Developing a Phased Array Ultrasound Training Program

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Section 1

CURRENT TRAINING GUIDELINES
Current Training Guidelines

- 4A4 Specification 105  (Airlines 4 America)
- SNT-TC-1A  (ASNT, Personnel Qualification and Certification in Nondestructive Testing)

- First items we looked at:
  - Minimum Formal Training Hours
  - Minimum On-the-Job-Training / Experience
  - Training Course Outlines
Table 1-5.1 Minimum Formal Training Hour Requirements.

- Note 5, Training should be appropriate for the technology which is utilized (e.g. Time of Flight Diffraction, *Phased Array Ultrasonic* and Eddy Current Array *require additional training* and completion of Level I Eddy Current or Level I Ultrasonic training, as appropriate, as a prerequisite).
4A4 Specification 105

Table 1-5.2 Minimum Experience Requirements.

- Note 6, On-the-Job-Training should be appropriate for the technology which is utilized (e.g. Time of Flight Diffraction, Phased Array and Eddy Current Array require additional training and completion of Level I Eddy Current or Level I Ultrasonic experience, as appropriate, as a prerequisite).
Chapter 2. Training Outlines

Please refer to the Training Outlines found in The American Society for Nondestructive Testing, Inc. (ASNT document CP-105 for the following methods:
Table 6.3.1A: Recommended Initial Training and Experience Levels.

<table>
<thead>
<tr>
<th>Examination Method</th>
<th>NDT Level</th>
<th>Technique</th>
<th>Training Hours</th>
<th>Experience Minimum Hours in Method or Technique</th>
<th>Total Hours in NDT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultrasound</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>II</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phased Array</td>
<td>II</td>
<td>Time of Flight Diffraction</td>
<td>40</td>
<td>160</td>
<td>n/a</td>
</tr>
<tr>
<td>II</td>
<td>Phased Array</td>
<td>80</td>
<td>160</td>
<td></td>
<td>n/a</td>
</tr>
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</table>
Note: Recommended training course outlines are contained in ANSI/ASNT CP-105: ASNT Standard Topical Outlines for Qualification of Nondestructive Testing Personnel.
ANSI/ASNT CP-105

Phased Array Topical Course Outline

Phased Array (PA) Evaluation Course

1.0 Introduction
   1.1 Terminology of PA
   1.2 History of PA – Medical ultrasound etc...
   1.3 Responsibilities of Levels of Certification

2.0 Basic Principles of PA
   2.1 Review of ultrasonic wave theory: longitudinal and shear wave
   2.2 Introduction to PA concepts and theory

3.0 Equipment
   3.1 Computer-based systems
      3.1.1 Processors
      3.1.2 Control panel including input and output sockets
      3.1.3 Block Diagram showing basic internal circuit modules
      3.1.4 Multi-element/multi-channel configurations
      3.1.5 Portable battery operated versus full computer-based systems
Section 2

TRAIN THE TRAINER
PA-101 (Introduction to Phased Array Ultrasonics)
This *40 hour course* covers the basic theory and equipment operation associated with phased array and is taught using portable phased array systems. This class covers the first half of the 80 hours of phased array training required by SNT-TC-1A and CP-189 and includes overviews relative to all industries.

PA-102 (Advanced Phased Array for Weld Inspection)
This is a *40 hour class* devoted to teaching the necessary principles needed to perform manual and encoded line scans of welds using the phased array technique. This class covers the second half of the required 80 hours of phased array classroom training as required by SNT-TC-1A and CP-189.
B787 Damage and Repair Nondestructive Inspection Course (32 hours)

- Part 4, 51-00-06
  Damage Detection in BMS 8-276 (Guided A-scan)

- Part 4, 51-00-07
  Damage Detection in BMS 8-276 (C-scan)

- Part 4, 51-00-08
  Bonded Repair Inspection of BMS 8-276 (Guided A-scan)

- Part 4, 51-00-09
  Bonded Repair Inspection of BMS 8-276 (C-scan) with the Olympus Omniscan
➤ Olympus OmniScan Webinars
➤ Olympus Phased Array Ultrasound Handbooks
Section 3

OBTAINING THE NEW EQUIPMENT
ST8871 Step wedge for the B787 Composite Skin Inspections

TEK-9012 - Step wedge holder
Section 4

OBTAINING TRAINING PARTS
Boeing Miami

- Boeing provided a partial section of the B787 Tail Section Skin.
- We had the constant thickness pieces milled out with different depths to simulate delamination.
Section 4

OUR FIRST EXPERIENCES IN PHASED ARRAY
Lightning Strike on B787 Fuselage
Lightning Strike on 787 Window Frame
Double Scarf Repair
Section 5

CREATING A PAUT TRAINING COURSE FOR AVIATION
AAL PAUT Plan

- Phased Array Classroom Book Outline
- Developed Training Labs
- Developed PAUT Procedure Training Lessons
- Developed OmniScan Onboard Programs
- Complex Inspection Evaluation Process
Phased Array Classroom Book Outline

• Following the ANSI/ASNT CP-105 outline for Classroom book.
• Plus OmniScan Instrument & Software overview.
Training Labs

• Probe Sensitivity Calibration
• Beam Angle Verification
• Wedge Delay Calibration
• Encoder Calibration
• Time Corrected Gain
PAUT Procedure Training Lessons

• Boeing B787, Guided A-Scan Procedure
• Boeing B787, Laminate Damage Detection (C-Scan)
• Boeing B757, Scribe Line Inspection
• Airbus A330, Engine Pyramid PAUT Inspection
• Airbus Composite, Tape & Fabric, Damage Detection
4. Instrument Calibration
   A. Attach the encoder and linear array or the X-Y scanner and transducer as specified in the manufacturer’s instructions. Energize the instrument.
Procedure Training Lessons Example

B. If a file for damage inspection is in the instrument memory, open this file and follow the instructions below to make sure that the instrument is set correctly. If a file is not available, follow the calibration instructions in this procedure.

**NOTE:** Set up files are available for download in the Software Set Up Files section of the 787 Non-Destructive Testing Manual on the MyBoeingFleet web page.

![Diagram]

**Step A.** To Open a Program File, Press the Open Button (F8), Scroll through the menu selection with the Smart Knob and highlight the file to be opened. Next, press the Open Button (F7).
C. If the equipment includes an X-Y scanner, the inspection distance increments must be set. Set the scan resolution to 1/6 inch (4 mm) or smaller. With a single transducer, set the index resolution to 1/6 inch (4 mm) or smaller. With a linear array, set the index to the active array width.

The Boeing 787 Damage Detection program file has the Scan resolution set to 0.039” (1mm). Use the Scan Resolution to 0.039”
D. Set the pulser frequency to the frequency of your transducer.
E. If a receiver frequency can be adjusted, set it to broadband.
OmniScan Onboard Programs

- We have pre-programmed the OmniScan instruments with the basic settings.

- The Inspectors will need to Load the files and verify the Calibration steps.
Complex Inspection Evaluation Process

• For Composite Damage Detection and Repair Inspections the PAUT Inspector will be required to make scans and send images to a NDT Level III for evaluation.

OmniScan PC Software
Section 6

AA REQUIREMENTS FOR THE PAUT INSPECTOR
AAL Phased Array Requirements

- Meet the minimum requirements of a Level I Ultrasound Inspector
- Successfully complete the PAUT Classroom 40 hour Course
- OJT – Our current Jobs are incorporated within the 40 hour course
- Any new PAUT procedures will require additional training
PAUT Classroom in Action

****The End****