Liquid Penetrant Inspection
and
Human Factors

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Human Factors Good Practices in Fluorescent Penetrant Inspection
August 1999

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Background

National Transportation Safety Board (NTSB) report (N75B/AAR-98/01) concerning the failure of the inspection system to detect a crack in a JT8D engine hub.

- Inspection failure in engine maintenance can cause engine failure and take lives!
Human Factors Study

- Five site visits were made, four air carriers and one OEM repair station.
- Emphasis on Human Factors relating to the FPI process and critical rotating parts.
- Interaction was with inspection management, cleaners and inspectors.
- Provided out briefing at each facility.
Task description and analysis of each process:

- 1.0 Cleaning
- 2.0 Load/Transport in FPI
- 3.0 Apply Penetrant
- 4.0 Water Wash
- 5.0 Dry Part
- 6.0 Apply Developer and Air Clean
- 7.0 Read Part
Human Factors Study
Appendix 2

- Detailed Human Factors Good Practices for Each FPI Process:

Breaks down each of the seven processes into very specific **Good Practices** and detailed explanations as to **Why!**
Process Control

- Write measured values in process control logs, i.e. actual numbers versus a check mark.
- Allow good access room around inspection booths for inspectors and maintenance.
- Wash and/or discard gloves between processes.
- Reduce ambient white light levels where UV light is used.
- Maintain good communication between cleaning and FPI.
Cleaning

• Train cleaners in the critical nature of how their job relates to the total penetrant inspection process!!

• Train cleaners to recognize when a part is inadequately cleaned by providing good feedback from inspectors.

• Use clearly visible/audible timers for processes

• Design indicator dials to be easily read

• Ensure system for matching components and paperwork is simple and visible.

• Ensure parts handling systems are functional
• Provide custom hangers for parts.
• Ensure parts are marked for which process.
• Ensure part and paperwork are easily matched.
• Design handling system and hangers to ensure that chemicals can reach all parts of component.
Applying Penetrant

- Dip tanks need to be clearly labeled as to type of penetrant.
- Metal to metal contact should be eliminated using nonmetallic rollers.
- Timers need to be used and visible/audible
- Proper parts handling equipment is needed
Applying Penetrant

- Make spray gun easier to maneuver (balanced)
- Label all process tanks
- Design drum-to-spray gun connections so each gun can only be used with correct penetrant.
- Assure that the emulsifier spray gun is properly labeled and positioned.
- Perform spraying under UV light
Washing

- Design wash booths so that component can be washed at shoulder height.
- Wash under UV light with minimal white light.
- Provide air line and suction line.
Reading

- Provide timer for dark adaptation time, 3 – 5 minutes minimal for adaptation.
- Ensure objects in booth are not fluorescent.
- Provide clean surface for inspecting, soft, easy to clean.
- Ensure lights etc. can’t make metal to metal contact.
- Train inspectors in a consistent strategy of eye movement, search strategy and marking of locations to assure 100% inspection coverage.
TAM Panels

- Often used as quality assurance tool.
- Each penetrant sensitivity level should have a separate panel.
- There should be guidance in place for the care, cleaning and use of TAM Panels.
- What is done if a TAM Panel fails a check?
Contaminated TAM Panels

- Ask to have panels prepared for testing as they are normally, then:
  * View panels under black light looking for starbursts.
  * Look for blue fluoresces from oils or yellow-green glow from residual penetrant.
  * Apply developer and view under black light looking for starbursts.
- What happens if panels show contamination?
CONCLUSION

- TRAINING!! TRAINING!! TRAINING!!
- This includes EVERYBODY involved in the penetrant process!
- Simple method?
- Mistakes, positive and negative are costly.
NDI Check List

Prepared by: FAA Center for Aviation Systems Reliability

Iowa State University

Prepared for: Federal Aviation Administration Training Academy

Course # 22518

http://www.faa.gov/avr/afs/300/afs300a.html
Audit and Surveillance
Audit/Surveillance

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An organization should have a documented means of assuring that only “qualified” persons perform Nondestructive Inspections.

- Written records
- Computer records
Documentation

Sufficient documentation must be available and retained for each individual.

Records shall include:

- Education
- Experience
- Vision examination
- Training documentation
An organization performing Nondestructive Inspections should be audited to assure compliance with their accepted procedure for training, qualifying and certifying NDI personnel.
Five Elements for Evaluation

- Documentation
- Organization
- Environment
- Calibration
- Training
Documentation

Written procedures, processes, specifications and/or methods used by air operators or air agencies in the performance and control of NDI activities.

Is it CREDIBLE?
Organization

Relationship of NDI organization to management.

- Who is in charge?
- Who is consulted if questions arise?
- Who purchases equipment?
Environment

The general physical condition of the facility, e.g., housekeeping, storage, safety, consumable management, equipment.

- Is size of NDI area sufficient?
- Is parts handling equipment adequate?
- Is metal to metal contact prevented?
Calibration

Process by which an item is checked against a standard.

- Is there a procedure for calibrating inspection devices to certified standards?
- Are referenced standards properly labeled?
- Are calibration methods documented?
- Are setup verifications performed on all shifts?
Training

Methods used and records maintained to train and retrain NDI personnel.

- What is the criteria for training and certification?
- Are training methods identified in the manual/written practice?
- Is OJT recorded?
- Is there a procedure for rectification/decertification?
Methods Covered by Check List

- Visual
- Liquid Penetrant
- Magnetic Particle
- Eddy Current
- Ultrasound
- Radiography
Liquid Penetrant

- Has adequate training been provided?
- Are gauges, thermometers, and timers adequate?
- Are test panels used to verify system?
- Are calibration requirements followed and documented?
- Have cleaning personnel been trained?
Liquid Penetrant (Cont.)

- Is proper light intensity determined on a regular basis?
- Is the correct penetrant sensitivity being used?
- Are precleaning and post cleaning procedures in place?
- Are tanks protected from contaminates?
- Is the examining area free of interfering debris and “stray” fluorescent materials?
Specifications

- Two most common references for penetrant inspection are:
  * SAE AMS 2647B
  * ASTM E 1417

- Neither one allows visible (red) dye penetrants for aviation inspections!
Cleaning and Drying

- Is there standing water on parts waiting to be inspected?
- Is there dust and dirt on incoming parts?
- How does the inspector know the part is clean and dry enough to inspect?
- Are the cleaning personnel aware of how clean and dry parts need to be?
- Is there communication between inspectors and cleaners?
Conclusion

- Is the operation “credible”?
- Are they trying to be in compliance and not sure how to follow limited guidance?
- If the organization is trying to be in compliance, counsel, work with, provide references.