Aerospace Inspection Training

Course Curriculum Documents

Revised: September, 2015

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ULTRASONIC INSPECTION – LEVEL TWO

CURRICULUM FOR 80 HOUR COURSE

This curriculum meets or exceeds the examination syllabus for the certification of Level 2 personnel in Ultrasonic Inspection of Aerospace Materials, Components and Structures, to the current issue of PCN/AERO Appendix Z.1

Day 1 (Hours 1 to 4) **THEORY**	**CHAPTER 1: Generation and Detection of Ultrasonic Energy** The nature of sound Acoustics Transmission of sound Basic application to the detection of defects Electro-acoustic transducers Natural piezo-electric crystals Synthetically grown crystals Artificially produced piezo-electric materials Polarized PVDF film Curie temperature Piezo-electric transducer qualities Standing waves Resonant frequency **APPENDIX B: Reference Literature: Standards and Specifications** **APPENDIX E: Glossary of Terms**	
Day 1 (Hours 5 to 8) **PRACTICAL**	Hour 5 **Instructor Demo** Equipment calibration	Hours 6 to 8 **Student Practice** Practical Exercises (QRS 29)

HOMEWORK Chapter 1 issued

Day 2 (Hours 9 to 12) **THEORY**	**Review of Homework Chapter 1** **CHAPTER 2: Propagation of Ultrasonic Waves in Materials** Modes of propagation: Compressional, Shear, Surface, Plate (Lamb), Creeping **CHAPTER 3: Sound Distribution from a Crystal** Huygens Principle Near field Far field Beam Axis Sound attenuation in the far field Calculation of near field and beam spread Calculation of beam diameter Beam profile	
Day 2 (Hours 13 to 16) **PRACTICAL**	Hour 13 **Instructor Demo** Characteristics of Reflectors	Hours 14 to 16 **Student Practice** Practical Exercises (QRS 29)

HOMEWORK Chapters 2 & 3 issued

Day 3 (Hours 17 to 20) **THEORY**	**Review of Homework Chapters 2 & 3** **CHAPTER 4: Behaviour of Ultrasound at Material Interfaces (Reflection)** Reflection Characteristic acoustic impedance Significance of acoustic impedance variations Couplant Reflection and refraction of ultrasonic energy Reflection of incident compressional wave Reflection of incident shear wave Main applications in ultrasonic inspection Effect of beam spread Plate or wall thickness Applications Relative amplitudes and angles	
Day 3 (Hours 21 to 24) **PRACTICAL**	Hour 21 **Instructor Demo** Acoustic Impedance Beam spread	Hours 22 to 24 **Student Practice** Practical Exercises (QRS 29)

HOMEWORK Chapter 4 issued

Day 4 (Hours 25 to 28) **THEORY**	**Review of Homework Chapter 4** **CHAPTER 5: Behaviour of Ultrasound at Material Interfaces (Refraction)** Refraction of incident compressional wave First critical angle Second critical angle Refraction of incident shear wave Main applications in ultrasonic inspection Effect of temperature changes Skip distance Path length	
Day 3 (Hours 29 to 32) **PRACTICAL**	Hour 29 **Instructor Demo** Shear wave calibration Skip distance Path length	Hours 30 to 32 **Student Practice** Practical Exercises (QRS 29)

HOMEWORK Chapter 5 issued

Day 5 (Hours 33 to 36) **THEORY**	**Review of Homework Chapter 5** **CHAPTER 6: Probe Design, Operating Frequency and Identification** Probe design Probe design considerations Piezo-electric elements Probe operating frequency Natural resonant frequency Pulse length and backing members Q and bandwidth Sensitivity, acoustic impedance and resolving power Optimum sensitivity and resolution Probe performance Probe identification Probe types: compressional, shear, surface, lamb, delay, twin, water immersion and water irrigated, roller, focussed, paintbrush (mosaic) **CHAPTER 7: Flaw Detector Principles** Basic components of flaw detector, including: Cathode ray tube, pulse generator, prf, pulse transmitter, timebase sweep generator, amplifier, reject, gain, attenuators, signal processing, filters, gates, displays, A-scan presentation.	
Day 5 (Hours 37 to 40) **PRACTICAL**	Hour 37 **Instructor Demo** Flaw detector: PRF, filters, displays, damping, pulse length, reject.	Hours 38 to 40 **Student Practice** Practical Exercises (QRS 29)

HOMEWORK Chapters 6 & 7 issued

Day 6 (Hours 41 to 44) **THEORY**	**Review of Homework Chapter 6 & 7** **Review of Days 1 to 5** **CHAPTER 8: Practical Applications** Advantages, limitations and disadvantages of ultrasonics Factors affecting the sensitivity and resolution of an ultrasonic technique including: probe, test set, specimen, flaw Probe selection **APPENDIX A: Writing of Reports and Instructions**
Day 6 (Hours 45 to 48) **PRACTICAL**	Hours 45 to 48 **Student Practice** Writing of a Report and an Instruction Practical Exercises (QRS 29)

HOMEWORK Chapters 8 issued

Day 7 (Hours 49 to 52) **THEORY**	**Review of Homework Chapter 8** **Review of Reports and Instructions** **CHAPTER 9: Calibration and Performance Checking of Equipment** Calibration blocks Timebase calibration and linearity Amplifier linearity and calibration of gain control Probe frequency, pulse shape and duration Sensitivity and signal-to-noise ratio Dead zone Beam width Resolution Probe index, beam angle, squint Periodicity and acceptance criteria	
Day 7 (Hours 53 to 56) **PRACTICAL**	Hour 53 to 54 **Instructor Demo** Calibration and Performance Checking of Equipment	Hours 55 to 56 **Student Practice** Calibration and Performance Checking of Equipment Practical Exercises (QRS 29)

HOMEWORK Chapter 9 issued

Day 8 (Hours 57 to 60) **THEORY**	**Review of Homework Chapter 9** **CHAPTER 10: Immersion Techniques** Immersion systems Advantages and disadvantages of immersion testing Water gap Probes Scrubbers Back reflector method Effect of curvature on sound beam **CHAPTER 11: Defect Sizing** The Decibel Equivalent flat bottom hole (FBH) method FBH reference blocks Distance, gain, size (DGS) method 6 dB drop method 20 dB drop method Maximum amplitude method Distance amplitude correction (DAC) curves Reject	
Day 8 (Hours 61 to 64) **PRACTICAL**	Hour 61 to 62 **Instructor Demo** Immersion system Defect sizing	Hours 63 to 64 **Student Practice** Immersion system Defect sizing Practical Exercises (QRS 29)

HOMEWORK Chapters 10 & 11 issued

Day 9 (Hours 65 to 68) **THEORY**	**Review of Homework Chapters 10 & 11** **CHAPTER 12: Other Ultrasonic Methods** B-Scan C-Scan Resonance method Digital readout thickness gauges Acoustic emission
Day 9 (Hours 69 to 72) **PRACTICAL**	Hours 69 to 72 **Student Practice** Immersion system Defect sizing Practical Exercises (QRS 29)

HOMEWORK Chapter 12 issued

Day 10 (Hours 73 to 80) **THEORY**	**Review of Homework Chapters 12** **Review of Days 6 to 9** **APPENDIX C: Comparison of Methods** **Course Review** Theory Review Practical Review **End of Course Examination** **Debrief**
Day 10 (Hours 73 to 80) **PRACTICAL**	Hours 73 to 80 **Student Practice** Completion of Exercises as required Practical Exercises (QRS 29)

RADIOGRAPHIC INSPECTION – LEVEL TWO

CURRICULUM FOR 80 HOUR COURSE

This curriculum meets or exceeds the examination syllabus for the certification of Level 2 personnel in Radiographic Inspection of Aerospace Materials, Components and Structures, to the current issue of PCN/AERO Appendix Z.1

Day 1 (Hours 1 to 4) **THEORY**	**CHAPTER 1: Introduction** History What is radiation? Characteristics of radiation Applications of radiography Advantages of radiography Ionising Radiation Exposure of film Specimen Types of radiation X-ray equipment Principles of radiography Structure of radiographic film and film emulsion Film types and methods of film packing **CHAPTER 2: Photographic Aspects** The darkroom, darkroom equipment and lighting Processing unit Principles of development Developing, stopping, rinsing, fixing, washing and drying Methods of checking 'keeping' properties of radiographs Developer maintenance and replenishment Stop and fix tanks maintenance Density reduction Processing and handling faults (Artifacts) Identification of radiographs Description of film artifacts
Day 1 (Hours 5 to 8) **PRACTICAL**	Hour 5 **Radiation Safety Brief** Local Rules Hour 6 to 8 **Instructor Demo** Use of x-ray equipment Monitoring Production of radiograph Film processing Quality control procedures

HOMEWORK Chapters 1 & 2 issued

Day 2 (Hours 9 to 12) **THEORY**	**Review of Homework Chapters 1 & 2** **APPENDIX B: Reference Literature: Standards and Specifications** **APPENDIX F: Glossary of Terms** **CHAPTER 3: Sensitometry** Density, contrast, threshold difference, definition Characteristic curves and exposure factors Film types or grades and film speed Graininess (granularity) Film contrast **APPENDIX E: Exercise 1 – Production of film characteristic curves**
Day 2 (Hours 13 to 16) **PRACTICAL**	Hours 13 to 16 **Student Practice** Practical Exercise - APPENDIX E: Exercise 1 – Production of film characteristic curves (QRS 29)

HOMEWORK Chapter 3 issued

Day 3 (Hours 17 to 20) **THEORY**	**Review of Homework Chapter 3** **CHAPTER 4: Production of X-rays** Structure of the atom Atomic number and mass number The x-ray tube Focal spot size, spot sizes and variable spot size Benson line focus Operation X-ray continuous spectrum and the Quantum Limit Self rectified and constant potential equipment Characteristic radiation **CHAPTER 3: Sensitometry (continued)** Exposure charts X-ray exposure charts Producing an exposure chart **APPENDIX E: Exercise 2 – Production of an exposure chart in aluminium**
Day 3 (Hours 21 to 24) **PRACTICAL**	Hours 21 to 24 **Student Practice** Practical Exercises - APPENDIX E: Exercise 2 – Production of an exposure chart in aluminium (QRS 29)

HOMEWORK Chapter 4 issued

Day 4 (Hours 25 to 28) **THEORY**	**Review of Homework Chapter 4** **CHAPTER 5: Absorption and Scatter** Absorption and Scatter Photoelectric effect, rayleigh scattering, compton effect, pair production High speed electrons Half value layer Scattered radiation and reduction of scatter Intensifying screens, salt (fluorescent) screens, lead screens and fluoro-metallic screens Reciprocity Law Care of intensifying screens Cassettes and film holders **CHAPTER 6: Factors Governing Exposure** Kilovoltage, mA time, distance Film types Intensifying screens Processing conditions Filtration X-ray equipment Object being radiographed Equivalent absorption factor and equivalence charts
Day 3 (Hours 29 to 32) **PRACTICAL**	Hours 29 to 32 **Student Practice** Practical Exercises – Use of characteristic curves and exposure charts (QRS 29)

HOMEWORK Chapters 5 & 6 issued

Day 5 (Hours 33 to 36) **THEORY**	**Review of Homework Chapters 5 & 6** **CHAPTER 7: Factors Affecting Sensitivity** Sources of loss of sensitivity Contrast and definition Unsharpness – geometric, movement, film, inherent and screen Scattered radiation Subject and film contrast Characteristic curves Latitude Radiographic sensitivity Penetrameters (IQI) Image quality, image quality indicators, image quality value Selection and placement of image quality indicator Determination of image quality value Strip penetrameters (USA) Placement of penetrameters Comparators
Day 5 (Hours 37 to 40) **PRACTICAL**	Hours 37 to 40 **Student Practice** Practical Exercises – Use of characteristic curves and exposure charts Equivalent exposure factors Control of scatter Use of Image Quality Indicators (QRS 29)

HOMEWORK Chapter 7 issued

<table>
<tr><td>Day 6 (Hours 41 to 44)
THEORY</td><td colspan="2">**Review of Homework Chapter 7**

Review of Days 1 to 5

CHAPTER 8: Health Physics
Radiation hazard to human body
Radiation hazards and dosage
Roentgen, Gray, Quality Factor, Sievert
Bequerel and Exposure Rate Factor
Permissible and annual maximum radiation dose
Radiation effects – deterministic and stochastic
Protection against radiation – ALARP
Time, distance, shielding
Half Value Layer
Film badges, thermoluminescent dosimeters, quartz fibre dosimeters
Dose-rate meters (survey meters)

CHAPTER 9: Gamma Rays
Isotopes
Gamma radiation and Iridium 192
Decay and half life of radioactive isotopes
Gamma ray sources
Calculation of safe distances
Containers and equipment
Precautions – radioisotopes and emergency recovery action
Transportation of isotopes by road
Gamma Techniques
Advantages and disadvantages of using gamma isotopes
Isotope energy and equivalent energy
Exposure calculations</td></tr>
<tr><td>Day 6 (Hours 45 to 48)
PRACTICAL</td><td>Hour 45 **Instructor Demo**
Use of gamma equipment
Emergency recovery
(Dummy source only)</td><td>Hours 46 to 48 **Student Practice**
Practical Exercises:
Use of characteristic curves and exposure charts
Equivalent exposure factors
Control of scatter
Use of Image Quality Indicators (QRS 29)</td></tr>
</table>

HOMEWORK Chapters 8 & 9 issued

Day 7 (Hours 49 to 52) **THEORY**	**Review of Homework Chapters 8 & 9** **CHAPTER 10: Applied Radiography** Radiographic considerations Castings Cylinders – solid and hollow Welds, Assemblies Aircraft structures Techniques for ribs and frames including tube positioning, tubular members and thick section structure Multi-thickness and multi-film techniques Triangulation, defect location and thickness measurement **APPENDIX A: Writing of Reports and Instructions**
Day 7 (Hours 53 to 56) **PRACTICAL**	Hours 53 to 56 **Student Practice** APPENDIX A: Writing of Reports and Instructions Practical Exercises (QRS 29)

HOMEWORK Chapter 10 issued

Day 8 (Hours 57 to 60) **THEORY**	**Review of Homework Chapter 10** **Review of Reports and instructions** **CHAPTER 11: Radiographic Film Interpretation** Procedures, specifications, codes and reference standards Viewing and viewing conditions Film viewers (illuminators) Visual contrast Reading and qualifying the radiograph Film reading techniques Determining film quality Film identification Penetrameter clarity Film density Radiographic technique and coverage Processing Analysing the image Indications – false, non-relevant, relevant Flaw – types, geometry, size, location, distribution Correlate the information Terminology Marking the film Radiographic standards Report the results – written and verbal Actual condition and disposition
Day 8 (Hours 61 to 64) **PRACTICAL**	Hours 61 to 64 **Student Practice** Practical Exercises: Film Interpretation Use of characteristic curves and exposure charts Equivalent exposure factors Control of scatter Use of Image Quality Indicators (QRS 29)

HOMEWORK Chapter 11 issued

Day 9 (Hours 65 to 68) **THEORY**	**Review of Homework Chapter 11** **CHAPTER 12: Trends and Developments** Fluoroscopy Image intensifier and photo anode Fluorography, Radioscopy, Micro-radiography Radioscopic and advanced radioscopic systems Neutron radiography Accelerators – electron, betatron and linear **CHAPTER 13: Aerospace Sector Technology Supplement** Typical radiographic discontinuities Castings and casting defects Welds and weld defects Aluminium and magnesium welds Spot welds Service inspection – wear, corrosion, cracks and water in honeycomb Location of foreign objects Assembly inspections Paints, sealants and adhesives Radiographic standards Radiographic reference sources
Day 9 (Hours 69 to 72) **PRACTICAL**	Hours 69 to 72 **Student Practice** Practical Exercises: Film Interpretation Use of characteristic curves and exposure charts Equivalent exposure factors Control of scatter Use of Image Quality Indicators (QRS 29)

HOMEWORK Chapters 12 & 13 issued

Day 10 (Hours 73 to 80) **THEORY**	**Review of Homework Chapter 12 & 13** **Review of Days 6 to 9** **APPENDIX C: Comparison of Methods** **Course Review** Theory Review Practical Review **End of Course Examination** **Debrief**
Day 10 (Hours 73 to 80) **PRACTICAL**	Hours 73 to 80 **Student Practice** Completion of Exercises as required Practical Exercises (QRS 29)

PENETRANT INSPECTION – LEVEL TWO

CURRICULUM FOR 40 HOUR COURSE

This curriculum meets or exceeds the examination syllabus for the certification of Level 2 personnel in Penetrant Inspection of Aerospace Materials and Components, to the current issue of PCN/AERO Appendix Z. 1.

Day 1 (Hours 1 to 4) **THEORY**	**CHAPTER 1: Introduction to Penetrant Testing** Background history Capabilities of penetrant inspection Basic penetrant process Leak detection Reasons for selecting penetrant inspection Personnel requirements Equipment requirements Advantages, capabilities, disadvantages and limitations of pentrant inspection Safety precautions Types of penetrant Methods of removal Sensitivity Developers Classification of penetrant materials and processes Systems or family concept Basic penetrant processes Equipment requirements **CHAPTER 2: Inspection and Interpretation** Lighting and facilities Black light (UV-A) - sources, generation, hazards, fixtures and intensity requirements Ambient light restrictions Visible and UV-A light intensity measurement Black light intensity variables Inspection conditions **APPENDIX B: Reference Literature: Standards and Specifications** **APPENDIX E: Glossary of Terms**
Day 1 (Hours 5 to 8) **PRACTICAL**	Hour 5 to 8 **Instructor Demo** Fluorescent water-washable method Fluorescent hydrophilic remover method Dry powder developer - dust storm application Non-aqueous developer – aerosol application Use of PSM-5 panel – systems check Pre-use checks – UV-A lights, refractometer, dry powder contamination

HOMEWORK Chapter 1 issued

Day 2 (Hours 9 to 12) **THEORY**	**Review of Homework Chapter 1** **CHAPTER 2: Inspection and Interpretation (continued)** Inspection, interpretation and evaluation Classification of discontinuities Manufacturing and service induced discontinuities Evaluation of indications Photography of indications **CHAPTER 3: Pre-testing, Cleaning, Pre-cleaning and Post-cleaning** Pre-testing Cleaning Contaminants and soils Cleaning processes Mechanical working processes Post-cleaning after penetrant inspection **CHAPTER 4: Mechanism, Properties and Application of Penetrant** Requirements of a penetrant Mechanism of a penetrant Penetrant properties and sensitivity Application of penetrant Temperature limitations Penetrant dwell
Day 2 (Hours 13 to 16) **PRACTICAL**	Hours 13 to 16 **Student Practice** Use of PSM-5 panel – systems check Pre-use checks – UV-A lights, refractometer, dry powder contamination Practical Exercises (QRS 29)

HOMEWORK Chapters 2, 3 & 4 issued

Day 3 (Hours 17 to 20) **THEORY**	**Review of Homework Chapters 2, 3 & 4** **CHAPTER 5: Penetrant Removal** Factors influencing removability Flaw size and shape Type of penetrant Methods of removal Water-washable penetrant removal Lipophilic emulsifier and hydrophilic remover processes Comparison of lipophilic and hydrophilic Solvent removal **CHAPTER 6: Developers** Developer functions Mechanisms of developer action Slovent action Drying Dry, water soluble, water suspendable and solvent-based developers Comparison of developers
Day 3 (Hours 21 to 24) **PRACTICAL**	Hours 21 to 24 **Student Practice** Practical Exercises (QRS 29)

HOMEWORK Chapters 5 & 6 issued

Day 4 (Hours 25 to 29) **THEORY**	**Review of Homework Chapters 5 & 6** **CHAPTER 7: Materials and Process Control** New and in-use materials Causes of material degradation Frequency of materials verification and process control checks Materials control and process control testing Penetrant Systems Monitor (PSM) procedure and storage Systems performance testing In-process penetrant testing BS EN 3452:2000 Annex B process control tests **APPENDIX A: Writing of Reports and Instructions**
Day 3 (Hours 30 to 32) **PRACTICAL**	Hours 30 to 32 **Student Practice** APPENDIX A: Writing of Reports and Instructions Practical Exercises (QRS 29)

HOMEWORK Chapter 7 issued

Day 5 (Hours 33 to 40) **THEORY**	**Review of Homework Chapter 7** **Review of Writing of Reports and Instructions** **CHAPTER 8: Special Purpose Materials** Oxygen compatible penetrants Low sulphur, low chlorine penetrants High temperature penetrant materials Dye precipitation penetrant system,reversed fluorescence method, thixotropic penetrant, plastic film developers and filtered particle penetrants **APPENDIX C: Comparison of Methods** **Course Review** Theory Review Practical Review **End of Course Examination** **Debrief**
Day 5 **PRACTICAL**	Hours as available **Student Practice** Practical Exercises (QRS 29)

MAGNETIC PARTICLE INSPECTION – LEVEL TWO

CURRICULUM FOR 40 HOUR COURSE

This curriculum meets or exceeds the examination syllabus for the certification of Level 2 personnel in Magnetic Particle Inspection of Aerospace Materials and Components, to the current issue of PCN/AERO Appendix Z.1

Day 1 (Hours 1 to 4) **THEORY**	**Chapter 1: Introduction** Advantages of magnetic particle testing Significant disadvantages of magnetic particle testing Ferromagnetic and non-ferromagnetic materials Magnetic 'Domain' Theory Properties of the magnet, magnetic field and flux leakage **Chapter 2:Magnetizing Ferromagnetic Materials** Magnetic flow Current flow Direct and alternating current Magnetic properties of materials Formation of a Hysteresis loop **Appendix B: Reference Literature: Standards and Specifications** **Appendix E: Glossary of Terms**
Day 1 (Hours 5 to 8) **PRACTICAL**	Hour 5 to 8 **Instructor Demo** Use of magnetic particle bench units – AC and Half Wave DC Use of electromagnet – AC and DC modes Pre-use checks – UV-A lights, ink concentration, current flow and coil checks

HOMEWORK Chapters 1 & 2 issued

Day 2 (Hours 9 to 12) **THEORY**	**Review of Homework Chapters 1 & 2** **Chapter 3: Methods of Magnetisation** Circular magnetisation – current flow and threader bar Longitudinal magnetisation – coil Quick break technique Magnetic flow Induced current magnetisation Combined electric current magnetisation **Chapter 4: Assessing Amperage** Single phase alternating current Half wave and full wave rectification MagAmps Three phase full wave rectification Current flow, threader bar, coil Extenders Magnetic flow Prods Meter readings and current flow for various waveforms Relative depth of penetration Methods for assessing current
Day 2 (Hours 13 to 16) **PRACTICAL**	Hours 13 to 16 **Student Practice** Practical Exercises – assessing amperage and inspection (QRS 29)

HOMEWORK Chapters 3 & 4 issued

Day 3 (Hours 17 to 20) **THEORY**	**Review of Homework Chapters 3 & 4** **Chapter 5: Detecting Media** Properties of magnetic particle materials Dry powders Magnetic Inks (wet) Preparation and use of inks Particle content and content checks Standard test pieces Comparison and advantages of wet and dry methods Comparison of water and petroleum/oil suspension Magnetic rubber inspection **Chapter 6: Equipment** Magnetisation using electrical current DC surge Coils and threader bars Field and flux indicators (penetrameters) Hall effect and tangential field strength meter (gauss meter) Particle contents testing kit Ketos ring Lighting and facilities Black light (UV-A) - sources, generation, hazards, fixtures and intensity requirements Ambient light restrictions Visible light intensity measurement UV-A light intensity measurement Black light intensity variables Inspection conditions
Day 3 (Hours 21 to 24) **PRACTICAL**	Hours 21 to 24 **Student Practice** Practical Exercises – assessing amperage and inspection Pre-use checks – UV-A lights, ink concentration, current flow and coil checks (QRS 29)

HOMEWORK Chapters 5 & 6 issued

Day 4 (Hours 25 to 28) **THEORY**	**Review of Homework Chapters 5 & 6** **Chapter 7: Demagnetisation** Residual magnetisation Demagnetisation process Demagnetisation methods Precautions **Chapter 8: Interpretation of Indications** Indications Interpretation Viewing conditions Defect and spurious indications Changes in permeability and magnetic writing Confirmation of indications **Appendix A: Writing of Reports and Instructions**
Day 3 (Hours 29 to 32) **PRACTICAL**	Hours 29 to 32 **Student Practice** APPENDIX A: Writing of Reports and Instructions Practical Exercises (QRS 29)

HOMEWORK Chapters 7 & 8 issued

Day 5 (Hours 33 to 40) **THEORY**	**Review of Homework No. 4** **Review of Writing of Reports and Instructions** **Chapter 9: Practical Procedures** Inspection methods – continuous and residual Types of particles Surface preparation, degreasing and cleaning Initial demagnetisation Instruction application Residual magnetisation Inking and magnetisation Viewing and marking indications Assessment and recording flaws Demagnetisation Cleaning and surface protection **Appendix C: Comparison of Methods** **Course Review** Theory Review Practical Review **End of Course Examination** **Debrief**
Day 5 **PRACTICAL**	Hours as available **Student Practice** Practical Exercises (QRS 29)

THERMOGRAPHY INSPECTION – LEVEL TWO

CURRICULUM & TRAINING SYLLABUS FOR 60 HOUR COURSE

This combined curriculum and training syllabus satisfies the qualification requirements for the certification of Level 2 personnel in Thermographic Inspection of Aerospace Materials, Components and Structures, to the current issue of EN 4179:2009 and AIA NAS 410. The curriculum and training syllabus are adapted from PCN CM/GEN Appendix B issue 2.

Day 1 (Hours 1 to 4) **THEORY**	**CHAPTER 1: Introduction** Principles of IRT Applications of IRT **CHAPTER 2: The Infrared Camera** Infrared camera introduction Controlling the image Measurement functions Capturing an image Temperature range Optical focusing Image composition Storage devices	
Day 1 (Hours 5 to 8) **PRACTICAL**	Hour 5 **Instructor Demo**	Hours 6 to 8 **Student Practice**

Day 2 (Hours 9 to 12) **THEORY**	**Review of Chapters 1 & 2** **CHAPTER 3: Thermal Science** Heat and Temperature The electromagnetic spectrum Atmospheric Transmission Rules in thermal science Zeroth Law First Law of Thermodynamics Second Law of Thermodynamics Third Law of Thermodynamics
Day 2 (Hours 13 to 16) **PRACTICAL**	Hours 13 to 16 **Student Practice**

Day 3 (Hours 17 to 20) **THEORY**	**Review of Chapter 3** **CHAPTER 4: Heat Transfer** Heat transfer modes Conduction Thermal conductivity Fourier's Law of Heat Conduction Steady state and transient heat transfer Thermal capacity Volumetric heat capacity Thermal diffusivity Convection Newton's Law of Cooling Convection & wind effect Evaporation and condensation Latent heat	
Day 3 (Hours 21 to 24) **PRACTICAL**		

Day 4 (Hours 25 to 28) **THEORY**	**Review of Chapter 4** **CHAPTER 5: Radiation Heat Transfer** Radiation heat transfer Radiation energy exchange modes Incident radiation Incident radiation properties Reflections off specular and diffuse surfaces Exitant radiation Exitant radiation properties Emissivity and absorptivity Blackbodies Planck Curves Wiens Displacement Law Stefan-Boltzmann Law	
Day 3 (Hours 29 to 32) **PRACTICAL**		

Day 5 (Hours 33 to 36) **THEORY**	**Review of Chapter 5** **CHAPTER 6: Thermal Image Interpretation** Camera Principle Filters Visual versus infrared The thermal image FOV and IFOV Minimum resolvable temperature difference Apparent temperature Apparent temperature measurement Compensation Apparent temperature and emissivity Emissivity effects	
Day 5 (Hours 37 to 40) **PRACTICAL**		

Day 6 (Hours 41 to 44) **THEORY**	**Review of Chapter 6** **CHAPTER 7: Thermal Image Analysis** Thermal image analysis Thermal gradient Camera tools for pattern enhancement – thermal tuning Camera tools for pattern enhancement – isotherm Camera tools for pattern enhancement – palettes Misleading patterns Avoiding spot reflections **CHAPTER 8: Qualitative and Quantitative** Qualitative thermography Quantitative thermography Comparing qualitative and quantitative	
Day 6 (Hours 45 to 48) **PRACTICAL**		

Day 7 (Hours 49 to 52) **THEORY**	**Review of Chapters 7 & 8** **CHAPTER 9: Factors Influencing Emissivity** Materials Surface structure Geometry Angle Wavelength Temperature Reflected apparent temperature Solutions to emissivity problems
Day 7 (Hours 53 to 56) **PRACTICAL**	Hours 53 to 56 **Student Practice**

Day 8 (Hours 57 to 60) **THEORY**	**Review of Chapter 9** **CHAPTER 10: Measuring Emissivity** Estimating emissivity Measuring emissivity Typical emissivity values **CHAPTER 11: Camera Calibration** How the camera is calibrated Calibration check **CHAPTER 12: Thermographic Laws & Formulae** Fourier's Law of Heat Conduction Newton's Law of Cooling Radiation Properties of a General Object (Incident) Kirchoff's Law of Radiation Radiation Properties of a General Object (Exitant) Radiation Properties of an Opaque Object Stefan-Boltzmann Law Stefan-Boltzmann Law for Real Bodies Emissivity Temperature Scales **CHAPTER 13: Glossary of Terms** **APPENDIX A: Active and Passive Thermography** Active and passive thermography Flash thermography
Day 8 (Hours 61 to 64) **PRACTICAL**	

EDDY CURRENT INSPECTION – LEVEL TWO

CURRICULUM FOR 80 HOUR COURSE

This curriculum meets or exceeds the examination syllabus for the certification of Level 2 personnel in Eddy Current Inspection of Aerospace Materials, Components and Structures, to the current issue of PCN/AERO Appendix Z.1

Day 1 (Hours 1 to 4) **THEORY**	**CHAPTER 1: Basic Principles of Eddy Currents** Applications Advantages Limitations Eddy currents Alternating current in a coil Magnetic coupling Production of eddy currents Lenz's Law Eddy current inspection Calibration of high frequency meter instruments Inspection using high frequency meter instruments Calibration of high frequency phase display instruments Inspection using high frequency phase display instruments **CHAPTER 2: Factors affecting Eddy Currents** Conductivity Permeability Ferrous, non-ferrous, paramagnetic and diamagnetic materials Frequency Geometry Proximity Discontinuities Probe handling Depth of penetration **APPENDIX B: Reference Literature: Standards and Specifications** **APPENDIX E: Glossary of Terms**	
Day 1 (Hours 5 to 8) **PRACTICAL**	Hour 5 **Instructor Demo** Impedance Bridge Instrument Conductivity Meter	Hours 6 to 8 **Student Practice** Impedance Bridge Instrument Conductivity Meter Practical Exercises (QRS 29)

HOMEWORK Chapters 1 & 2 issued

Day 2 (Hours 9 to 12) **THEORY**	**Review of Homework Chapters 1 & 2** **CHAPTER 3: Electrical Theory** Direct current (DC) Direct current theory Alternating current (AC) theory
Day 2 (Hours 13 to 16) **PRACTICAL**	Hours 13 to 16 **Student Practice** Impedance Bridge Instrument Conductivity Meter Practical Exercises (QRS 29)

HOMEWORK Chapter 3 issued

Day 3 (Hours 17 to 20) **THEORY**	**Review of Homework Chapter 3** **CHAPTER 4: Phase Analysis** Current/Voltage phase relationship Conductivity changes Dimensional changes Change in frequency Change in permeability Changes in probes Choice of operating point and f/fg Characteristic frequency	
Day 3 (Hours 21 to 24) **PRACTICAL**	Hour 21 **Instructor Demo** Impedance Plane Instrument High Frequency Application	Hours 22 to 24 **Student Practice** Impedance Plane Instrument High Frequency Application Practical Exercises (QRS 29)

HOMEWORK Chapter 4 issued

Day 4 (Hours 25 to 28) **THEORY**	**Review of Homework Chapter 4** **Review of Chapter 4: Phase Analysis** **CHAPTER 5: Practical Impedance Plane Analysis** Reviewing impedance plane fundamentals Presentation of conductivity Lift-Off (coating thickness measurement) Selection of frequency Corrosion and cracks in subsurface layers Location of 2nd layer corrosion or cracking Change of probe Change of permeability	
Day 3 (Hours 29 to 32) **PRACTICAL**	Hour 29 **Instructor Demo** Impedance Plane Instrument Conductivity Measurement	Hours 30 to 32 **Student Practice** Impedance Plane Instrument High Frequency Application Conductivity Measurement Practical Exercises (QRS 29)

HOMEWORK Chapters 5 issued

Day 5 (Hours 33 to 36) **THEORY**	**Review of Homework Chapter 5** **CHAPTER 6: Coils and Probes** Surface coils High frequency surface probes Low frequency surface probes Encircling coils Internal coils Fill factor Coil magnetic fields Ferrite core probes Air core probes Shielded coil probes Saturation probes Factors effecting eddy current probe performance **CHAPTER 7: Coil Arrangement** Single absolute coil Double absolute coil Single differential coil Double differential coil Self comparative system External comparative system	
Day 5 (Hours 37 to 40) **PRACTICAL**	Hour 37 **Instructor Demo** Impedance Plane Instrument Differential Coils High Frequency Application	Hours 38 to 40 **Student Practice** Impedance Plane Instrument High Frequency Application Differential Coils Practical Exercises (QRS 29)

HOMEWORK Chapters 6 & 7 issued

Day 6 (Hours 41 to 44) **THEORY**	**Review of Homework Chapters 6 & 7** **Review of Days 1 to 5** **CHAPTER 8: Practical Eddy Currents** High frequency crack detectors (surface faults) Hole inspection Low frequency tests sets (variable frequency) Corrosion detection-subsurface Crack detection-subsurface	
Day 6 (Hours 45 to 48) **PRACTICAL**	Hour 45 to 46 **Instructor Demo** Impedance Plane Instrument Low Frequency Application Corrosion Detection-subsurface Crack Detection-subsurface	Hours 47 to 48 **Student Practice** Impedance Plane Instrument Low Frequency Application Corrosion Detection-subsurface Crack Detection-subsurface Practical Exercises (QRS 29)

HOMEWORK Chapter 8 issued

Day 7 (Hours 49 to 52) **THEORY**	**Review of Homework Chapter 8** **APPENDIX A: Writing of Reports and Instructions**
Day 7 (Hours 53 to 56) **PRACTICAL**	Hours 53 to 56 **Student Practice** Writing of a report and an instruction Practical Exercises (QRS 29)

Day 8 (Hours 57 to 60) **THEORY**	**Review of Reports and Instructions** **CHAPTER 9: Use of Filters** Modulation Eddy current instrument filter usage Filters Selection of frequency **CHAPTER 10: Bolt And Fastener Hole Inspection using Rotating 'Spinning' Probe Equipment** Advantages Probes Displays – time-base and spot Interpretation Effect of frequency Calibration blocks Calibration Inspection Spinning probes	
Day 8 (Hours 61 to 64) **PRACTICAL**	Hour 61 to 62 **Instructor Demo** Impedance Plane Instrument Use of Filters Bolt And Fastener Hole Inspection	Hours 63 to 64 **Student Practice** Impedance Plane Instrument Use of Filters Bolt And Fastener Hole Inspection Practical Exercises (QRS 29)

HOMEWORK Chapters 9 & 10 issued

Day 9 (Hours 65 to 68) **THEORY**	**Review of Homework Chapters 9 & 10** **CHAPTER 11: Dual Frequency Inspection** Overview of dual frequency inspection Reference standard Principle of dual frequency calibration Choice of Frequency 1 and Frequency 2 Practical calibration **CHAPTER 12: Basic Test Set Design** Bridge circuits Bridge circuits with resonant probes Pure impedance measuring circuits Phase comparison circuits Warning devices Impedance plane analysis display instruments Cathode Ray Tube	
Day 9 (Hours 69 to 72) **PRACTICAL**	Hour 69 **Instructor Demo** Impedance Plane Instrument Dual Frequency Calibration Dual Frequency Inspection	Hours 70 to 72 **Student Practice** Impedance Plane Instrument Dual Frequency Calibration Dual Frequency Inspection Practical Exercises (QRS 29)

HOMEWORK Chapters 11 & 12 issued

Day 10 (Hours 73 to 80) **THEORY**	**Review of Homework Chapters 11 & 12** **Review of Days 6 to 9** **APPENDIX C: Comparison of Methods** **Course Review** Theory Review Practical Review **End of Course Examination** **Debrief**
Day 10 (Hours 73 to 80) **PRACTICAL**	Hours 73 to 80 **Student Practice** Impedance Plane Instrument Completion of Exercises as required Practical Exercises (QRS 29)