16/20
- SHM Approval hurdle: Unwritten visual when doing NDT (access)
 - OEMS/regulators may have used this for credit for WFD, ALIs

Some technologies
clearly NDT; other
not clear

What about SHM? NDT or not?

- SHM in Boeing NDT Manuals as Part 5
- SHM Training & Qualification, Certification
 - Modelled after FAA Funded Composite Inspector Training
 - Testia offers (see Holger presentation)
 - FAA & ODA SHM Training Available
 - NDT Training for FAA now includes some SHM
 - Ken Working - OKC
- Equivalency? POD, Gage R&R
- Training & Qualifications – who signs off?

The screenshot shows the Boeing MyBoeingFleet Maintenance Documents website. The header includes the Boeing logo and navigation links for Maintenance Docs, Contact Us, and Help. Below the header, there's a section for 'Maintenance & Repair Documents' with a dropdown menu to 'Select a Product or Service...'. The main content area displays the '737 Non-Destructive Testing Manual' with document details: D6-37239, Revision: 15Nov2015, and Rev Level: 117. A search bar is present with a 'Submit' button and a 'Search Tips' link. To the right, there are links for 'Supplemental Videos' and 'Go Back'. Below this, a table lists the manual's sections, each with a checkbox and a link. A blue arrow points from a red box labeled 'Chapter 1 – Comparative Vacuum Monitoring' to the 'PART 05 – STRUCTURAL HEALTH MONITORING' entry in the table.

Non-Destructive Testing Manual	
Check boxes to add or remove from search. Check All Uncheck All	
☒	FRONT MATTER
☒	PART 01 - GENERAL
☒	PART 02 - X-RAY
☒	PART 04 - ULTRASONIC
☒	PART 05 – STRUCTURAL HEALTH MONITORING
☒	PART 06 - EDDY CURRENT
☒	PART 09 - THERMOGRAPHY
☒	PART 10 - VISUAL/OPTICAL

SHM Variations

- Conventionally scheduled tasks making use of AHM/SHM equipment
 - Go to aircraft at fixed intervals (Scheduled SHM or S-SHM)
 - Use equipment to determine condition; Act if necessary
- Conventional tasks scheduled by smart usage parameters (Operational)
 - Monitor usage of aircraft to determine time when action required
 - Perform conventional task (inspection, restore, discard) at that time
- Continuous monitoring of the structure/system
 - Continuously collect, process and analyze data; Act when required

This is in-situ NDT

Less clear; But same questions...

- What is criticality?
- Who is signing off?
- What is their qual?
- What is their training?

Summary

- New/changes to industry & new frontiers (Additive, AI)
 - Default documents, definitions may be questioned
- 25.571 implications (Fatigue & Damage Tolerance)
 - Criticality
 - Risk Management
 - Flaw sizes, Crack growth
 - Probability of Detection (POD) required
 - Specialized processes need to achieve POD
 - Training (Qualified and Certified) to ensure quality, confidence
 - Job Codes/classifications (Maintenance vs Inspection)
- Must safeguard ATA 105, and its reason for existing
- Must be engaged in industry discussions or changes will be forced upon us
- Level IIIs should examine each inspection for classification, requirements

